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Securing Ecosystem Health for the Well-Being of People and the Planet

Marcello Herńandez-Blanco and Robert Costanza

A crisis of priorities

Society's socio-economic and environmental impact today is so significant that we have entered a new geological epoch called the Anthropocene. We have left behind the Holocene, the last 11,700 years that contained relatively stable climate conditions that allowed the development of our current civilization (Steffen et al, 2011). The precursor to the Anthropocene was the Industrial Revolution. But the Anthropocene did not start in earnest until the middle of the 20th century after World War II. This was the beginning of the "Great Acceleration" due to the exponential growth of human impact on the Earth system (Steffen et al., 2011).

But we may now be moving from the Great Acceleration to the Great Decline (Attenborough, 2020), putting one million species at risk of disappearing (IPBES, 2019) and risking the health of the planet we depend on for our survival. We are approaching global tipping points in endangering our Earth system. Rockström et al. (2009) described 9 Planetary Boundaries which should not be transgressed in order to avoid global environmental risks: climate change, ocean acidification, stratospheric ozone depletion, atmospheric aerosol loading, biogeochemical flows (interference with P and N cycles), global freshwater use, land-system change, rate of biodiversity loss and chemical pollution.) found that humanity has already transgressed two boundaries: the rate of loss of biosphere and biochemical flows. Furthermore, humanity is close to surpassing the boundaries related to climate change and land-system change, both of which are in a zone of uncertainty where risk of transgressing them is increasing.

The transgression of planetary boundaries and the consequent deterioration of planetary ecosystem health is the result of the current economic paradigm which is based on the possibility infinite economic growth. Infinite growth on a finite planet is an obvious impossibility, as stated in the preamble of the Earth Charter: "The global environment with its finite resources is a common concern of all peoples". Therefore, society requires a new vision of the economy, one in which the economy is viewed as a subsystem of the encompassing Earth system, instead of viewing the rest of nature as just another source of resources and sink for wastes. This is a core principle of ecological economics, which, contrary to "growth at all costs" neoliberal economics, prioritizes sustainable scale of the economy and creates the polices to assure that the throughput of the economy stays within planetary boundaries (Costanza, Cumberland, et al., 2014).

Therefore, society's priority should be to find a development path that is based on a symbiotic relationship with the rest of nature and the conservation and restoration of planetary ecosystem health. This is reflected in the seventh principle of the Earth Charter which states that we need to "adopt patterns of production, consumption, and reproduction that safeguard Earth's regenerative capacities, human rights, and community well-being".

The health of complex socio-ecological systems

Human well-being depends on natural capital (i.e. the planet's stock of natural ecosystems and resources) for the provision of ecosystem services (i.e. the benefits people obtain from ecosystems), such as food, water, climate regulation, protection from natural phenomena, recreation and inspiration, among many others (Hernández-Blanco & Costanza, 2019; Daily, 1997; Millennium Ecosystem Assessment, 2005). Nevertheless, natural capital and its services do not generate human well-being in isolation. It needs to interact with human capital, social capital, and built capital (Figure 1 -Costanza et al. 2014).

The provision of ecosystem services depends on healthy ecosystems (Costanza, 1992; Rapport, 1995; Rapport et al., 1998). Costanza (1992) states that "an ecosystem is healthy if it is stable and sustainable, that is, if it is active and maintains its organization and autonomy over time and is

resilient to stress". From this definition, vigor, organization, and resilience are the main features of ecosystem health. The vigor of a system is a measure of its activity or metabolism and can be measured through indicators such as gross primary production and net primary production. The organization of an ecosystem refers to the number and diversity of interactions among the components of the system, which can be measured through its biological diversity and by the number and strength of pathways of exchange among components of the system. Finally, resilience refers to the ecosystem's ability to maintain its structure (i.e. organization) and function (i.e. vigor) in the presence of stress (Figure 1) (Costanza & Mageau, 1999; Mageau et al., 1995).

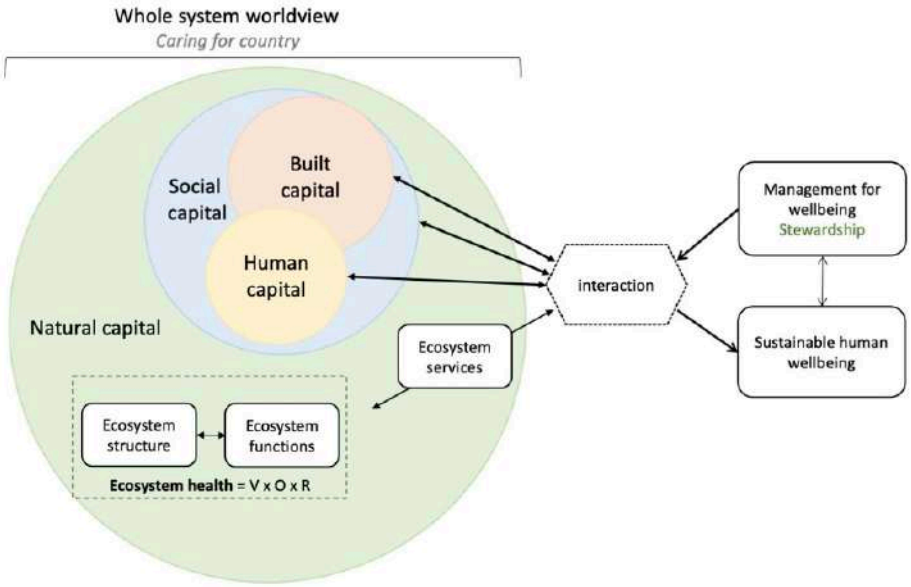

Figure 1: Role of healthy ecosystems in providing human well-being in combination with the other three types of capitals. This framework considers the economy as a subsystem of the broader Earth system, instead of considering nature as just another source of raw materials and sink for wastes. Ecosystem health can change positively or negatively under different ecosystem stewardship schemes. V = vigor, O = organization, R = resilience

(Source: Hernández-Blanco et al., 2022)

Ecosystem health can be expressed as an ecosystem health index, determined by multiplying the ecosystem's vigor (as a cardinal measure) by its organization (as a 0-1 index) and its resilience (as a 0-1 index). In other words, the health index estimates the ecosystem's activity weighted by

indices for relative organization and resilience (Costanza, 2012). Assessing ecosystem health using these three parameters provides a snapshot in time, and a key feature of ecosystems is that they are dynamic, and so is their health. Therefore, assessments of ecosystem health should consider periods of time long enough so they can capture the different phases of ecosystems that are an intrinsic part of their long-term survival.

Planetary ecosystem health will therefore be determined by the interconnected health of the ecosystems across land and seascapes. Protecting and restoring our Earth system for the well-being of humans and the rest of nature will require a whole system worldview, which is in line with the preamble of the Earth Charter which states that "the resilience of the community of life and the well-being of humanity depend upon preserving a healthy biosphere with all its ecological systems". In practical terms, this requires an Ecosystem Based Management (EBM), focused on maintaining the ecosystem's structure and function, allowing the system to maintain redundancies and resilience in the face of changes (Ruckelshaus et al., 2008).

Costa Rica as a lab for planetary well-being

From an early stage as an independent nation, Costa Rica recognized both the intrinsic and economic value of its unique natural capital. We highlight here two of the most significant policies the country has implemented to protect and restore the health of its ecosystems, contributing to the local and planetary well-being of people and the rest of nature.

From 1950 to 1987, Costa Rica had one of the highest deforestation rates in the world, going from 72% to just 21% forest cover (Hernández-Blanco, 2019). This put the rich biodiversity that exists in these ecosystems, as well as the benefits society at all levels receive from them, at risk. This decrease in forest cover was mainly due to the growth in cattle ranching and general agriculture, an activity focused only on the provision of one benefit (i.e. food) at the expense of the wide variety of ecosystem services that the forest provides. To tackle this threat, in 1996 the country established the Forest Law, in which among other things, it prohibited land use change (i.e. deforestation) in all its territory and created a Payment for Ecosystem Services (PES) scheme that was the first of its kind in the world.

This scheme pays farmers to protect and restore forests in their properties as a way of securing the provision of ecosystem services such as climate regulation, habitat for biodiversity, scenic beauty, and water regulation. Twenty-six years after its creation, the PES scheme still provides this economic incentive to private landowners thanks to a constant flow of resources the program receives each year. These come primarily from a fossil fuel tax (3.5% of revenues from the tax) and a water tax (25% of the revenues from a tax on water use), both related to the ecosystem services considered under the program (Hernández-Blanco, 2019).

Only two years after passing the landmark Forest Law, Costa Rica established the Biodiversity Law, which created the National System of Conservation Areas (SINAC by its acronym in Spanish), allowing Costa Rica to consolidate its conservation strategy aimed at halting deforestation. Today, SINAC has 145 Protected Areas (PAs). The management categories within these PAs are protective zones (21%), national parks (19%) and mixed national wildlife refuges (19%). The PAs cover 25% of the continental territory of Costa Rica, and 2.6% of the marine Exclusive Economic Zone (Corrales-Chaves, 2019). The vision of the government of Costa Rica to invest in nature conservation through its network of protected areas has proven to be beneficial not only for biodiversity but for people. Costa Rica has been able to steadily increase its GDP per capita at the same time it has increased its forest cover, currently having one of the highest GDP per capita in Latin America (The World Bank, 2020).

The sustained increase over the years in the extent of the PAs has been a major reason that Costa Rica has become a world-class ecotourist destination. According to the Costa Rican Tourism Institute, between 2016 and 2018, approximately 64% of all tourists who visited Costa Rica did so to carry out activities related to ecotourism (Instituto Costarricense de Turismo, 2019).

Conclusion

The conceptual framework of ecosystem health described here, along with indicators for measuring it, provides the basis for better understanding and measuring planetary well-being, composed by the health of all the interconnected ecosystems across the land and seascape at different

scales, as well as the benefits the entire community of life, including humans, receives from them.

Costa Rica's efforts to protect and restore the extent and health of natural capital provides a clear example that sustainable stewardship of natural capital and social and economic development is not only possible, but they go hand in hand. Costa Rica therefore is a lab of successful ideas to improve planetary well-being, which can only be achieved by first understanding how well-being is intimately related to the well-being of the Earth system, and secondly by empowering all actors to take bold decisions to implement a development path in harmony with the rest of nature.

References

Albrecht, G. A. (2020). Negating solastalgia: An emotional revolution from the Anthropocene to the Symbiocene. American Imago, 77(1), 9–30.

Attenborough, D. (2020). A life on our planet: My witness statement and a vision for the future. Random House.

Corrales-Chaves, L. (2019). Uso, conservación y gestión de la biodiversidad y los recursos forestales. Programa Estado de la Nación.

Costanza, R. (1992). Toward an operational definition of ecosystem health. In Ecosystem health: New goals for environmental management. Island Press.

Costanza, R. (2012). Ecosystem health and ecological engineering. Ecological Engineering, 45, 24–29.

Costanza, R., Cumberland, J. H., Daly, H., Goodland, R., Norgaard, R. B., Kubiszewski, I., & Franco, C. (2014). An introduction to ecological economics. CRC Press.

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., Farber, S., & Turner, R. K. (2014). Changes in the global value of ecosystem services. Global Environmental Change, 26, 152–158.

Costanza, R., & Mageau, M. (1999). What is a healthy ecosystem? Aquatic Ecology, 33(1), 105–115.

Daily, G. (1997). Nature's services: Societal dependence on natural ecosystems. Island Press.

Hernández-Blanco, M. (2019). The Treasure of the Commons: Valuing and Managing Natural Capital in Costa Rica [PhD Thesis]. The Australian National University (Australia).

Hernández-Blanco, M., & Costanza, R. (2019). Natural Capital and Ecosystem Services. In The Routledge Handbook of Agricultural Economics (1st ed.). Routdledge.

Hernández-Blanco, M., Costanza, R., Chen, H., deGroot, D., Jarvis, D., Kubiszewski, I., Montoya, J., Sangha, K., Stoeckl, N., Turner, K., & Hoff, V. van 't. (2022). Ecosystem health, ecosystem services, and the well-being of humans and the rest of nature. Global Change Biology.

Instituto Costarricense de Turismo. (2019). Principales actividades realizadas por los turistas.

IPBES. (2019). Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (p. 1144). IPBES secretariat.

Mageau, M. T., Costanza, R., & Ulanowicz, R. (1995). The development and initial testing of a quantitative assessment of ecosystem health. Ecosystem Health, 1(14), 201–203.

Millennium Ecosystem Assessment. (2005). Ecosystems and human well-being: Synthesis. Island, Washington, DC.

Rapport, D. J. (1995). Ecosystem health: An emerging integrative science. In Evaluating and monitoring the health of large-scale ecosystems (pp. 5–31). Springer.

Rapport, D. J., Costanza, R., & McMichael, A. J. (1998). Assessing ecosystem health. Trends in Ecology & Evolution, 13(10), 397–402.

Rockström, J., Steffen, W. L., Noone, K., Persson, \AAsa, Chapin III, F. S., Lambin, E., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., & others. (2009). Planetary boundaries: Exploring the safe operating space for humanity.

Ruckelshaus, M., Klinger, T., Knowlton, N., & DeMaster, D. P. (2008). Marine ecosystem-based management in practice: Scientific and governance challenges. BioScience, 58(1), 53–63.

Steffen, W., Persson, \AAsa, Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., Crumley, C., Crutzen, P., Folke, C., Gordon, L., & others. (2011). The Anthropocene: From global change to planetary stewardship. Ambio, 40(7), 739–761.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., & others. (2015). Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223), 1259855.

The World Bank. (2020). GDP per capita (current US$)—Latin America & Caribbean. The World Bank Data.

Marcello Herńandez-Blanco (PhD) is an international consultant and speaker for over a decade on topics related to natural capital valuation, green and blue economy, financial mechanisms for conservation, environmental policy design, climate change, and environmental management. He is also a member of IUCN thematic group on ecosystem services from the commission of ecosystem management.

Robert Costanza is a professor of ecological economics at the institute for global prosperity at University College London. He is a global pioneer of trans-disciplinary research at the complex intersection of dynamic human economic and social systems and stressed ecosystems that is informing new models of, and pathways to, sustainable prosperity.