Planetary Boundaries in Post-2015 Sustainable Development Goals: Safeguarding Ecological Integrity as a Priority Goal and a *Grundnorm* of International Law

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Executive Summary

The concept of sustainable development has not been effective in guiding human societies towards a sustainable future. Much of our attention has been on 'development' than 'sustainability', while human societies have pushed a number of Earth's subsystems beyond their critical thresholds. Humanity is now entering an unknown geological epoch named the Anthropocene, which is unlikely to be conducive to human development. There is a clear need to revise and clarify the concept of sustainable development in light of the latest Earth system science. The current global debate on post-2015 Sustainable Development Goals has opened a window of opportunity in this regard.

This discussion paper aimed to outline and address some of the critical challenges for creating effective legal governance of planetary boundaries, a nexus of biophysical preconditions that are essential for long-term sustainable development. The key argument we make is that the international community must agree on *the protection of Earth's life-support system as a single, overall priority for post-2015 Sustainable Development Goals*. We support our case using empirical examples of different goal-systems, including the Millennium Development Goals, the system of multilateral environmental agreements, and the Resource Management Act 1991 of New Zealand.

In search of legal content for the envisaged priority goal, we explored existing international legal documents, and identified the notion of ecological integrity as an emerging common denominator. In this paper, we define integrity as the identity of a system maintained by resilience or robustness. At the planetary scale, this notion of ecological integrity can be translated into *the integrity of Earth's life-support system*, which can be *measured and monitored using control variables associated with interlinked planetary boundaries*. In general terms, the planetary integrity is maintained if the Earth system stays in the Holocene, but it is lost if human-induced stress reduces the resilience or robustness and Earth undergoes a regime shift into the Anthropocene. Recognizing the integrity of Earth's life-support system as a priority goal in post-2015 SDGs would, in principle, give effect to the planetary boundaries framework in multi-level decision-making processes, including decisions of the treaty bodies of multilateral environmental agreements.

For effective implementation at the international level, we propose that this priority goal of safeguarding the integrity of Earth's life-support system should be recognized as an

environmental *grundnorm* of international law. A *grundnorm* is defined here as a basic norm to bind any governmental power. The recognition of a new *grundnorm* would require *an eco-constitutional moment in global governance*, by adopting an international environmental constitution in the form of, for example, the Draft International Covenant on Environment and Development complemented by the Earth Charter. Furthermore, we suggest that the United Nations Environment Programme needs to be empowered with a mandate to uphold this new constitutional framework, and act as a trustee and legal guardian for the global commons and common concerns of humankind that are recognized under international law.

1 Introduction

The neoclassical economic model assumes a free and infinite supply of natural resources, hence failing to recognize the limits to economic growth imposed by a finite environmental carrying capacity (Daly 1992; Costanza et al. 1997; Daly and Farley 2010). Despite the fact that the underlying assumption defies the fundamental laws of physics such as the second law of thermodynamics (Rees 1996; Norde 1997; Ayres 1998; Kay et al. 1999; Muys 2013), they have formed the basis of the contemporary sustainable development discourse. For example, the authors of the Brundtland Report did not believe in the absolute ecological limits, but only relative limits imposed by "the present state of technology and social organization on environmental resources" (World Commission on Environment and Development 1987, para. 27; see also Mauerhofer 2008). For the past several decades, human societies have denied the biophysical reality and focused on finding convenient ways to sustain economic growth from a technocentric worldview.

Against this backdrop, the international community adopted the Millennium Declaration at the Millennium Summit in 2000. A set of eight Millennium Development Goals (MDGs) and related targets and indicators were then identified by the United Nations (UN) Secretariat as a blueprint for the next fifteen years. The MDGs were mostly development-oriented, specifically targeting poverty-related issues in developing countries for creating "an environment … which is conducive to development and the elimination of poverty" (Millennium Declaration 2000). MDG 7 on ensuring environmental sustainability was the only environmental goal of the eight, but it did not set absolute limits on the amount of environmental impact that human societies may exert. Among the four targets within MDG 7, only two were genuinely about environmental conditions (Targets 7.A and 7.B) while the other two were about human basic needs (Targets 7.C and 7.D).[4]

However, in light of the worsening global environmental conditions (Millennium Ecosystem Assessment 2005; Intergovernmental Panel on Climate Change 2007; United Nations Environment Programme 2012), there is a general consensus on the need for post-2015

[4] Target 7.A: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources; Target 7.B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss; Target 7.C: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation; Target 7.D: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers.

Sustainable Development Goals (SDGs) to pay far greater attention to the environment than the MDGs did (Brito 2012; Leach et al. 2012; Griggs et al. 2013). In particular, there is an emerging consensus within the scientific community that environmental boundaries for planetary well-being need to be incorporated in post-2015 SDGs (Griggs et al. 2013; Rockström and Sachs 2013). Human societies have already pushed a number of Earth-system processes beyond their critical thresholds (Lenton et al. 2008; Rockström et al. 2009; Schellnhuber et al. 2009), and we are now entering a new geological epoch named the Anthropocene (Crutzen 2002; Steffen et al. 2007). According to the best available scientific knowledge, the Anthropocene will be different from the Holocene, which has been conducive to human prosperity. The environmental conditions of the Anthropocene are very likely to be catastrophic to the development and resilience of human societies and economies (Steffen et al. 2004; Steffen et al. 2007). Our best bet is, therefore, to maintain the Holocene state by avoiding disruptive global environmental change (Rockström et al. 2009; Folke et al. 2011; Steffen et al. 2011).

To that end, a new set of SDGs must fill the 'ecological' gap in the MDGs and ensure human societies to operate within the safe operating space defined by planetary boundaries. But, of course, the question is *how* to introduce the idea of planetary biophysical limits to international environmental law, or more broadly, the governance of states and corporations (e.g., Vidas 2011; Kim and Bosselmann 2013; Whiteman et al. 2013). A number of innovative and transformative institutional reform options already exist (e.g., Walker et al. 2009; Steffen et al. 2011; Biermann et al. 2012; Bosselmann et al. 2012; Galaz et al. 2012; Kanie et al. 2012; Rockström and Sachs 2013). In this paper, we put forward a novel idea of organizing post-2015 SDGs as a nested system of goals, targets, and indicators with a single priority goal at the apex. We propose that this goal should be formulated in terms of planetary boundaries and ecological integrity, a common denominator concept that can be found widely in the existing international environmental instruments (Kim and Bosselmann 2013).

The paper proceeds in the following format. We start by briefly describing the science and ethics of planetary boundaries, and their implications for SDGs. We argue that we need to redefine sustainable development and agree on a single priority goal in the context of SDGs. In searching for what this goal might be, we arrive at the multifaceted concept of ecological integrity (De Leo and Levin 1997). We outline how it has been expressed in international law, define what it means in terms of planetary boundaries, and discuss practical governance

implications. We then explore how the priority goal, as defined in terms of planetary integrity and boundaries, might be achieved through the rule of law. We pay particular attention to a specific form of legal principle called *grundnorm*, and how it could be institutionalized and implemented within the UN system.

2 Planetary Boundaries: The Preconditions for Sustainable Development

This section reviews the scientific and ethical underpinnings of the planetary boundaries framework.

2.1 Science

Building on decades of scientific research on the limits to growth (Meadows et al. 1972), safe minimum standards (Ciriacy-Wantrup 1952; Bishop 1978; Crowards 1998), and tolerable windows (Petschel-Held et al. 1999), a group of environmental scientists have recently identified nine planetary biophysical subsystems or processes that determine the self-regulating capacity of the Earth system (Rockström et al. 2009; see also Steffen et al. 2004; Lenton et al. 2008; Schellnhuber 2009; Reid et al. 2010). The identified Earth system processes are climate change, biodiversity loss, interference with the nitrogen and phosphorus cycles, stratospheric ozone depletion, ocean acidification, global freshwater use, changes in land use, chemical pollution, and atmospheric aerosol loading. The scientists argue that each subsystem or process has a certain 'boundary' which, if crossed, may trigger non-linear changes in the functioning of the Earth system. As these boundaries are tightly coupled with each other, one issue alone cannot be managed in isolation. Collectively, therefore, the planetary boundaries define the safe operating space for humanity with respect to the Earth system.

The planetary boundaries framework is grounded on resilience theory (Folke et al. 2002; Walker et al. 2004; Walker and Salt 2006; Folke 2006), in which the Earth system *in toto* is considered as a complex adaptive, social-ecological system. A social-ecological system is "a system in which people depend on resources provided by ecosystems, and ecosystem dynamics are influenced, to varying degrees, by human activities" (Chapin et al. 2009: 2).

The characterization as a complex adaptive system implies that the Earth system self-organizes within certain limits (Holland 1995; Levin 1998). Within the limits, the system is resilient, that is, it has "the capacity … to absorb shocks while maintaining function" (Folke et al. 2002; Holling 1986). When these limits are exceeded the system no longer tends to recover towards its current 'identity', but instead tends towards some different configuration (Steffen et al. 2004; Walker and Salt 2006).

Such a regime shift is arguably what has been happening at the planetary scale since the Industrial Revolution (Steffen et al. 2007). Human activities have put too much stress on the Earth system, hence reducing its resilience. There is compelling evidence to suggest three of the nine planetary boundaries have already been crossed, and others are under threat (Rockström et al. 2009). The Earth system is no longer in the relatively stable Holocene period, but moving into the unpredictable Anthropocene (Steffen et al. 2007).

The planetary boundaries framework is intended to be used in defining the boundary between the Holocene and the Anthropocene, thereby conditioning the type and level of human activities upon respecting the thresholds in the Earth subsystems or processes. The positions of most thresholds can be defined and measured through one or more control variables such as the atmospheric carbon dioxide (CO_2) concentration and the species extinction rate (Rockström et al. 2009). The threshold levels in these variables are, in essence, a set of Earth's 'safe minimum standards' for safeguarding the planetary sustainability 'must-haves' (Griggs et al. 2013), which are absolutely essential for human survival, and for that matter, sustainable development of any kind.

2.2 Ethics

At the fundamental level, our ecological crisis is an ethical crisis. The roots of almost all environmental problems can be traced to the misconceived human-nature relationship (Bosselmann 2010). That is, thinking humans are above or outside nature, and that we have the right and ability to dominate over and even control nature. Such a worldview is probably nicely captured in the current proposals for and tacit acceptance of geoengineering as inevitable by both the science and policy communities (Victor 2008; Victor et al. 2009; Bellamy et al. 2012; Galaz 2012; Ridgwell et al. 2012). On that premise, we have built our exploitative economic systems, which is degrading the environment to the point where human security is highly threatened. For the past several decades, therefore, the

international community has repeatedly called for ‘a new ethic, embracing plants and animals as well as people, which will enable human societies to live in harmony with the natural world on which they depend for survival and well-being’ (World Conservation Strategy 1980, section 13.1).

The planetary boundaries framework provides a scientific groundwork for this new ethic. By focusing on the biophysical dimensions of the Earth system dynamics, planetary boundaries place a greater importance on staying within the ‘environmental ceiling’ over the so-called ‘social floor’ (Raworth 2013; see also Mauerhofer 2008). In this sense, this framework is ecocentric, although it is principally concerned about human development, rather than the intrinsic value of nature as such. Nonetheless, implicit in the concept of planetary boundaries is ecosystems thinking, that humans are fellow citizens of the wider community of life, who need to take the role of planetary stewardship (Chapin et al. 2009).

However, this does not mean that we undervalue the importance of social equity. We reject the widespread criticism that the planetary boundaries approach involves conflict between global equity and environmental sustainability goals. Similarly, Steffen and Stafford Smith (2013) argue that it is necessary and possible to address the biophysical aspects of these boundaries in ways that are compatible with enhancing many aspects of social equity.

3 Implications for Post-2015 Sustainable Development Goals

The science and ethics of the planetary boundaries framework has important implications for post-2015 SDGs. In this section, we discuss the need to revisit the concept of sustainable development, and agree on a single priority goal in the context of SDGs.

3.1 Revisiting Sustainable Development

The oft-quoted definition of sustainable development can be found in the Brundtland Report as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development 1987). The central idea was about achieving a balance or integration of competing interests of the environment, society, and economy. However, the transgression

of the thresholds for several planetary equilibria serves as an empirical evidence for the failure of the existing model of sustainable development for acting within planetary boundaries (Muys 2013).

Sustainable development as defined by the World Commission on Environment and Development is a paradoxical concept because "it aimed at reconciling the right of development of every world citizen with the global environmental burdens associated with the current development model" (Muys 2013: 42). From a purist point of view, it is a contradiction in terms because genuine sustainability and genuine development would be irreconcilable (Du Pisani 2006). Given the general bias towards tangible economic benefits over the intangible environmental concerns in today's neoliberal economies, striking a tenuous balance between the three pillars of sustainable development was not successful in most cases. Rather, sustainable development has been driven by general imperatives of growth or progress. Therefore, as Leach et al. (2012: 4-5) argue, "broad calls for integration need to be underpinned by finer-grained attention to what sort of sustainability and development are being pursued, for whom and how, and what this implies for improved stewardship of our planet" (see also Dobson 1996). It should be remembered that 'sustainability' is what conditions 'development' in the concept of sustainable development, not vice versa (Bosselmann 2008).

This implies the need to delve deeper into the authentic meaning of sustainability. The idea of sustainability has deep roots in all cultures of the world (Mebratu 1998; Weeramantry 2004; Du Pisani 2006; Grober 2007; see also Bosselmann 2008; Voigt 2009). The term itself, however, was shaped in the 17th century European discourse on timber shortage. Initiated by the Royal Society and its founding member John Evelyn, this discourse soon spread to Europe, and paved the way to a new approach to the management of forests. In Germany, for example, it led to the coining of the new term *nachhaltigkeit* (sustainability). Its first legislative use dates back to 1713 by Hanns Carl von Carlowitz, the head of the Royal Mining Office in the Kingdom of Saxony, in the context of meeting the challenge of a predicted shortage of timber (Du Pisani 2006). The principle of sustainability was fundamental in forest legislation of the nineteenth century. For example, Article 2 of the Bavarian Forest Law of 1852 read: "The management of state-owned forests has to follow sustainability as its highest principle".

The historical sources shed a new light on the essence of the modern composite term 'sustainable development', which is often diluted and distorted. The fact that sustainability was a legal term with a defined content and used in legislation is important for the interpretation of sustainable development (Bosselmann 2008). It would be wrong to assume that this construct only emerged following the Brundtland Report and could only be interpreted accordingly (Bosselmann 2008). We need to revise the concept of sustainable development in light of historical usage and refocus on its core meaning as 'not risking the substance'.

At the global level, the international community as a whole would have to acknowledge that planetary boundaries define the environmental target corridor within the larger context of sustainable development (Biermann 2012b). They are the biophysical preconditions for sustainable development. In this context, Muys (2013: 45), for example, proposed a new definition of sustainable development: "the increase of human prosperity (exergy content) and human well-being (exergy buffering) without the loss of ecosystem structure (exergy content) and ecosystem functioning (exergy buffering)", which in short can be expressed as "development that does not degrade the biosphere".

3.2 Organizing Sustainable Development Goals in a Normative Hierarchy

How can we design post-2015 SDGs so that they collectively work towards such a revised definition of sustainable development? In this section, we argue that it is necessary to organize SDGs in a normative hierarchy, with a single priority sustainability goal at the apex.

3.2.1 Why a Single Priority for Sustainable Development Goals?

The MDGs have formed a nested system of 8 goals, 21 targets, and 60 indicators. The goals, targets, and indicators are interrelated and should be seen as a whole. However, in practice, the MDGs and their subsidiary targets and indicators may point in different directions. For example, poverty eradication (MDG 1) and environmental conservation (MDG 7) may require different actions to be taken in order to achieve one's own objective most efficiently. They may even contradict one another depending on how the goals and targets are implemented, and which indicators are used to measure progress. For example, two

indicators used for MDG 1 and MDG 7, "proportion of population below $1 (PPP) per day" (Indicator 1.1) and "CO_2 emissions, total, per capita and per $1 GDP (PPP)" (Indicator 7.2), may come into conflict. Between 1990 and 2010, the proportion of population in extreme poverty in China was reduced from 60 to 12 per cent (United Nations 2013). It is questionable, however, whether the source of this progress is climatically benign. Indeed, during the same period, China increased its total and per capita CO_2 emissions by about three fold (World Bank 2013). Here, causality can be suggested that the recent economic growth and associated progress in poverty eradication were largely driven by burning more fossil fuels and degrading the local and global environment.

Therefore, improving the performance of one goal or target in isolation may come to constrain the actions of another goal or target to the point of serious injury. In systems terminology this is called the problem of suboptimization, where optimizing the result for each of the subsystems independently (i.e., goals, targets, or indicators) may actually suboptimize the performance of the overall system (Heylighen 1992). The principle of suboptimization explains why some targets are met (United Nations 2013), but the spirit of the MDGs is not.

Such a systems perspective to goal-setting and implementation needs to be adopted when formulating post-2015 SDGs. What we can do to make sure the spirit of post-2015 SDGs, that is, human development within the ecological limits, is met is to formulate SDGs with the whole system, including its self-organizing evasive possibilities, in mind (Meadows 2008). The collective goal of a system, in this case a 'goal system', is a powerful and necessary leverage point for steering the direction of self-organization (Meadows 2008).

Here is an example from economics. Because of non-linear dynamics between micromotives and macrobehaviour (Schelling 1978), macroeconomics cannot be derived from microeconomics. In order to direct economic systems towards desired macroscopic outcomes which might be keeping the market competitive, the self-organizing aspects of the market must be complemented by the top-down feedbacks. These feedbacks would come from goal-oriented central agencies, which modify local rules of interaction to prevent each individual corporation from eliminating its competitors (Meadows 2008; Levin 2002). Similarly, in ecosystems, the goal of keeping populations in balance and evolving trumps the goal of each population to reproduce without limit (Meadows 2008).

In this context, we argue that the international community has to be clear about what post-2015 SDGs will collectively aim to achieve, and bind individual SDGs and targets to contribute to the ultimate purpose. In other words, a single priority goal needs to be agreed to and it should be given the power to trump other auxiliary SDGs and targets lower in the goal-system hierarchy.

Our proposal for a single priority goal does not cancel out the importance of diversity of goals, targets, and indicators. It should be emphasized that our single-goal approach is not a top-down, monolithic approach to global governance. The goal-oriented approach is rather directed towards achieving coherence under change while maintaining some degree of institutional diversity (Ostrom 1999; Dietz et al. 2003; Low et al. 2003; Ostrom 2005). Our approach needs to be differentiated from the centralization argument, which is often associated with the idea of establishing an authoritative organization (Biermann 2000; see also Najam 2003; Oberthur and Gehring 2004). Here, we do not assume the presence of a central authority. In fact, a goal-oriented approach to orchestration would prove to be particularly relevant in a decentralized system without central control, such as the international system.

3.2.2 Sustainable Development *per se* is Unfit as a Priority Goal

In response to our case for a single priority goal, one may claim that sustainable development itself is already the *de facto* priority goal of the international community as a whole. However, we consider the concept of sustainable development as lacking the necessary qualities of an overarching goal for the purpose of guiding SDGs.

Commonly agreed definitions of sustainable development contain two different objectives, namely environmental conservation (sustainability) and socio-economic growth and equity (development). However, none of them provide a clear guidance on how to integrate the two competing interests in a principled manner. This includes the revised definition of sustainable development in the context of SDGs in Griggs et al. (2013: 306): "development that meets the needs of the present while safeguarding Earth's life-support system, on which the welfare of current and future generations depends". Here, the two objectives of sustainable development, namely their 'updated MDGs' (i.e., end poverty and hunger, universal education, gender equality, health, environmental sustainability, and global partnership) and 'planetary must-haves' (i.e., materials use, clean air, nutrient (N and P)

cycles, hydrological cycles, ecosystem services, biodiversity, and climate stability), are linked in an unclear manner by the connecting word 'while'. Does the latter, some level of environmental integrity that could not be traded away, condition the former, development? From a grammatical point of view, probably yes, but different interpretations can be derived. In fact, Griggs et al. (2013: 305) stated that "the protection of Earth's life-support system and poverty reduction must be the *twin priorities* for SDGs" (emphasis added), without discussing how potential conflicts between the two priorities might be addressed, which has always been the crux of the problem with sustainable development.

The Resource Management Act 1991 (RMA) of New Zealand provides an example of how wide ranging interpretations of such a definition could be in actual decision-making. The RMA is New Zealand's principal legislation for environmental management, which prioritizes the objectives of governing resource management and gives pre-eminence to sustainability. It explicitly states 'sustainable management' as purpose placed at the heart of the regulatory framework and that this purpose is to direct all other policies, standards, plans and decision-making under the RMA. The RMA, in section 5(2), defines 'sustainable management' as:

> managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while—
> (a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
> (b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
> (c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

According to Upton et al. (2002), section 5(2) was intentionally drafted to emphasize biophysical constraints and move away from the overly broad and unweighted list of socio-economic and environmental objectives in the previous Town and Country Planning Act 1977. However, Fisher (1991) was among the first to caution that the definition of sustainable management was possibly ambiguous, requiring clarity with meaning of the word 'while' which connect what he termed 'management function' and the 'ecological function'. The most grammatically correct would be the 'biophysical bottom line' interpretation, where the ecological function is regarded as a number of constraints within which this utilitarian ethic must function (Fisher 1991; Upton et al. 2002). However, Fisher (1991) noted that a 'single integrated purpose' definition could be made where providing for

human well-being was equal with and not subordinate to the 'biophysical bottom line' paragraphs (a) to (c) of section 5(2).

As Fisher (1991) warned, the Environment Court of New Zealand moved towards a 'broad overall judgement' approach to section 5(2) (Skelton and Memon 2002; Upton et al. 2002).[5] Decision-makers allowed on a case by case basis to make an overall judgement that weighed all benefits and negative effects of resource use (Upton et al. 2002). Consequently, therefore, resource users have been able to discount significant biophysical values if they were able to demonstrate major economic and social dividends. The overall broad-judgement defied the intention of lawmakers, which was to make a fundamental value judgement to avoid the obscure and uncertain business of weighing competing objectives (Upton et al. 2002).

This RMA example has significant implications for the design of post-2015 SDGs. The definitions of 'sustainable development' in Griggs et al. (2013) and 'sustainable management' in the RMA are very similar in their formulations. They both attempt to kill two birds with one stone with a connecting word 'while'. However, as the RMA example showed, without an explicit prioritization of biophysical constraints, SDGs are likely to fail to make progress. We must not be naive about the powerful influence of neoliberal ideology in decision-making processes. Whether or not a resource use is sustainable should be clearly defined by the law. The decision should not be left to an 'overall judgment', that is, the traditional viewpoint that juggles environmental, economic and social factors without giving 'principled priority' to environmental objectives (Lafferty and Hovden 2003). In the words of Anton (2012: 55), "[t]he time has come to return to *environmental protection* as the focus for international environmental law".

3.2.3 Environmental Problem Shifting between Planetary Boundaries

Another reason for a hierarchical goal-system structure is that individual actions taken to *protect* a part of the environment, when collectively considered, may not necessarily lead to an improved environment overall (Teclaff and Teclaff 1991). This problem of 'the whole

[5] See, for example, *New Zealand Rail Ltd v Marlborough District Council* [1994] NZRMA 70; *Trio Holdings Ltd. v Marlborough District. Council* [1997] NZRMA 97; *North Shore City Council v Auckland Regional Council* [1997] NZRMA 59. But see, *Foxley Engineering Limited v Wellington City Council*, W 12/94; *L A Campbell and Others v Southland Regional Council,* W 114/94.

being smaller than the sum of its parts' often results from environmental problem shifting across multiple planet's biophysical subsystems or processes (Kim and Bosselmann 2013). Notable examples of environmental problem shifting may actually be observed among the current environmental indicators for MDG 7. For example, expanding biofuel crop plantations, while potentially contributing to reductions in "CO_2 emissions, total, per capita and per $1 GDP (PPP)" (Indicator 7.2), will likely decrease the "proportion of land area covered by forest" (Indicator 7.1) (Danielsen et al. 2008; Fargione et al. 2008; Searchinger et al. 2008; Kim et al. 2009; Tilman et al. 2009; Yang et al. 2012; see also Mackey et al. 2013). Replacing hydrochlorofluorocarbons (HCFCs) with hydrofluorocarbons (HFCs) which has zero ozone depletion potential, while contributing to reducing the level of "consumption of ozone-depleting substances" (Indicator 7.3), exacerbate climate change because HFCs have a high global warming potential (Oberthür 2001; Velders et al. 2007). Our understanding of environmental problem shifting could be extended to include more passive forms of problem shifting such as the transformation of climate change to ocean acidification, as inadvertently facilitated by the UN Framework Convention on Climate Change (UNFCCC) (Kim 2012), thereby decreasing the "proportion of fish stocks within safe biological limits" (Indicator 7.4).

Cross-system, cross-scale interactions among planetary boundaries (Cash et al. 2006) reveal a governance challenge that goes well beyond the conventional debate on sustainable development, that is, the relationship between environmental and developmental policies. They call for much stronger attention to the *internal* coherence of international environmental law and governance with respect to strategies to stay within individual planetary boundaries (Kim and Bosselmann 2013). The climate, ozone, and biodiversity regimes, for example, would need to be designed and implemented in a mutually supportive manner, without compromising one over the other. The threats addressed and the solutions outlined by individual environmental institutions have to be evaluated in relation to an *overall* environmental goal (Steiner et al. 2003). Individual institutions with more specific objectives are then bound by the priority goal, but given a degree of flexibility to self-organize and make mutual adjustments (Galaz et al. 2012c). This could possibly translate into less efficient sectoral measures in the short term, but its aim is to ensure long-term global ecological integrity and sustainability.

In this sense, the provisional SDGs in Griggs et al. (2013), for they lack a single point of reference, would likely to struggle in managing trade-offs and maximising synergies among

the *environmental* goals and targets. They did identify goals that do not end up with a false opposition between improving human lives and planetary protection, but no guidance was given as to how their proposed SDGs could be coordinated for effective governance of interacting planetary boundaries (e.g., Galaz et al. 2012c; Nilsson and Persson 2012). In other words, Griggs et al. (2013: 305) acknowledged that "there can be conflict between individual goals, such as energy provision and climate-change prevention", but their proposed goal-system falls short of addressing such conflicts. There is a strong need for a single priority goal to ensure net environmental improvements. A clearly agreed priority goal would provide the system of international (environmental) law with a point of reference for legal reasoning and interpretation, thereby enhancing institutional coherence across Earth's subsystems (Kim and Bosselmann 2013).

4 In Search of a Priority Goal

We have explained the case for a single goal for prioritizing sustainability in post-2015 SDGs. The question, however, remains as to how this hypothetical goal could be expressed and defined both scientifically and legally. The outstanding task is about identifying a key concept or property of Earth's life-support system that might be acceptable to the international community *in toto* as the highest global common good.

4.1 Expressions of Ecological Integrity in International Law

In our view, the point of departure in the search for this key property should be the existing international legal documents which have been widely agreed to by the international community. We take the benefit of the study by Kim and Bosselmann (2013), which suggested that the notion of 'ecological integrity' is emerging as a common conceptual denominator.

The notion of ecological integrity first appeared in the international arena in 1978 with the Great Lakes Water Quality Agreement signed bilaterally between Canada and the United States (Manuel-Navarrete et al. 2007). The purpose of the agreement is "to restore and maintain the chemical, physical, and biological integrity of the Waters of the Great Lakes" (Article 2.1). The notion of ecological integrity has then been used as key concept in a wide

range of multilateral environmental agreements. The first multilateral agreement to include the notion was the Convention on the Conservation of Antarctic Marine Living Resources adopted in 1980, which recognized in its preamble, "the importance of safeguarding the environment and protecting the integrity of the ecosystem of the seas surrounding Antarctica". Today, more than a dozen multilateral environmental agreements contain some reference to the integrity of ecosystems in their preamble or the operative part (Table 1).

In other major multilateral environmental agreements where the term did not appear in their texts, we may still observe that the underlying ideas are very similar. For example, the ultimate objective of the UNFCCC, which is to "prevent dangerous anthropogenic interference with the climate system" (Article 2), can be interpreted to mean safeguarding the integrity of the climate system. The Vienna Convention for the Protection of the Ozone Layer aims to protect human health and the environment against "adverse effects", which it defines as "changes in the physical environment or biota, including changes in climate, which have significant deleterious effects on human health or on the composition, resilience and productivity of natural and managed ecosystems, or on materials useful to mankind" (Article 1.2). Here the objective is also to safeguard the integrity of the ozone layer. In the case of the UN Convention on the Law of the Sea, "pollution of the marine environment" which its parties are obliged to prevent, reduce, and control means "the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities" (Article 1.1.(4)). Again, the objective is to protect the integrity of the marine environment. The Ramsar Convention on Wetlands defines the wise use of wetlands as "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development" (Resolution IX.1, annex A), thereby incorporating the elements of ecological integrity (Kim 2011).

Perhaps more significantly, most of the key international environmental soft law instruments, including the World Charter for Nature (1982), the Rio Declaration on Environment and Development (1992), the Agenda 21 (1992), the Draft International Covenant on Environment and Development (2000, 2004, 2010), the Earth Charter (2000), the Plan of Implementation of the World Summit on Sustainable Development (2002), and

The Future We Want (2012) contain the notion of ecological integrity in their cores (Table 1; Kim and Bosselmann 2013). The Rio Declaration, which is arguably the most authoritative text in international environmental law, states in the preamble that the UN Conference on Environment and Development worked towards "international agreements which respect the interests of all and protect the integrity of the global environmental and developmental system". Furthermore, one of its core principles obligates states to "cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem" (Principle 7). This was in the spirit of the World Charter for Nature of 1982, which firmly established the integrity of ecosystems or species as a non-negotiable bottom line when achieving "optimum sustainable productivity" of natural resources (Principle 4).

The Earth Charter (2000) put the concept of ecological integrity at its very core as a central category. It urges "all individuals, organizations, businesses, governments, and transnational institutions" to "[p]rotect and restore the integrity of Earth's ecological systems, with special concern for biological diversity and the natural processes that sustain life" (Principle 5). Despite the uncertain legal status of the Earth Charter (Bosselmann 2009), this document is significant as it was adopted as the civil society alternative to the Rio Declaration and was drafted through a global participatory process. The Charter has been formally endorsed by over 2,000 organizations, including numerous national and international associations, and international organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations University (UNU), and the International Union for Conservation of Nature (IUCN).

And there is the Draft International Covenant on Environment and Development, which aims to achieve "environmental conservation [as] an indispensable foundation for sustainable development" (Article 1). The first fundamental principle is to respect and safeguard "[n]ature as a whole and all life forms" as well as maintain and where necessary restore the "integrity of the Earth's ecological systems" (Article 2). It includes an article on 'resilience', where it recognizes the limited capacity of natural systems and human communities to withstand and recover from environmental disturbances and stresses (Article 9). Notably, among the twelve fundamental principles, social equity concerns such as "right to development" (Article 10) and "eradication of poverty" (Article 11) are listed below the ecological principles. Although still a draft, the inclusion here is significant because the Draft Covenant is a product of decades of work of leading scholars and practitioners, and has been regularly revised to reflect new developments in the field of

international environmental law and development through a deliberative process with inputs from all around the world. It is intended as a codification of existing environmental law, and a blueprint for an international framework agreement on the environment.

4.2 An Interpretation of Ecological Integrity in Terms of Planetary Boundaries

What does ecological integrity mean, and how can it me measured? Despite the widespread usage in the international environmental instruments, the concept has not been clearly defined. To the best of our knowledge, no international environmental treaty or institution has a definition of ecological integrity. Here we attempt to present a scientific definition of integrity at the planetary scale in light of the science of planetary boundaries and how the concept has been used in international law.

We propose to define integrity as a system property vis-à-vis the scientific concept of robustness or resilience (used here interchangeably like in Levin and Lubchenco (2008)). Robustness is a property that allows a system to maintain its functions in the face of disturbance (Holling 1973; Folke et al. 2002; Levin and Lubchenco 2008). It is often misunderstood to mean staying unchanged regardless of stimuli, so that the structure and components of the system is unaffected (Kitano 2004). However, robustness is the maintenance of specific *functionalities* of the system against perturbations (Levin and Lubchenco 2008), and it often requires the system to change its mode of operation in a flexible way. In other words, robustness maintains specific functions, while allowing changes in the structure and components of the system. The integrity, then, could be defined as a system property which is maintained through the robustness. If we apply this to ecosystems, ecological integrity would refer to "the continued healthy or proper functioning of … global- and local-scaled ecosystems and their ongoing provision of renewable resources and environmental services" (Mackey 2005: 66; see also Mackey 2004).

The climate system would be useful as an example for illustrating how the notion of integrity can be applicable at the planetary scale. The climate is a complex adaptive system, which self-organizes within limits (Jones 2000). Strong evidence of planetary self-regulation comes from the 420,000-year isotope record contained in the Vostok ice core (Petit et al. 1999), which shows the regular pattern of inferred atmospheric CO_2, methane concentrations and temperature through multiple glacial-interglacial cycles. The tightly

constrained upper and lower bounds of all these variables are a typical feature of a complex adaptive system. If the atmospheric concentrations are pushed beyond the upper or lower bounds, we risk that the climate system might move into an unstable state, which could have disastrous consequences for humanity. Such behaviour reflects the non-linear system nature of the climate system. The natural sciences, therefore, focus less on the somewhat vague term 'sustainability' and more on the idea of 'resilience' at a systemic level, and attempt to measure this via indicators (Whiteman et al. 2013). From a sustainable development perspective, the integrity of the climate system means the continued functioning of the global atmosphere within "natural climate variability observed over comparable time periods" (UNFCCC 1992, Article 1.2).

The integrity of the Earth system as a whole can be interpreted, and therefore, defined in terms of planetary boundaries. There are so far nine identified planetary boundaries (see above section 2.1). Most thresholds that define these boundaries can be determined by a critical value for one or more control variables, such as carbon dioxide concentration (Rockström et al. 2009). When these thresholds remain uncrossed, the Earth system remains in the Holocene state, and the integrity of the Earth's life-support system is maintained. We understand that the suggested threshold levels are preliminary estimates which need to be questioned and evaluated in the face of inherent scientific uncertainties. However, because thresholds do exist and we can choose values for control variables that are at a 'safe' distance from thresholds in a precautionary manner, the integrity of Earth's life-support system is no longer an ambiguous or impractical concept. It can be measured and monitored (Running 2012), hence even used as a direct measure of the legality of state behaviour (Kim and Bosselamnn 2013).

4.3 Implications for International Sustainable Development Governance

How might the concept of integrity, if recognized as a single priority goal in post-2015 SDGs, be practically useful for sustainable development? A major practical usefulness comes from the normative hierarchy between sustainability and development which the concept establishes. For example, the UNFCCC aims to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, and within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (Article 2). Implicit here

is a tension between the climate stability and the general imperative of economic growth. The SDG formulated in terms of ecological integrity would strictly prioritize the protection of the climate system as a precondition for food security and economic development.

Furthermore, the goal would prioritize maintaining the planetary integrity over myriad environmental objectives of treaties and institutions, thereby addressing trade-offs in a way that would ensure an improved environment overall. For example, in implementing the UNFCCC and its Kyoto Protocol, their provisions would need to be interpreted and applied in a way that would consider and address unacceptable unintended consequences for biodiversity, hence creating a mutually supportive relationship between the climate treaty and biodiversity-related treaties in light of the priority goal. Consider, for example, climate mitigation externalities in the form of ocean acidification (Kim 2012). In accordance with the priority to safeguard the integrity of Earth's life-support system as a whole, the UNFCCC would need to internalize the externalities. In a similar context, no large-scale geoengineering projects would be allowed because they involve risk of unacceptable unintended consequences (Allenby 2012; Galaz 2012). This could possibly translate into less efficient climate change mitigation measures in the short term, but its aim is to ensure long-term global ecological integrity and sustainability. In other words, effectiveness would be given priority over eco-efficiency (Mauerhofer 2008).

5 Towards the Rule of Law for Sustainable Development

We have made a case for the integrity of Earth's life-support system to be agreed to as a single priority for post-2015 SDGs. This section expands the argument further, and explores how the goal could be made legally binding. The rule of law is necessary because goal-setting is effective to the extent agents are willing and able to adhere to goals. We cannot rely totally on market incentives as they themselves cannot set environmental limits (Kosoy et al. 2012; Bosselmann et al. 2012; see also Brown and Garver 2009).

5.1 Safeguarding the Integrity of Earth's Life-support System as a *Grundnorm* of International Law

It has been already pointed out by international environmental governance scholars that the concept of 'planetary boundaries' invites further exploration of the concepts of *jus cogens* (peremptory norms) of international law that no state may derogate from (Galaz et al. 2012a; see also Walker et al. 2009; Biermann 2012b). However, the case for *jus cogens* tolerates multiple environmental rules or principles to guide state actors, hence failing to address the issues which we have discussed in this paper. Furthermore, *jus cogens* of international law must be grounded on *opinio juris* (i.e., state practice), hence only a few, specific, sectoral commitments such as limiting the emissions of ozone depleting substances could be considered as potential *jus cogens*. Yet, no one has successfully identified any specifically environmental rules or principles with a *jus cogens* status (Boyle 2007).

We suggest that this new commitment to safeguarding the integrity of Earth's life-support system should be promoted as a most fundamental environmental rule of international law or *grundnorm* (Kim and Bosselmann 2013). A *grundnorm* is here understood as a basic norm to bind any governmental power (Bosselmann 2013). This understanding differs from Kelsen's definition, and is closer to Kant's argument that any positive law must be grounded in a 'natural' norm of general acceptance and reasonableness (*Vernunft*) to prevent pure arbitrariness (*blosse Willkür*) (Kant 1907). The existence of an environmental *grundnorm*, therefore, rests on the assumption that respecting planetary boundaries is a dictate of reason (*Gebot der Vernunft*) and general acceptance (*allgemeine Gültigkeit*). Conceptually, a *grundnorm* exists independently of a legal system, but underpins legal reasoning in the form of an inference rule (Feteris 1999). In this way, the legal decision-making process, for example in courts, will always be informed by some fundamental concerns along the lines of the Kelsian idea of a *grundnorm*. By contrast, the Kantian understanding suggests the prevalence of common interest or general acceptance. Only what can be assumed as reflecting the common interest could be considered as a *grundnorm*. Examples in this sense include a constitution, but also the rule of law or the idea of justice, the concept of human rights and similar values of fundamental importance.

As default law, an environmental *grundnorm* would underpin and guide the interpretation of existing and the creation of new laws. As a "core adjudicatory norm" (Bosselmann 2008: 67), it will help build systemic relationships between international rules by envisaging them as part of the shared purpose. In the international law context, the principle of systemic integration of Article 31(3)(c) of the Vienna Convention on the Law of Treaties of 1969 would help *grundnorms* to carry out this critical role. Pursuant to this principle, international

environmental agreements would be interpreted and applied by reference to their normative environment, or "any relevant rules of international law", especially *grundnorms*. However, the current absence of an environmental *grundnorm* has created a vacuum that is filled with utilitarian, state-centred and other traditional considerations that can be perceived as in themselves reflecting a certain *grundnorm* (Kim and Bosselmann 2013).

5.2 A Post-2015 Institutional Framework for a Flourishing Earth

We anticipate that recognizing and implementing an environmental *grundnorm* may require a major reform in international environmental governance. The international community is in need of a new constitution-type agreement that will redefine the relationship between humans and the rest of the community of life. In the run up to Rio+20 Summit, the academic community called for a constitutional or charter moment (Biermann et al. 2012; Kanie et al. 2012), or 'greening' the UN Charter (Biermann 2012a). Such a call for a defining moment in global governance can be traced at least to 1987, when the World Commission on Environment and Development called for creation of a "universal declaration" in the form of a "new charter to guide state behavior in the transition to sustainable development" and also recommended that the charter "should prescribe new norms for state and inter-state behavior needed to maintain livelihoods and life on our shared planet". In 1990, the former UN Secretary-General, Javier Perez de Cuellar, stated (Report of the Secretary-General on the Work of the Organization 1990):

> The Charter of the United Nations governs relations between States. The Universal Declaration of Human Rights pertains to relations between the State and the individual. The time has come to devise a covenant regulating relations between humankind and nature.

In this statement, the UN Secretary-General was referring to an overarching eco-constitutional framework that would identify living within ecological limits as a fundamental concern and commitment of all humanity. According to Bodansky (2009), what we currently have is state-driven, 'thin' constitutionalism with vague general principles of international environmental law. The Stockholm Declaration on the Human Environment (1972), the World Charter for Nature (1982), and the Rio Declaration on Environment and Development (1992) contain important widely accepted principles in this regard, but most of these principles cannot be directly implemented (Burhenne and Hassan 1995; Kim and Bosselmann 2013). Although they announce objectives and, in some cases,

provide directives to achieve them, but none of them state a general international obligation on all states to protect the whole of the environment, comparable to Article 192 of the Law of the Sea Convention (Burhenne and Hassan 1995).

Potential candidates for an international environmental constitution or covenant include the Draft International Covenant on Environment and Development and the Earth Charter which we discussed.

In implementing this hypothetical agreement, it will be useful to have an international organization which has similar functions and capacity of the World Health Organization and International Labour Organization, mandated to protect the global environment. A practical option would be to make use of the UNEP, which has recently been strengthened by the UN General Assembly as "the leading global environmental authority that sets the global environmental agenda" (The Future We Want 2012, para. 88; UNGA 2013). A key component of this upgrade was the UN Environment Assembly in place of the Governing Council of UNEP. The Assembly will have universal membership of all UN member states, which would strengthen governance, and responsiveness and accountability of UNEP to the member states.

From a planetary boundaries perspective, the upgraded UNEP must aim to promote "the coherent implementation of the environmental dimension of sustainable development" (The Future We Want, para. 88), not 'sustainable development' as such. The environmental conservation goal must not be compromised within international environmental law. International environmental law should be about environmental protection, not sustainable development (see also Anton 2012).

It is yet uncertain what the upgraded UNEP will look like. Although the new UN Environment Assembly will certainly have more authority than its predecessor, the Governing Council of UNEP, it will still be far from instituting "a better way to make international law for the environment" as proposed by Palmer (1992). In order to be an effective "authoritative advocate for the global environment" (The Future We Want 2012, para. 88), one option would be to consider giving the UN Environment Assembly a global trusteeship function over common concerns of humankind under international law, such as biodiversity conservation (CBD 1992, preamble), climate change (UNFCCC 1992, preamble), and possibly the availability and use of fresh water (Brown Weiss 2012). The

trusteeship duties will include global obligations for the integrity of planetary boundaries and the wellbeing of the greater community of life; overseeing markets to ensure that they are protective of non-market common goods; and ensuring impartiality between all interests along with respect for human rights and concern for ecological wellbeing (Bosselmann et al. 2012).

The trusteeship mandate will require that it has the means to stop individuals or states from degrading the global commons or transgressing planetary boundaries. A major issue which has hampered the advancement of an international response to ecological issues is the lack of accountability for states in breach of their legal obligations. Traditionally, it has been up to states to call upon the International Court of Justice when another state acts outside of the bounds of their legal jurisdictions. However, problematically, both states have to agree upon the Court's jurisdiction, and in the past state have been able to avoid the legal ramifications of decisions by political manoeuvring. The upgraded UNEP should, therefore, be mandated with the power to act with dispute resolution mechanisms similar to those of the World Trade Organization.

Furthermore, a new institutional mechanism should allow states to unilaterally be able to take another to court (Bosselmann et al. 2012). The judgements entered into by the panel would need to be legally binding, and backed by sanctions. In the case of the global commons, where there is the issue of the lack of a plaintiff clearly qualified to demonstrate both standing and injury, the legal guardians could be drawn from existing international agencies such as the UNEP, and possibly from other non-governmental organizations such as WWF. This is similar in concept to guardians for infants, the insane, and the senile, or the UN Trusteeship Council that acted on behalf of yet-to-be state entities that are not legally recognized.

6 Conclusion

The scientific community has a consensus on where the Earth system is likely to be heading, the largely unknown Anthropocene (Crutzen 2002; Steffen et al. 2004; Steffen et al. 2007; Rockström et al. 2009). If the business-as-usual trend continues, humanity is very likely to face disastrous consequences in the next few decades. Due to the complex nature of the Earth's social-ecological system, the changes will not be incremental but likely be abrupt,

involving a societal collapse (Diamond 2005). To avoid the collapse, human societies must find ways to protect Earth's life-support system as an absolute precondition for human existence and development.

This discussion paper drew on the latest scientific findings and their implications for effective legal governance of planetary boundaries. The key argument we put forward is that post-2015 SDGs must be organized around a single priority at the apex of the goal-system hierarchy. We define the priority goal as the protection of the biophysical preconditions that are essential for long-term sustainable development. Our case stands in contrast to other more common claims for twin priorities of environmental protection and poverty eradication (Griggs et al. 2013). We insist that all other interests such as socio-economic development, albeit important, must be subordinated under this ultimate biophysical priority goal.

In search of the core concept around which this priority goal could be defined, we identified the notion of ecological integrity as an emerging common denominator among international legal documents. Integrity is a system property maintained by resilience of robustness of the system. At the Earth system level, the integrity can be measured and monitored through multiple control variables associated with interlined planetary boundaries. In general terms, the integrity is maintained if the Earth system stays in the Holocene, but it is lost if human-induced stress reduces the robustness and Earth undergoes a regime shift into the Anthropocene.

We propose to adopt safeguarding the integrity of Earth's life-support system as the priority goal for post-2015 SDGs. For an effective implementation of post-2015 SDGs, the priority goal needs to be legally binding. To that end, the goal should be recognized as a *grundnorm*, and instituted through global eco-constitutionalism. Where there is a regulatory gap, this *grundnorm* fills in the void. Where there is already a treaty obligation, it reinforces and clarifies treaty obligations in light of the planetary boundaries framework. The *grundnorm* could be implemented through the upgraded UNEP as a trustee and a legal guardian for the global commons and common concerns of humankind. These institutional building blocks would constitute the core of the next generation of international environmental law, which we call 'Earth system law'.

Table 1. Selected international environmental instruments with references to ecological integrity.

Year of Adoption	**Title**	**Location**	**Text** (with 'integrity' underlined)
1980	Convention on the Conservation of Antarctic Marine Living Resources	Preamble	RECOGNISING the importance of safeguarding the environment and protecting the integrity of the ecosystem of the seas surrounding Antarctica;
1982	World Charter for Nature	I. General Principles	4. Ecosystems and organisms, as well as the land, marine and atmospheric resources that are utilized by man, shall be managed to achieve and maintain optimum sustainable productivity, but not in such a way as to endanger the integrity of those other ecosystems or species with which they coexist.
1990	Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	Preamble	Conscious of the grave threat restrictions on fish and wildlife consumption; (ii) tainting of fish and wildlife flavour posed by ill-conceived development options to the integrity of the marine and coastal environment of the Wider Caribbean Region,
1992	Rio Declaration on Environment and Development	Preamble Principle 7. State Cooperation to Protect Ecosystem	Working towards international agreements which respect the interests of all and protect the integrity of the global environmental and developmental system, States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.
1992	Agenda 21	Chapter 10 Integrated Approach to the Planning and Management of Land Resources Chapter 16 Environmentally Sound Management of Biotechnology Chapter 18 Protection of the Quality and Supply of Freshwater Resources Chapter 31 Scientific and Technological Community	10.1. Land is normally defined as a physical entity in terms of its topography and spatial nature; a broader integrative view also includes natural resources: the soils, minerals, water and biota that the land comprises. These components are organized in ecosystems which provide a variety of services essential to the maintenance of the integrity of life-support systems and the productive capacity of the environment. 16.4. Governments at the appropriate level, with the assistance of international and regional organizations and with the support of non-governmental organizations, the private sector and academic and scientific institutions, should improve both plant and animal breeding and micro-organisms through the use of traditional and modern biotechnologies, to enhance sustainable agricultural output to achieve food security, particularly in developing countries, with due regard to the prior identification of desired characteristics before modification, taking into account the needs of farmers, the socio- economic, cultural and environmental impacts of modifications and the need to promote sustainable social and economic development, paying particular attention to how the use of biotechnology will impact on the maintenance of environmental integrity. 16.22. The aim of this programme is to prevent, halt and reverse environmental degradation through the appropriate use of biotechnology in conjunction with other technologies, while supporting safety procedures as an integral component of the programme. Specific objectives include the inauguration as soon as possible of specific programmes with specific targets: […] c. To apply biotechnologies and their products to protect environmental integrity with a view to long-term ecological security. 18.38. Three objectives will have to be pursued concurrently to integrate water-quality elements into water resource management: a. Maintenance of ecosystem integrity, according to a management principle of preserving aquatic ecosystems, including living resources, and of effectively protecting them from any form of degradation on a drainage basin basis; 31.9. The objective should be to develop, improve and promote international acceptance of codes of practice and guidelines relating to science and technology in which the integrity of life-support systems is comprehensively accounted for and where the important role of science and technology in reconciling the needs of environment and development is accepted. […]
1994	Convention Establishing the Association of Caribbean States	Preamble	Convinced of the critical importance of preserving the environment of the region and, in particular, their shared responsibility for the preservation of the environmental integrity of the Caribbean Sea, by deploying the collective capabilities of their peoples in developing and exploiting its resources on an environmentally sound and sustainable basis, in order to enhance the quality of life of present and future generations of Caribbean peoples;

1995	Copenhagen Declaration on Social Development	B. Principles and goals (para. 26(b))	"Fulfill our responsibility for present and future generations by ensuring equity among generations and protecting the integrity and sustainable use of our environment"
1995	Washington Declaration on Protection of the Marine Environment From Land-Based Activities	Preamble	Recognizing the interdependence of human populations and the coastal and marine environment, and the growing and serious threat from land-based activities, to both human health and well-being and the integrity of coastal and marine ecosystems and biodiversity,
1995	UN Fish Stocks Agreement	Preamble	CONSCIOUS of the need to avoid adverse impacts on the marine environment, preserve biodiversity, maintain the integrity of marine ecosystems and minimize the risk of long-term or irreversible effects of fishing operations,
1995	Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean	Preamble Article 6 Protection Measures Annex 1. D. Protection, Planning and Management Measures	Considering that all the Contracting Parties should cooperate to conserve, protect and restore the health and integrity of ecosystems and that they have, in this respect, common but differentiated responsibilities, The Parties, in conformity with international law and taking into account the characteristics of each specially protected area, shall take the protection measures required, in particular: […] (b) the prohibition of the dumping or discharge of wastes and other substances likely directly or indirectly to impair the integrity of the specially protected area; […] 5. In the respect of the specificity characterizing each protected site, the protection measures for a SPAMI must take account of the following basic aspects: a) the strengthening of the regulation of the release or dumping of wastes and other substances likely directly or indirectly to impair the integrity of the area; […]
1996	Istanbul Declaration on Human Settlements		10. In order to sustain our global environment and improve the quality of living in our human settlements, we commit ourselves to sustainable patterns of production, consumption, transportation and settlements development; pollution prevention; respect for the carrying capacity of ecosystems; and the preservation of opportunities for future generations. In this connection, we shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. […]
1997	Seoul Declaration on Environmental Ethics	Preamble Principles (Introduction) Principle 4. Sharing Responsibilities Guidelines for Action	The critical decisions that we make must be determined by our own sense of moral strength, nobility of spirit, and a reverence for life. To this end, we require an ethical paradigm based on social equity, respect for diversity, and a culture of cooperation and shared responsibility in preserving the integrity of the Whole-Life-System. Earth's Whole-Life-System refers to a totality in which human beings, together with other life forms, natural elements and forces, coexist interdependently as a cohesive entity - The viability of the Whole-Life-System is essential to and dependent upon the very existence and integrity of all of its constituent components, and no species has an exclusive right to Earth's environment. All human decisions ought to be made and implemented on the premise that the existence of all life, including human life, can be sustained only when the integrity and wellbeing of the Whole-Life-System is preserved. All members of human society are responsible for maintaining the integrity of the global environment as a Whole-Life-System. We must accept our accountability and fulfil our responsibilities to protect the integrity of the global environment with determination in our everyday lives. These individual efforts can be enhanced through building networks within and among groups of civil society and government, industry and business, and non-governmental organizations (NGOs). With such cooperation and coordinated participation, appropriate policies can be developed and implemented effectively. (Religious and Faith Communities) 11. Spiritual View. The scale and magnitude of environmental problems are such that they must be recognized as having a religious as well as scientific dimension. Efforts to safeguard the environment need to be infused with a vision of the sacred. Religious and spiritual leaders must accept a responsibility to make known the full dimensions of this challenge. The cause of environmental integrity and justice must occupy a position of utmost priority for people of faith.
1998	Cooperative Agreement for the Conservation of Sea Turtles of the Caribbean Coast of Costa Rica, Nicaragua and Panama	Annex 6: Nesting Beaches	2. The Parties shall ensure that nesting beaches within protected wildlands are of adequate size to protect the ecological integrity of dynamic beach ecosystems.
2000	Earth Charter	II. Ecological Integrity	5. Protect and restore the integrity of Earth's ecological systems, with special concern for biological diversity and the natural processes that sustain life.
2000 (revised in 2004, 2010)	Draft International Covenant on Environment and Development (2nd, 3rd, and 4th editions)	Article 2 Respect for All Life Forms	Nature as a whole and all life forms warrant respect and are to be safeguarded. The integrity of the Earth's ecological systems shall be maintained and where necessary restored.
2000	Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central	Preamble	Conscious of the need to avoid adverse impacts on the marine environment, preserve biodiversity, maintain the integrity of marine ecosystems and minimize the risk of long-term or irreversible effects of fishing operations,

	Pacific Ocean		
2000	Framework Agreement for the Conservation of the Living Marine Resources of the High Seas of the South Pacific	Preamble	With these goals in mind, the coastal States in question agreed to establish the South Pacific Permanent Commission (SPPC), to coordinate their maritime policies and to promote the adoption of measures to preserve the environment and protect the integrity of the South Pacific's marine ecosystem;
2001	Protocol on Fisheries to the Treaty of the Southern African Development Community	Article 1 Definitions	2. In this Protocol, unless the context otherwise requires: […] "critical habitat" means a habitat that is essential for maintaining the integrity of an ecosystem, species or assemblages of species;
2002	Plan of Implementation of the World Summit on Sustainable Development	IV. Protecting and managing the natural resource base of economic and social development	24. Human activities are having an increasing impact on the integrity of ecosystems that provide essential resources and services for human well-being and economic activities. Managing the natural resources base in a sustainable and integrated manner is essential for sustainable development. In this regard, to reverse the current trend in natural resource degradation as soon as possible, it is necessary to implement strategies which should include targets adopted at the national and, where appropriate, regional levels to protect ecosystems and to achieve integrated management of land, water and living resources, while strengthening regional, national and local capacities. This would include actions at all levels as set out below.
2002	Black Sea Biodiversity and Landscape Conservation Protocol to the Convention on the Protection of the Black Sea Against Pollution	Article 3	1. In accordance with their national legal system, the Contracting Parties shall take all necessary measures to ensure the integrity, sustainability and development of protected areas, namely: […] b) the prohibition of the dumping or discharge of wastes and other substances likely directly or indirectly to impair the integrity of the protected area or species
2002	Treaty between the Government of the Republic of Mozambique, the Government of the Republic of South Africa and the Government of the Republic of Zimbabwe on the Establishment of the Great Limpopo Transfrontier Park	Preamble Article 4 Objectives	DESIRING to prone ecosystem integrity, biodiversity conservation and sustainable socio-economic development across international boundaries; The objectives of the Transfrontier Park shall be to — […] (c) enhance ecosystem integrity and natural ecological processes by harmonising environmental management procedures across international boundaries and striving to remove artificial barriers impeding the natural movement of wildlife;
2002	Convention for Cooperation in the Protection and Sustainable Development of Marine and Coastal Environment of the Northeast Pacific	Article 10	Integrated management and sustainable development of the marine and coastal environment 1. As part of the implementation of their policies and strategies for integrated management and sustainable development of the marine and coastal environment, the Contracting Parties shall incorporate into their economic development projects in marine and coastal areas those environmental criteria that provide sustainability in the use of resources and in the maintenance of the integrity of ecosystems. 2. Also as part of these policies, the Contracting Parties shall strive to implement integrated management and bring about sustainable development of the marine and coastal environment. To this end, the Contracting Parties shall endeavour to: […] (h) Establish protected coastal areas with the objective of maintaining biological integrity and diversity;
2003	African Convention on the Conservation of Nature and Natural Resources	Annex 2 Conservation Areas	National Park: protected area managed mainly for ecosystem protection and recreation Definition Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
2006	Dubai Declaration on International Chemicals Management		10. We commit ourselves to respecting human rights and fundamental freedoms, understanding and respecting ecosystem integrity and addressing the gap between the current reality and our ambition to elevate global efforts to achieve the sound management of chemicals;
2008	Protocol on Integrated Coastal Zone Management in the Mediterranean	Article 5	Objectives of Integrated Coastal Zone Development The objectives of integrated coastal zone management are to: […] (d) ensure preservation of the integrity of coastal ecosystems, landscapes and geomorphology;
2009	Conservation on the Conservation and Management of High Seas Fishery Resources in the South Pacific Ocean	Preamble	Conscious of the need to avoid adverse impacts on the marine environment, preserve biodiversity, maintain the integrity of marine ecosystems and minimise the risk of long term or irreversible effects of fishing;
2012	The Future We Want	II. Renewing Political Commitment	40. We call for holistic and integrated approaches to sustainable development which will guide humanity to live in harmony with nature and lead to efforts to restore the health and integrity of the Earth's ecosystem.

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