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Short communication

# Post-2015 Sustainable Development Goals still neglecting their environmental roots in the Anthropocene☆

Andrea J. Reid[a,*], Jill L. Brooks[a], Lana Dolgova[b], Bruce Laurich[b], Brittany G. Sullivan[a], Petra Szekeres[a], Sylvia L.R. Wood[c], Joseph R. Bennett[a,d], Steven J. Cooke[a,d]

[a] Department of Biology, Carleton University, 1125 Colonel By Drive, Ottawa, ON K1S 5B6, Canada
[b] National Wildlife Research Centre, Carleton University, 1125 Colonel By Drive, Ottawa, ON K1S 5B6, Canada
[c] The Earth Institute, Columbia University,2910 Broadway, New York, NY 10025, USA
[d] Institute of Environmental Sciences, Carleton University, 1125 Colonel By Drive, Ottawa, ON K1S 5B6, Canada

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ABSTRACT

The Sustainable Development Goals (SDGs; promulgated in 2015), officially known as "Transforming our world: the 2030 Agenda for Sustainable Development", are an intergovernmental set of 17 goals and 169 constituent targets that succeed the Millennium Development Goals (MDGs; 2000–2015). Despite a clear mandate to integrate social, economic and environmental objectives in the SDGs, ecosystem health remains underrepresented in this latest iteration of the United Nation's global development agenda. We submit that maintaining ecosystem health (Goal 14: *life below water* and Goal 15: *life on land*) is a necessary precondition to achieving the 2030 Agenda for Sustainable Development. Here, we present a reconceptualized SDG framework akin to a tree that places Healthy Ecosystems as the roots for five branches of development (Clean Energy, Water Security, Food Security, Lives and Livelihoods, Governing for Sustainability). As universal examples, we put forward the vital role of life below *fresh* water for ending poverty by 2030 (Goal 1: *no poverty*) and describe how children's environmental health is the foundation for the major health priorities of reproductive, maternal and child health (Goal 3: *good health and well-being*). This framework provides insight and evidence for policymakers and the public to be cognizant that prioritizing ecosystem health goals can serve human development objectives which we deem as key to realizing the unified plan of action for people, planet and prosperity.

## 1. Introduction

Despite a clear mandate to integrate social, economic and environmental objectives in the post-2015 Sustainable Development Goals (SDGs), ecosystem health remains underrepresented in this latest iteration of the United Nation's (UN) global development agenda (Wood and DeClerck, 2015). Successors to the eight Millennium Development Goals (MDGs) for 2000–2015, the 17 SDGs and their 169 constituent targets include only two goals and 29 targets that explicitly address environmental concerns (see Table 1). Put forward by the UN Open Working Group and adopted by the UN General Assembly (2015), the SDGs are being operationalized over the next 15 years not by their creators but by those who study and enact social, economic and environmental development. As early-career environmental scientists, we (the authors) and other early-career researchers will form one of the main cohorts, along with policy people and entrepreneurs, tasked with achieving the global goals by 2030 and beyond. We submit that maintaining healthy ecosystems is a necessary precondition to achieving the 2030 Agenda for Sustainable Development and ensuring post-2030 sustainability. Here, we argue that ecosystem health is the foundation for social and economic development activities and present two universal examples where human welfare hinges on environmental health. Our hope is that this document will guide policymakers and practitioners to recognize that ecosystem health maintenance is a means of enabling social and economic well-being.

## 2. Sustainability is rooted in the environment

The three pillars of sustainable development (society, economy, environment) are inextricably linked, with the connections between

☆ Second through sixth authors contributed equally to this work and are listed alphabetically.

* Corresponding author.
*E-mail addresses:* AndreaJReid@cmail.carleton.ca (A.J. Reid), JillBrooks@cmail.carleton.ca (J.L. Brooks), LanaDolgova@cmail.carleton.ca (L. Dolgova), BruceLaurich@cmail.carleton.ca (B. Laurich), BrittanySullivan@cmail.carleton.ca (B.G. Sullivan), PetraSzekeres@cmail.carleton.ca (P. Szekeres), SylvieWood@gmail.com (S.L.R. Wood), Joseph.Bennett@carleton.ca (J.R. Bennett), Steven.Cooke@carleton.ca (S.J. Cooke).

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**Table 1**
The Sustainable Development Goals' (SDG) constituent targets (n = 169) agglomerated into six focal areas following Griggs et al. (2013). SDG targets categorized as either being 'explicitly connected' (n = 29) or 'plausibly or not connected' (n = 140) with promoting Healthy Ecosystems. Targets are deemed 'explicitly connected' when they unambiguously prescribe protection and sustainable use of ecosystems and their services (e.g., Target 6.6 "By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes") and 'plausibly or not connected' when such a link is not established (e.g., Target 6.1 "By 2030, achieve universal and equitable access to safe and affordable drinking water for all").

| | Sustainable Development Goals' (SDGs) constituent targets and their connections with ecosystem health | | |
|---|---|---|---|
| | | Connected to Healthy Ecosystems | |
| Goal | Focal area | Explicitly | Plausibly or not |
| Goal 1: *no poverty* | Lives and Livelihoods | 1.5 | 1.1, 1.2, 1.3, 1.4, 1.a, 1.b |
| Goal 2: *zero hunger* | Food Security | 2.4, 2.5 | 2.1, 2.2, 2.3, 2.5, 2.a, 2.b, 2.c |
| Goal 3: *good health and well being* | Lives and Livelihoods | | 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.a, 3.b, 3.c, 3.d |
| Goal 4: *quality education* | Lives and Livelihoods | | 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.a, 4.b, 4.c |
| Goal 5: *gender equality* | Lives and Livelihoods | | 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.a, 5.b, 5.c |
| Goal 6: *clean water and sanitation* | Water Security | 6.3, 6.5, 6.6 | 6.1, 6.2, 6.4, 6.a, 6.b |
| Goal 7: *affordable and clean energy* | Clean Energy | | 7.1, 7.2, 7.3, 7.a, 7.b |
| Goal 8: *decent work and economic growth* | Lives and Livelihoods | 8.4 | 8.1, 8.2, 8.3, 8.5, 8.6, 8.7, 8.8, 8.9, 8.10, 8.a, 8.b |
| Goal 9: *industry, innovation and infrastructure* | Clean Energy | | 9.1, 9.2, 9.3, 9.4, 9.5, 9.a, 9.b, 9.c |
| Goal 10: *reduced inequalities* | Lives and Livelihoods | | 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.a, 10.b, 10.c |
| Goal 11: *sustainable cities and communities* | Lives and Livelihoods | 11.6, 11.a | 11.1, 11.2, 11.3, 11.4, 11.5, 11.7, 11.b, 11.c |
| Goal 12: *responsible consumption and production* | | 12.2, 12.4, 12.5, 12.8, 12.c | 12.1, 12.3, 12.6, 12.7, 12.a, 12.b |
| Goal 13: *climate action* | Clean Energy | | 13.1, 13.2, 13.3, 13.a, 13.b |
| Goal 14: *life below water* | Healthy Ecosystems | 14.1, 14.2, 14.4, 14.5, 14.a, 14.c | 14.3, 14.6, 14.7, 14.b |
| Goal 15: *life on land* | Healthy Ecosystems | 15.1, 15.2, 15.3, 15.4, 15.5, 15.8, 15.9, 15.a, 15.b | 15.6, 15.7, 15.c |
| Goal 16: *peace, justice and strong institutions* | Governing for Sustainability | | 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9, 16.10, 16.a, 16.b |
| Goal 17: *partnerships for the goals* | Governing for Sustainability | | 17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7, 17.8, 17.9, 17.10, 17.11, 17.12, 17.13, 17.14, 17.15, 17.16, 17.17, 17.18, 17.19 |
| | TOTAL: | 29 | 140 |

these spheres long recognized (2002 World Summit on Sustainable Development). These connections, however, are not fully developed, nor are they capitalized upon, in the current SDG framework.

The linkages and feedbacks between social, economic and environmental systems are many and varied. Humans rely on services from ecosystems, such as clean air, water and food, for both wealth and security. Meanwhile, ecosystems are transformed by human actions to appropriate these resources, such as deforestation for agricultural or urban expansion, which can leave ecosystems unable to continue to support those crucial services now and into the future (Folke et al., 2002). Indeed, human transformation of natural systems is so profound (Vitousek et al., 1997) that many are referring to this period as the Anthropocene (Crutzen, 2006). Recognition that human development and associated activities are producing environmental consequences on an unprecedented scale and that their effects can undermine development gains in the long-term points to a need for a fundamental reorganization of the way in which the SDGs are currently being framed and discussed.

Despite recommendations following the MDGs to recognize that the global goals are connected and interdependent (Lubchenco et al., 2015), the current SDG Knowledge Platform (see https://sustainabledevelopment.un.org/sdgs) and the supporting UN documentation continue to present the global goals as a linear, enumerated list. This sets the stage for addressing the goals in isolation and in a sequence that prioritizes social and economic goals (Goals 1–13) ahead of environmental objectives (Goals 14–15). The interactions between the SDGs have recently been described and mapped by Nilsson (and colleagues 2016; 2017), illustrating that a more integrated view of the global goals could allow for progress towards one goal to be understood in terms of its cascading impacts on other related goals. Identifying, understanding and quantifying each of the synergistic and antagonistic linkages between the environment and human development presents one of the formidable challenges that those operationalizing the SDGs now face.

We assert here that an important starting point for this undertaking is a reconceptualization of the current SDG framework, whereby the environmental goals, Goal 14 (*life below water*) and Goal 15 (*life on land*), are recognized as a necessary precondition for achieving sustainable development. While a comprehensive list of goals and targets (see Table 1 and SDG Knowledge Platform) has helped the SDGs become more precise and quantifiable than their MDG predecessors (Nilsson, 2017), the many new global goals can be agglomerated into


**Fig. 1.** *The environmental roots to achieving the post-2015 Sustainable Development Goals (SDGs)*. The dependencies of social and economic health on a strong ecological foundation are analogous to a tree. The roots are Healthy Ecosystems – Goals 14 (*life below water*) and 15 (*life on land*) – that provide the basis for social and economic prosperity (branches and canopy) through ecosystem service provisioning and sustainable resource use practices. SDG groupings follow Griggs et al. (2013) and icons are obtained and modified from the SDG Knowledge Platform (see https://sustainabledevelopment.un.org/sdgs). See text for description of individual environmental linkages.

six, more tractable focal areas following Griggs and colleagues (2013): Healthy Ecosystems; Clean Energy; Food Security; Water Security; Lives and Livelihoods; and Governing for Sustainability. Healthy Ecosystems support these other development areas analogously to a tree whose branches depend upon its roots for survival and growth (see Fig. 1); severing the branches and trunk from the roots of a tree necessarily seals its fate. In much the same way, we assert that social and economic goals cannot be attained wholly independent from their environmental underpinnings.

Healthy Ecosystems (Goals 14–15), drawn on by *responsible consumption and production* (Goal 12), can lead to energy, food and water security as immediate outcomes (branches). First, Healthy Ecosystems sustain clean energy by generating renewable energy sources for Goal 7 (*affordable and clean energy*), supplying natural resource industries for Goal 9 (*industry, innovation and infrastructure*), as well as sequestering carbon, essential for furthering Goal 13 (*climate action*). Second, sustainable systems of production, distribution and consumption are necessary for achieving global Food Security (Godfray et al., 2010) and Water Security (Grey and Sadoff, 2007). Safe, sufficient and nutritious food and potable water are two vital ecosystem services that underpin Goal 2 (*zero hunger*) and Goal 6 (*clean water and sanitation*). From this strong environmental and economic base, prosperous Lives and Livelihoods emerge (canopy). By supporting resource-based employment and income generation, Healthy Ecosystems promote Goal 8 (*decent work and economic growth*) and Goal 1 (*no poverty*) for men, women and children of varying socioeconomic status [e.g., Case Study 1]. This can narrow inequality gaps, promoting Goals 5 (*gender equality*) and 10 (*reduced inequalities*). Helping to naturally mitigate disease risk and filter out air, water and soil contaminants, a healthy environment also directly promotes Goal 3 (*good health and well-being*) (Hancock, 1993) [e.g., Case Study 2]. Moreover, the environment provides the basis for environmental education programs and is linked to mental health and cognitive capacity (Bratman et al., 2012), helping to meet Goal 4 (*quality education*). Finally, Healthy Ecosystems supply the building blocks and renewable energy sources required for sustainably achieving Goal 11 (*sustainable cities and communities*). To ensure that ecosystem health is not compromised in the development process, extractive and consumptive practices must be regulated per Goal 12 (*responsible consumption and production*) with international support, cooperation and accountability mediated by Governing for Sustainability through Goals 16 (*peace, justice and strong institutions*) and 17 (*partnerships for the goals*).

Singling out these dependencies is not to say that other connections between the global goals do not exist or are of lesser importance (see Nilsson et al., 2016 and Nilsson, 2017 for full description of SDG relationships). Rather, this exercise serves the main purpose of demonstrating that if environmental health is compromised (for instance, by not being prioritized by global development agendas and policies at various levels of governance) then the already-challenging task of ensuring social and economic health may be made more difficult, and in some cases impossible. The dependence of Goal 6 (*clean water and sanitation*) on unpolluted waterways, or Goal 2 (*zero hunger*) on stable and productive agro-environments, as examples, are intuitive and require little explanation. Less obvious dependencies, however, also exist between other central sustainable development activities and Healthy Ecosystems. For example, life below *fresh* water plays a vital but often overlooked role in reducing poverty in developing nations (Goal 1: *no poverty*) [see Case Study 1]. Similarly, Healthy Ecosystems are key to ensuring reproductive, maternal and child health (Goal 3: *good health and well-being*), with environmental hazards directly linked to heightened disease risk and fatalities in mothers and children [see Case Study 2]. Below we explore the linkages between Healthy Ecosystems and these goals in greater detail.

### 2.1. Case Study 1. Life below fresh water & Goal 1 (no poverty)

#### 2.1.1. Global importance

In contrast with Goal 14 (*life below water*) which focuses singularly on marine life, 'life below *fresh*water' includes aquatic organisms that inhabit inland waters such as lakes, rivers, streams, canals and reservoirs (FAO, 2014). These organisms play vital social and economic roles by supporting recreational fishing mostly in developed countries (Cooke and Cowx, 2004), supplying the trade of ornamental freshwater species globally (Gerstner et al., 2006) and, most critically for developing nations, sustaining inland capture fisheries (Welcomme et al., 2010) – the latter of which bears most significance for global poverty issues and is thus our focus here. The reported annual yield from inland fisheries was 11.9 million tonnes in 2014, representing a 37% increase over the last decade (FAO, 2016). Some 60 million people are involved in inland fisheries and many more derive much of their diet from inland fish (World Bank, 2012).

#### 2.1.2. Links to Goal 1

The contribution that life below *fresh* water makes to food security has been documented and, as abovementioned, is highly pertinent to Goal 2 (*no hunger*) (Béné et al., 2016). Less apparent is the significant role that this also plays in supporting Goal 1 (*no poverty*) and its targets (see Fig. 2; Lynch et al., unpublished results). Take for instance, target 1.2 which states "By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions" and women's contribution to inland fisheries. Globally, upwards of half (46%) of the inland fisheries workforce are women (BNP, 2009), and in the Lake Victoria basin of East Africa, for example, it can be as high as 70–87% of fish workers (Medard et al., 2001). As the primary or often sole providers for

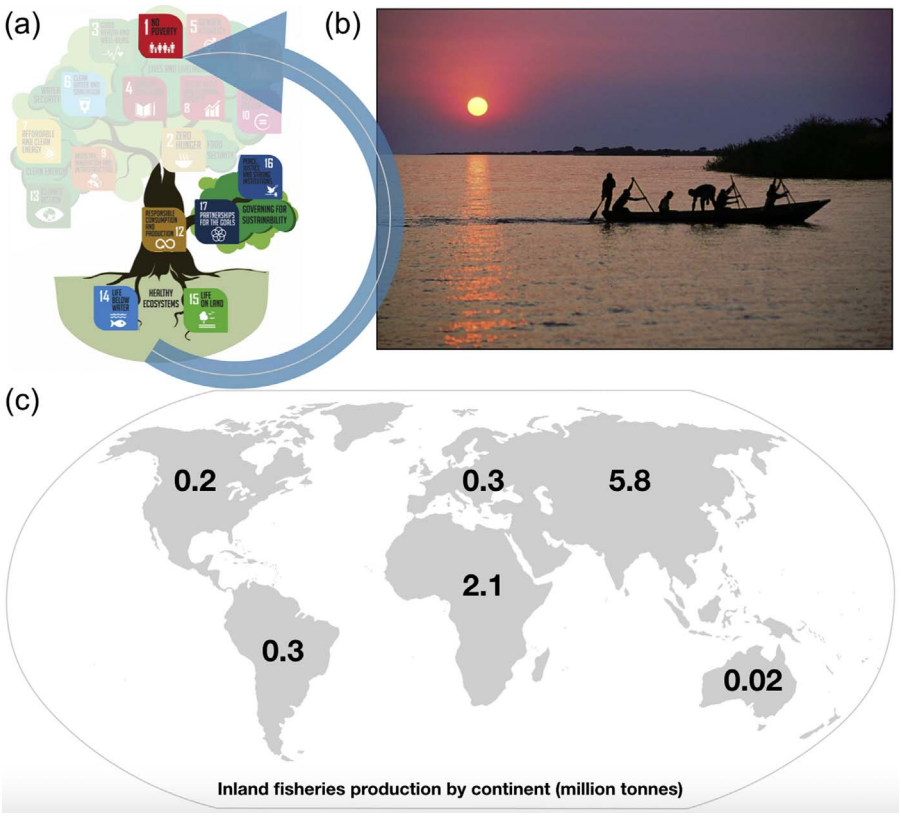


**Fig. 2.** *The vital role of life below fresh water for ending poverty by 2030.* (a) The environmental roots to achieving Goal 1 (*no poverty*). (b) Fishermen on Lake Tanganyika, Zambia (Creative Commons). (c) Global map of inland fisheries production by continent (million of tonnes; data from FAO, 2003).

children, these women rely heavily on inland fish for food and income. As highlighted in Goal 1 (*no poverty*), most people who live on < 2USD per day live in low-income and food-deficit countries in Africa and Asia, and it is here that inland fisheries are most essential to food and economic security, with inland fisheries production being highest on these continents (see Fig. 2c) and fish making up a larger proportion of household budgets in low-income households (Dey et al., 2005).

#### 2.1.3. The problem

Life below *fresh* water, as well as its role in alleviating poverty, is often ignored (Cooke et al., 2016) and is largely omitted from the SDG text. For instance, the only mention of fisheries is within Goal 14 (*life below water*) and solely in relation to marine systems (Targets 14.4, 14.6, 14.7, 14.b). Because freshwater biodiversity faces multiple threats from water users and associated sectors (e.g., overexploitation, water pollution, flow modification, destruction or degradation of habitat and invasion by exotic species; Dudgeon et al., 2006), lack of policy prioritization undermines its ability to contribute to global poverty issues. More specifically, overlooking the role and contribution that inland fisheries make to reducing poverty will make reaching Goal 1 (*no poverty*) even more challenging (Lynch et al., unpublished results).

#### 2.1.4. The solution

Recognizing the foundational role of life below *fresh* water for poverty alleviation in many developing nations is an important first step. The inclusion of inland fisheries alongside marine fisheries in national policy statements and management programs, for example, is one concrete means of better protecting them from the multiple threats present and thereby promote economic and social growth for the poor, prevent further poverty and help to achieve Goal 1 (*no poverty*) as well other targets (particularly food security). Why Goal 14 (*life below water*) excludes freshwater systems is puzzling and directly opposes the UN Food and Agriculture Organization's (FAO) recent recognition of the role of life below *fresh*water for supporting social and economic development (32nd Session; Rome, 11–15 July 2016).

### 2.2. Case Study 2. Children's environmental health & Goal 3 (good health and well-being)

#### 2.2.1. Global importance

Maternal, prenatal and early childhood periods are particularly vulnerable life stages where environmental hazards (e.g., water and air pollution) can result in premature births and other pregnancy complications, lifelong diseases (e.g., respiratory disorders, cancer, cardiovascular disease) and premature death (Drisse and Goldizen, 2017). The environment thus represents a major factor in children's health, with effects seen in every region of the world (see Fig. 3).

#### 2.2.2. Links to Goal 3

Reproductive and children's health are cornerstones of Goal 3 (*good health and well-being*). By 2030, Target 3.1 aims to "reduce the global maternal mortality ratio to less than 70 per 100,000 live births" and Target 3.2 strives to "end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births". While the known connections between public health and the physical environment date back to the mid-nineteenth century (e.g., Dr. John Snow's removal of the Broad Street pump handle to prevent use of cholera-contaminated water; Green et al., 1996), a significant opportunity is currently being missed to improve maternal, prenatal and early childhood health by way of Healthy Ecosystems. In 2015, a reported 26% of the deaths of 5.9 million children who died before the age of five could have been prevented by addressing environmental risks and hazards (Drisse and Goldizen, 2017). While child deaths caused by diarrhoea have fallen steeply during the Millennium Development period (Liu et al., 2015), an additional 361,000 such deaths could have been prevented through access to clean water and sanitation in 2012 alone (Drisse and Goldizen, 2017). Another major children's environmental health concern is malnutrition, for which compromised agro-environments and unpredictable extreme weather events are widespread exacerbating

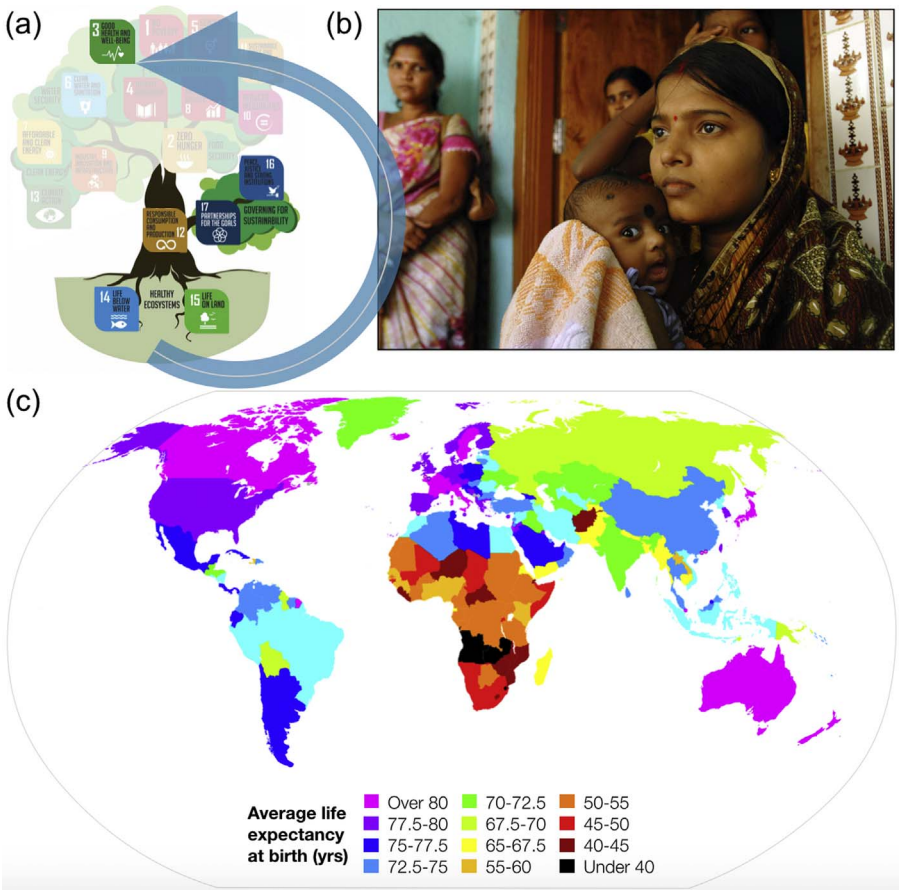


**Fig. 3.** *Children's environmental health is central to promoting global health and well-being by 2030.* (a) The environmental roots to achieving Goal 3 (*good health and well-being*). (b) Mother and child patients of a neo-natal survival unit in Odisha, India (Creative Commons). (c) Global life expectancy at birth in 2008 (data from CIA – The World Factbook 2008); lowest average life expectancies in Africa and Asia.

factors (Wheeler and Von Braun, 2013). Over one-third of croplands are now degraded (MEA, 2005), with nearly one in three people suffering from malnutrition and upwards of half of under-5 mortality attributable to undernutrition (Black et al., 2013). Malnutrition, which comprises undernutrition as well as overweight and obesity, increases the frequency and severity of common infections in children and delays recovery time, leads to stunted growth, and as described, contributes to premature mortality, shortening the average life expectancy at birth, particularly in Africa and Asia (see Fig. 3c; Black et al., 2013).

### 2.2.3. The problem

Children's environmental health is scarcely mentioned in the SDG text. While many of the Goal 3 targets either focus or touch on improving maternal and child health (Targets 3.1, 3.2, 3.4, 3.7), addressing environmental hazards is only made explicit in Target 3.9, which states "By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination", with no connection made to the especially vulnerable maternal, prenatal and early childhood periods. Being a major factor in children's health and with effects seen in every region of the world, the environment represents a major opportunity for improving child health and well-being. By not fully establishing this connection, it is not made clear that promoting Healthy Ecosystems can serve as a means of improving early life health globally.

### 2.2.4. The solution

Because Goal 3 has its foundations in children's environmental health, and as it is children who will inherit the legacy of the policies and actions taken today, it behooves us to build policy frameworks that promote Healthy Ecosystems as an avenue for ensuring children's good health and well-being. Current efforts are identifying the linkages between environmental health risks to children and the SDGs (e.g., Drisse and Goldizen, 2017) and these connections require explicit attention in policies and planned actions to "Ensure healthy lives and promote well-being for all at all ages" moving forward.

## 3. Conclusions

Presented here are two global-scale cases where Healthy Ecosystems are a demonstrated precondition for social and economic well-being, and they reinforce the concerning conclusion that a compromised environmental state undermines the likelihood of achieving progress towards the tightly connected social and economic outcomes. Escalating efforts are also being made to collect examples and case studies of social–economic–ecological systems at the local scale and through a sustainable development lens. For instance, *Beautiful Solutions* and *This Changes Everything* have partnered to gather individual storylines and ideas for approaching the climate crisis as an opportunity for strategic change (see https://solutions.thischangeseverything.org/). Similarly, the *Solutions* peer-reviewed journal–cum–popular magazine publishes real, integrative solutions to current sustainability challenges (see https://www.thesolutionsjournal.com/).

Taken together, examples and case studies such as these can inform and provide models for sustainable development strategies that yield mutual co-benefits. This accumulation of evidence helps to shift the balance away from regarding the environment as a barrier to development (Schultz, 2001), or a competitor for development resources (Panayotou, 2016), towards the perspective that ecosystem health maintenance in fact provides a solution space for social and economic development problems as demonstrated above in Fig. 1 and supporting text, as well as by both case studies (also see Wood and DeClerck, 2015). The nexus between the environment and human development and/or rights can be quite fraught, and there is a current need for accrued examples where co-benefit strategies have benefitted people,

planet and prosperity (e.g., Robinson et al., 2016).

How the gap is closed between the ambitious numerical targets outlined in the SDGs and the current state of the world's human populations and ecosystems in the Anthropocene presents an immense challenge. While reconceptualizing the SDG framework does little in the way of concrete policy changes towards this end, it importantly provides a starting point for this dialogue and is a necessary reformulation if we are to achieve all SDGs by 2030. Recognizing the foundational role of Healthy Ecosystems also makes clear how environmental scientists (one of the main cohorts operationalizing the global goals) fit into the broader development agenda. We believe this connection will empower early-career environmental researchers to approach ecological problems from a multidisciplinary perspective, whereby ecosystem health is managed and maintained for its own sake as well as that of the human users and associated sectors. Given that it is the next generation of scientists and practitioners that will be charged with implementing the SDGs, it seems timely to ensure that those individuals are prepared to embrace the foundational environment that, as we have shown here, underpins our ability to achieve the post-2015 SDGs.

## Declaration of interest

The authors declare no conflict of interest related to this work.

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