Autonomy and its limits in social-ecological systems

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ABSTRACT: Traditionally, autonomy has been perceived through the lens of individualism and internalism, a view increasingly challenged by contemporary biological, cognitive, sociotechnical, feminist and philosophical approaches, as well as by the context of global environmental sustainability. These challenges underline the need to shift from Earth-imposed limits to social-ecological limitations to achieve autonomy, democracy, and sustainability. In the realm of sustainability sciences, the concept of social-ecological systems has been developed to explore the interdependencies between humans and their environments. Despite the significance of autonomy in discussions around sustainability of the multiplicity of social-ecological systems on Earth, its exploration within this field remains limited. The goal of this chapter is precisely to bring to the surface the potential contribution of the concept of outonomy for social-ecological systems and the planetary scale, and conversely to open up the concept of autonomy to the deep planetary-ecological dependencies it carries with it.

KEYWORDS: Social-ecological systems, Earth limits, Gaia, social-ecological outonomy.

> "The need to "stay with the trouble," to not look for a reference that transcends the troubling entanglement of the diverging ways in which a situation matters, is a concern felt by many activist groups today. Such concern is what enables me to discern, and cast my lot with, a new understanding of autonomy as the invention of ways of living, not just surviving, in the ruins—whatever the final outcome."
>
> STENGERS, 2017

1. The modern notion of autonomy and social-ecological thinking

The concept of autonomy, as the capacity of a system to govern itself in terms of self-generated norms, is central to Western thinking and modernity. Its use and significance span from biology (Varela, 1979; Moreno & Mossio, 2015) to psychology (Legault & Inzlicht, 2013), moral philosophy (Mele, 1995), and, social and political theorizing (Castoriadis, 1991a; Hardt & Negri, 2005; Zibechi, 2007). However, autonomy has traditionally been understood as being confined within the strict boundaries of the individual or social system of interest in an abstract, rationalistic and self-sufficient manner. Autonomy, as such, has been questioned at different scales (Armstrong et al., 2019). Still, nothing seems to challenge its core precepts more than that we are crossing the boundaries of environmental sustainability on a planetary scale (Rockström et al., 2009).

Whereas the conditions of the Earth system determine limits to the material expansion of human societies, capitalist economies appear to be constantly defying any external limit. The issue is thus how to transit from the limits that are determined by the functioning of the Earth's dynamics as a life-sustaining system to the self-limitation of human societies as a condition for autonomy, democracy (Castoriadis, 1991a; Kallis, 2017), and sustainability.

Feminist scholars working on relational perspectives such as new materialisms or posthumanism are among those critical of the notion of autonomy conceived as the autopoiesis or self-production of a self-sufficient individual, independent of others (Haraway, 2016; De La Bellacasa, 2017; Tsing, 2021). They share a call to acknowledge interdependencies and caring relations as the basis for all existence, especially for social-ecological thriving. Whereas we fundamentally agree with this call, these criticisms are based on a limited notion of autonomy that, as illustrated in the next section and along this book, has been substantially enriched by enactivist theory.

With Stengers (2017, p. 398), in this text, we aim to *reclaim* a new understanding of autonomy that enables "the invention of ways of living, not just surviving, in the ruins—whatever the final outcome". We argue that an updated notion of autonomy that applies to the Earth system (including humans) is critical at both descriptive and prescriptive levels: first, to better conceptualize the complex adaptive potential of beyond-the-individual social-ecological assemblages; and second, to improve the promotion of the ensuing response-ability (Haraway, 2016) that such a conceptualization brings forth.

2. Autonomy and interdependence in life and mind

The concept of autonomy has been developed in biological and cognitive sciences through the legacy of Maturana and Varela's notion of autopoiesis (Maturana & Varela, 1980). The original focus on operational closure has progressively led to a thermodynamically open (Ruiz-Mirazo & Moreno, 2004), adaptively agentic (Barandiaran et al., 2009), interactively constituted (Gallagher, 2020) and social-ecologically interdependent conception (Escobar, 2018). At its root, the autonomy of life is the capacity of living organisation to sustain itself (far-from-equilibrium in the face of a continuous flow of matter and energy) as a network of production and repair processes (metabolism) while differentiating such a network from an environment it, nevertheless, depends upon. The paradigmatic example is the cell: absorbing molecules from the environment to feed its metabolic reaction network, while producing a membrane that encapsulates the network and mediates with the environment. In doing so, the cell defines a set of viability *norms* (requirements to keep itself alive: temperature, nutrient input rate, etc.) and a *self*: an individual produced and kept distinct from its environment. Yet, as Hans Jonas put it, the relationship with the environment is not an opposing or purely self-differentiating one but one of "needful freedom" (Jonas, 1966).

Enactivism has extended this concept of biological autonomy to the cognitive domain (Di Paolo et al., 2017; Varela et al., 1991). Far from the Kantian self-sufficiency of encapsulated reason to guide behaviour, sensorimotor autonomy implies a radical openness to the environment to constitute mental processes as interactive structures (sensorimotor coordinations, habits, activities, etc.). A fundamental dimension of this openness is linguistic sociality. It is constitutive of human autonomy, leaving it open to a world participated by and with others (Di Paolo et al., 2018). In fact, many worlds, some from an indigenous and decolonial stand, reclaim a deep sense of autonomy rooted in earthly social-ecological communal forms of life (Escobar, 2018). In human life as we know it, autonomy cannot ultimately be fulfilled but through a sense of political autonomy that brings participation to radical democracy and under the material limits of the Earth system (Asara et al., 2013; Castoriadis, 1991b; Maiese & Hanna, 2019).

The notion of autonomy is therefore understood as (re)emerging in different domains or scales: the molecular-metabolic, the multicellular, the neurobehavioural, the sociolinguistic, the political and the social-ecological. However, this last one has, surprisingly, attracted little attention from the complex systems approach to autonomy and to ecology. Some notable exceptions build a concept of function in ecosystems in analogy with that of organismic function (Nunes-Neto et al., 2014) or by drawing inspiration from (Clarke, 2020a) or conflict with (Haraway, 2016) the autopoietic or autonomous concept of organism at ecological and planetary scales.. And yet, the study of social-ecological systems is deeply constituted by some of the ingredients essential to the bio-enactivist concept of autonomy.

3. Autonomy and social-ecological systems

The concept of social-ecological systems (SES) emerged within the field of sustainability sciences to study the interdependencies between humans and their environments (Berkes and Folke 1998; Berkes et al. 2003; Anderies et al., 2004; Ostrom 2009). Rooted in complex systems theory and theoretical ecology, SES are commonly defined as complex adaptive systems (Levin, 1998; Folke et al., 2016), composed of intertwined social and ecological constituents (Schlüter et al., 2020). SES constituents self-organize, giving rise to emergent rules (Ostrom, 1992; Aggarwal & Anderies, 2023) which in turn contribute to the arrangement of the systems' social-ecological patterns (Schlüter et al., 2019). These patterns are conceived as open to networks of connections from the local to the global and *vice versa* (Laroche et al., 2020). Whereas the notion of autonomy has not been explicitly explored within this field, in this section, we map features of SES that speak to an expanded, relational understanding of the concept, with the goal of outlining a conceptual integration and enrichment between different research traditions.

The field of SES research has evolved over time along with the development of theoretical perspectives and through their variegated applications (Colding & Barthel, 2019). Preliminary definitions portrayed two separate social and ecological constituents, with the social constituent self-organizing according to its own institutions aimed at governing the environmental constituent (Berkes & Folke, 1998). The idea of *adaptability* was central to these early conceptions, together with that of resilience, formulated as the capacity of a SES to navigate change without substantially compromising its functions (Berkes et al., 2003). Gunderson and Hooling (2003) defined the adaptive cycle as periodic shifts from stability to transformation driven by non-linear interactions, underlying the idea that SES both persist and adapt through time.

One of the most significant evolutions in the study of SES is the concept of *intertwinedness*. It refers to the idea that the social and the ecological are not separated elements in SES, but are rather co-constituted through continuous processes of intra-action (Schlüter et al. 2020). In this view, social-ecological phenomena, like the collapse of a fishery or the spiritual value of a forest, emerge from multi-level patterns of continuously evolving relations among humans and other living and nonliving entities (Schlüter et al., 2019). This idea of intertwinedness resonates with process interdependence in organizational and enactive accounts of autonomy.

Normativity and viability are fundamental notions in both the autonomy and SES fields. However, these two traditions do not define them in the same way. As outlined in the previous section, norms in autonomy refer to the limits that the system must not cross to remain viable (e.g. to regulate the temperature within survival ranges in an animal or pump ions at a given rate to avoid osmotic crisis on a cell). This conceptualisation resonates with research on the ecological side of SES, where, for example, diversity in the trophic networks has been shown to be fundamental for the viability of ecosystems. Nevertheless, the most common understanding of norms within sustainability sciences is inherited from social scientists' contributions to the field, that is, as social-institutional norms: formal or informal

rules created by social actors to regulate and act upon social-ecological dynamics. Various schools have studied how norms are socially created and enacted, from Elinor Ostrom's studies on local common pool resource management to more ample studies on environmental policy and adaptive, collaborative or multi-level governance (Ostrom, 1992; Newig & Koontz, 2014). Here the conceptual landscape gets complicated. Regulatory aspects permeate different organizational scales and levels of abstraction and concretization: from policies and laws dictated by regulatory institutions (e.g. the EU) to the practical application and integration of such norms in the different SES contexts, or the concrete "needs" and practices of forms of life in SES.

However, the challenge is to move from norms conceived as purely socially contingent to norms as social-ecologically intertwined. The SES literature is only recently engaging this question. Schlüter et al., (2019) distinguish social norms and biophysical rules and structures, such as food webs or climatic conditions, both of which would determine social-ecological phenomena. Linking cultural theory and SES analysis, Aggarwal & Anderies, (2023) advance a conceptualization of governance as emergent social-ecological feedback structures that enable a fine-tuning of SES relations. If we adopt the definition of norms put forward in enactive accounts of autonomy, we could further argue that a social-ecological norm establishes the viability limits of SES as an autonomous system and ensures its ecological and social long-term sustainability.

The enactment of such a norm requires defining viability limits for social-ecological intra-actions within the boundaries of each SES, which leads to the problem of SES not having clearly delineated frontiers. For example, where to set the border of a fishery or a natural protected area is a difficult governance or analytical question. This type of decision is not trivial, as illustrated by the ample literature discussing how to 'fit' social and ecological boundaries (Moss, 2012) and whether these boundaries are 'real' or 'constructed' according to particular analytical goals, scales and methods (Wu, 2013).

Another key point is that SES are open systems and thus their metabolic relations such as food production, fishing, transport, mining, fuel extraction or consumption of technologies, are always open and integrated across multiscale production chains that partially determine social-ecological local practices and regulations (Giampietro et al., 2011; Laroche et al., 2020). For this reason, it has proved to be particularly hard to define their limits in the form of an organizational or operational closure. In global capitalist economies, the capacity of the multitude of SES on Earth to redefine what is good, viable and sustainable for and by themselves, create their own response-able norms and care for their intra-actions is nowadays hampered.

This last problem of establishing the boundaries of SES brings us to the level of the whole earth as the ultimate SES and anchor of autonomy.

4. Gaia: social-ecological autonomy at the planetary scale

The concept of Gaia (the Earth system as a living entity) (Kleidon, 2023; Lenton et al., 2020; J. E. Lovelock & Margulis, 1974) provides a limit case, or the ultimate blender, between the concepts of autonomy (developed in biological theory) and of SES.

To conceive the Earth as an integrated system means questioning the strict separation between living individuals and their environments: both become merged into a single, functional, self-regulated entity. Thus, the concept of life is expanded from being the property of individual organisms and cells to a process that encompasses their collective activity and their surroundings (including the atmosphere and long-term geologic processes). James Lovelock and Lynn Margulis, an engineer and a biologist, presented in their seminal articles (J. Lovelock, 1972; J. E. Lovelock & Margulis, 1974) the idea that the composition of the atmosphere was somehow regulated by living activity on Earth in a way analogous to how an organism is able to achieve homeostasis in its internal variables.

Deeply influenced by her encounter with Francisco Varela, Lynn Margulis vindicated autopoietic thought as a way of emphasizing the independence of biology from physical science, from molecular and evolutionary reductionism, and the self-creative nature of life (Margulis, 1997; Clarke, 2020a). In this sense, the organic conception of the autonomy of life and living systems is at the core of Gaia theory through Margulis. In her view, the simplest autopoietic entity was the single bacterial cell, the largest, Gaia itself. The path from cells to ecosystems is a highly cooperative effort traversed by symbiotic and collectively organized structures.

In a similar vein, Haraway and others have proposed to move from the term autopoiesis to *sympoiesis*. However, these two terms do not substitute each other, and while the term sympoiesis does seem to do justice to the emphasis on symbiosis that was at the center of Margulis's understanding of life, the way in which autopoiesis describes the integrity of the individual cell, and the organized nature of the ecosystem of ecosystems that is the Earth as a whole, is not something to be thrown out with the dirty water.

In Latour's reading (2015), Gaia is stripped of its cybernetic background, claiming that any such conceptual apparatus is necessarily reductive, top-bottom, and ultimately theological, and based on a project of engineering control. However, this does not account for the rich discussions in second-order cybernetics where the possibility of strictly separating an active observer from a passive functioning system has been questioned, pointing to the necessary integration of observer and observed in a "second-order" system which relativizes any project of total control (Clarke, 2020b). Moreover, the subsequent development of complex theories of biological autonomy brings the opportunity for a bottom-up, non-reductive approach that sustains the living (by definition) out of heteronomous control. Stripping Gaia theory from any sense of autonomy is not only a historiographical mistake but also a political risk.

The climate crisis makes it clear that there are some "norms" at a planetary level that have been broken, something is "malfunctioning" (Rockström et al., 2009). It is through this malfunction that the normative functioning becomes visible and involved in a practical

problem: that of addressing climate change and building a sustainable future. Any discussion about SES sustainability and autonomy is thus necessarily enmeshed with that of global sustainability. The possibility of autonomy of local SES, at the scale of certain human-cultural and ecosystemic life-forms (like those of indigenous social-ecological systems), might be about to get irreversibly lost in the capitalocenic acceleration. This acceleration is bringing planetary scale autonomy (Gaia) down to the human scale SES, rapidly merging local SES into a global supply and inter-affected network.

Ultimately, here is the paradox: the modern category of autonomy, encompassing biological, moral and political spheres, as independent individual self-governing, cannot find any satisfying member other than the earth-system. This is the only form of living existence that, floating in the void, only depends on the energy of nuclear reactions of the sun and planetary nucleus. Below this, we are deemed to live outonomously, that is, acknowledging and bringing forth our deep mutual interdependence and the one we establish with the (non-living yet life sustaining) environment we produce.

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Global warming, the loss of biodiversity or the acidification of the oceans calls into question the individualistic vision of self-regulation and self-sufficiency that the modern conception of autonomy brought with it. It forces us to think that if the concept of autonomy has an ontological, epistemic and normative value, it is because it is necessarily relational, non-anthropocentric, and increasingly open to include larger scales of caring. We have argued that an updated notion of autonomy, as developed in organization and enactive traditions to the philosophy of biology and mind, can meet contemporary trends and can contribute to identifying limits, norms and regulatory capacities in SES research. We have argued that it is even crucial in order to enhance our capacity to design for (Escobar, 2018), to commit to and to inhabit more sustainable shared forms of life, ultimately encompassing the whole earth as an autonomous form of life

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