Global resources and resource justice - lost in frameworks and the way forward

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Suppl. File 1 - Definitions (according to Negrutiu, 2022)

Needs and Rights. The imperative of ensuring every person's claim to life's essentials (sufficiency in dignity) and avoid deprivations. The primordial nature of natural capital as commons and a fair access to it are gaining ground.

Resource justice. An institutional logic of resource allocation, redistribution, and governance; a pluralistic process of inclusive justice about collective and individual relationships encompassing the distribution of rights and responsibilities on resources (distributive justice) and the role and ability of stakeholders to contribute to decision-making (procedural justice).

Carrying Capacity. It measures the state of pressures exerted by communities on their environment and on themselves. The carrying capacity of a biological species in a given environment is the maximum population size of the species that the environment can support indefinitely (i.e., a measure of the amount of renewable resources in the environment). If the population size of the species exceeds its carrying capacity, the environment deteriorates more or less quickly and, as a result, the population declines.

The carrying capacity of an area of constant size and wealth should only change as the resource needs of organisms change. This is the case of human societies (Daily and Ehrlich, 1992, Turchin, 2001) following cultural evolutions in the types and quantities of resources consumed (including technological change and changes in land use, fossil resources, etc.). One can therefore distinguish the biophysical carrying capacity, i.e., the maximum size of the population which could be biophysically maintained within the framework of given technological capacities, and the social carrying capacity, i.e., the maxima that could be maintained within the framework of various social systems, such as the patterns of resource consumption associated with them.

Critical Zone is the thin outer layer of Earth's surface, extending from the top of the vegetation canopy down to groundwater aquifers. It involves a mix of biological, physical, and chemical processes at the interphase of lithosphere, hydrosphere, atmosphere, and the living (https://wiki.seg.org/wiki/Critical_zone).

The United States National Research Council's report (2001) defined the Critical Zone as the "heterogeneous, near-surface environment in which complex interactions involving rock, soil, water, air, and living organisms regulate the natural habitat and determine availability of life-sustaining resources".

Planetary Boundaries are the framework of Earth System threshold variables (such as biosphere integrity, land use change, water availability, pollution sources, and climate change) within which humanity can safely operate without endangering the life-support capacities of the biosphere. A boundary defines the low value of uncertainty and risk for a given variable.

Societal Boundaries. Essentially the social capital consisting of sets of institutions, relationships, and norms that shape social interactions and relations in society. The boundaries represent values-driven socioecological processes enabling anticipatory governance as change of analytical and political perspective.

One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. By linking humans, animals and the environment, One Health can help to address the full spectrum of disease control – from prevention to detection, preparedness, response and management – and contribute to global health security. https://www.who.int/health-topics/one-health#tab=tab_1; FAO, UNEP, WHO, and WOAH, 2022)

Planetary Health. The inclusive health of nature-society-people makes the three categories of health indivisible, interdependent, and reciprocal. Planetary Health encompasses societal relationships with nature and universal values, and the actionable, factual, scientific evidence-based policy dimension of socioecological health. (https//:www.planetaryhealth.ox.ac.uk/planetary-health/; https://www.mdpi.com/journal/challenges/special_issues/SG69LG2K7L)

Planetary Health Alliance is a solutions-oriented, transdisciplinary field and social movement focused on analyzing and addressing the impacts of human disruptions to Earth's natural systems on human health and all life on Earth (https://www.planetaryhealthalliance.org/planetary-health).

***Camparing* One Health and Planetary Health**. The definitions and action plans they propose evolve and change over time (Lerner and Berg, 2017; de Castaneda et al, 2023).

One Health tends to be exhaustive essentially on the public health aspects (human and animal health priority area) and has recently integrated broad range environmental aspects. The program is carried out by a quadripartite cooperation between the global international organizations WHO, WOAH (animal health), FAO, and UNEP. This is a political network operating in association with governmental, financial, economic partners, civil society organizations, joint program networks, education and training activities, with national targets and priorities across sectors (Mwatondo et al, 2023). For example, the 200 research networks - concentrated so far in Europe - investigate emerging infections and novel pathogens, endemic infections and Non Transissible Deseases, antimicrobial resistance, and extreme weather, water, environmental degradation, food safety, and food and nutrition security.

Planetary health has been initiated by the Lancet-Rockefeller Foundation commission and the ***Planetary health Alliance*** is built on a strong academic network (400 universities, among which Harvard, Oxford Martin School, Western, London Scool of Hygiene and Tropical Medicine, Sydney, California, Sunway), US and Chinese Academies, but also world leaders and experts from business, government (60 countries), and civil society organizations. The program is focused on teaching and training activities, and targets several environmental and health challenges (e.g., food systems and water, global pollution, climate, human pathologies).

Systemic integrated ecosystem, social, and individual health

(1) The health of nature over the long term. Examples concern biosphere functions and cycles within the critical zone as matrix of ecosystem services and externalities, and food chains as energy and biomass balance systems ;

(2) Social health by guaranteeing equitable access to resources, the foundation of

fundamental rights and social cohesion ;

(3) Human health as a state of complete physical, mental, and social well-being.

Suppl. File1 2 – Nine seminal texts and moments of the 1972-2021 diplomatic landscape. 50 years of science-to-policy agendas.

Olof Palme's Statement, 1972. Swedish Delegation to the UN Conference on the Human Environment
Stockholm declaration, 1972. UN
Brundtland report, 1987. UN
Rio Conference, Earth Summit, 1992.
UNEP-IRP, 2015. UN Policy Coherence SDGs
UNEP-IRP, 2017. Assessing Global Resource Use
UNEP-IRP, 2019. Global Resources Outlook
NASEM, 2021a. Sustainability Science
NASEM 2021b. Our Planet, Our Future

Olof Palme's Statement (1972), the Stockholm Declaration (1972), and the Brundtland report (1987) share narratives on principles and values promoting a socioecological way of thinking (responsibility, equity, solidarity, the commons, planning) to highlight priorities and rules centered on resources/scarcity, pollution, social and economic development (including health).

The Rio Summit (1992), focused on sustainable development (introduced in the Brundtland report in 1987) and its variations linked to the Millennium Goals and their sequel, the Sustainable Development Goals. Rio-1992 is a reflection of the 1980-1990 decade, a decade of commercial and financial liberations imposed by rich countries on the whole world.

The UNEP texts position themselves on strategic priorities, including climate change, chemical pollution and waste, and resources and resource efficiency, out of step with the spirit of the moment, "grow now, clean up later". They emphasize the unrelenting consumption demand based on unsustainable models of industrialization and development, as well as the unequal distribution of benefits from resource use, and their increasingly global and severe impacts on human well-being and ecosystem health.
Finally, the questions and positions of the Nobel Prize winners - brought together in conclave by NASEM, the joint American Academies in 2021 – are of particular societal significance. Here are some examples: Who has the power to decide what a "good transformation" is? Can systemic change arise from local initiatives? The need for a compelling vision to provide direction, to form networks, and weaken dominant structural forces.

Suppl. File 3 – Natural resource and their assessment

Human resources. Humanity at 8 billion is a recent reality, with an increase in living standards as a political horizon. This means that, with policies and technologies close to those of today, an increase in demand for food, water, and energy of respectively 35, 40 and 50% in 2030 is anticipated (Freibauer et al, 2011).

Energy sources, considered fundamental resources, determine our ability to reproduce, recycle, and replenish reserves. Consumption is constantly increasing, with electricity being the dominant demand. Energy pathways currently use 60 different metals. Their availability, functionality, capacity for substitution, and recycling constitute determining criteria in decision-making (Neumayer, 2000 ; Ramirez-Marquez et al, 2024). Market demand for transition minerals is on the rise. Scaling renewable energy technologies comes with new resource frontiers and associated pressures on societies and the environment (Kemp and Owen, 2024).

Water and soil. Pressure on water and reduction in soil fertility must be associated with increased competition for land (production of food, biofuels and biomaterials). For example, water scarcity forecasts indicate that two-thirds of countries will be affected by 2030 (http://water.worldbank.org/node/84122; http://www.weforum.org/issues/water/index.html ; Verburg et al, 2015 ; Negrutiu et al, 2020).

Non-renewable resources: differential scarcity and material intensity concerns. For minerals, the quantities available in the oceans and a 30 km thick earth's crust, as well as the recycling potential, mean that theoretically there is no absolute shortage, except for the energy costs of extraction. In the period 1980-2005, on a global scale, extraction increased by 160%, material consumption by 25%, while demographics increased by 45% (http://www.unep.org/greeneconomy; Dyxson-Declève et al, 2022). The decoupling between economic growth and resource consumption has not occurred.

Biological resources: renewable but exhaustible. The economy based on green carbon is dependent on biomass, and in particular, on primary productivity (Running, 2012). The use of biomass as a multi-use resource is increasing rapidly. For example, green materials in the construction industry are used to improve conventional materials' mechanical properties and as substitutes for conventional ones (such as biobased transparent wood; Boros and Tözser, 2023).With a global 40% of the global land surface representing man-made short-lived biomass (agro-ecosystems being simplified food chains), a theoretical reserve of 10% remains available for non-human biodiversity. The remaining difference of 50% is strictly necessary for the functions and maintenance cycles of the biosphere (Living planet report, 2012; Smil 2013). With the same intensity of consumption and 8 billion inhabitants, the margin will disappear (Barnosky et al, 2012). This is why an expansion of agriculture and other activities beyond 50% of highly anthropized ecosystems is considered a threshold that should not be crossed.

Evaluation methodologies for taking nature into account in economic decision-making. The broad range of approaches, methodologies, and instruments of environmental evaluation that emerged in the last 20-25 years tend to associate or integrate the environment and natural resources concerns into economical accounting frameworks. The underlying goals of these environmental assessments are manifold, from communication indicators to more operational metrics (Vardon et al, 2021). Their capacity to provide aid to decision-making needs science-based validation. At the same time, environmental diagnostics are performed on platforms managed by private operators specialized in the production of geospatialized information through processing of massive data on stocks and fluxes of accessible resources in quasi-real time primarily for profit-making (Google Earth Engine and, more recently, the European network "Earth Intelligence and Planetary health intelligence") (Arguello et al, 2022).

Suppl. File 4 - *Earh for all (Club of Rome report, according to Dixson-Declève et al, 2022)*

Five turnarouns and corresponding key levers

Poverty (expand policy space, trade re-regionalization, new growth models)
Inequality (progressive taxation, trade-re-unionisation, universal basic dividend)
Employment (aducation to all, female leadership and jobs, pensions)
Food (new farming techniques, food-system efficiency, change diets)
Energy (system efficiency, electricity everything, abundant reniewables).

Eleven synthetic parameters (>100 variables and 80 parameters)

« (1) Population sector: generates total population from fertility and mortality processes, potential workforce size, and the number of pensioners.

(2) Output sector: generates GDP, consumption, investment, government spending, and jobs. The economy is seen as a sum of a private sector and a public sector.

(3) Public sector: generates public spending from tax revenue, the net effect of debt transactions, and the distribution of the budget on governmental goods and services (including on technological advance and the five turnarounds).

(4) Labor market sector: generates the unemployment rate worker share of output, and the workforce participation rate, based on the capital output ratio.

(5) Demand sector: generates income distribution between owners, workers, and the public sector.

(6) Inventory sector: generates capacity utilization and the inflation rate.

(7) Finance sector: generates the interest rates.

(8) Energy sector: generates fossil fuel-based and renewable energy production, greenhouse gas emissions from fossil fuel use, and the cost of energy.

(9) Food and land sector: generates crop production, environmental impacts of agriculture, and the cost of food.

(10) Reform delay sector: generates the societal ability to react to a challenge (like climate change) as a function of social trust and social tension.

(11) Wellbeing sector: generates global indicators measuring both environmental and societal sustainability. Including the Average Wellbeing Index.

Eight novelties *that address some of the shortcomings in the global systems modeling field:*

1. Inequality: The distributional effects are investigated in terms of owner and worker share of output from both private investment and public sector activities, confirming the preliminary evidence that distributional patterns are relevant to sustainable policymaking. ex : universal basic divident

2. Ecology: Include the wider effect of the human economy on the main planetary boundaries (climate, nutrients, forests, biodiversity), the impact of natural boundaries on economic development, and their complex feedback effects.

3. Public sector: A model of an active public sector with public infrastructure capacity, welfare policies, and climate-change mitigation policy stance.

4. Finance: Includes the effects from debt and money supply, central bank interest rates, and corporate capital costs, addressing the call for further integration of financial mechanisms within integrated assessment models (IAMs), used to test the feasibility of climate goals.

5. Labor: A global first ability to simulate a recurrent ten-year unemployment cycle, and its macroeconomic consequences.

6. Population: In contrast to the UN's statistical approach, the Earth4All model has endogenous population dynamics affected by investment levels in public spending, education, and income levels, improving on existing IAMs with demographic sectors.

7. Wellbeing: Integrates an ***Average Wellbeing Index*** *(as a function of disposable income, income inequality, government services, the climate crisis, and perceived progress), illustrating the connection between environmental sustainability and social trust, and linking declining trust to public decision-making.*

8. Social tension: Integrates a ***Social Tension Index*** *(as a function of perceived progress, defined as the rate of change in the Average Wellbeing Index) that influences the speed and strength at which societies react to an emerging challenge. Implementing policies to share the wealth and commit to greater equality, e.g., a universal basic dividend, opens the door for the psychological conditions that build the level of social trust and social cohesion. A rising Social Tension Index is interpreted as driving greater polarization in societies, making it more challenging to agree on solutions to societal challenges like the climate emergency. »*

Example :

Average Wellbeing index - quantifies wellbeing through selected variables in the model:

Dignity: worker disposable income, after tax ; Nature: climate change (global surface average temperature) ; Connection: government services indicated by spending per person, i.e., to institutions that serve common good ; Fairness: the ratio of owner income after tax to worker income after tax ; Participation: people's observed progress and labor participation.