

Interweaving the Sciences: the transdisciplinaryization of the Anthropocene

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ABSTRACT – Interweaving the Sciences: the transdisciplinaryization of the Anthropocene. The Anthropocene has been considered a geological period of high risk due to the indiscriminate use of natural resources and the lifestyle assumed by the world population, to the detriment of ecosystem conservation. The set of problems requires a transdisciplinary scientific approach due to its complexity. But despite considerable advances, the anthropocene model is still considered controversial by the social sciences and humanities. The article brings the transdisciplinary approach as a methodological and epistemological tool to improve the connections between natural and human sciences in a new perspective to face realities (non-resistance zones) that underpin anthropocene transdisciplinaryization.

Keywords: Levels of reality. Transdisciplinaryization. Anthropocene. Socio-Environmental Crisis. Transdisciplinary research.

RESUMO – Entrelaçando as Ciências: a transdisciplinarização do Antropoceno. O Antropoceno tem sido considerado um período geológico de alto risco devido ao uso indiscriminado dos recursos naturais e estilo de vida assumido pela população mundial, em detrimento da conservação dos ecossistemas. O conjunto de problemas requer uma abordagem científica transdisciplinar devido à sua complexidade. Mas, apesar dos avanços consideráveis, o modelo antropocênico ainda é considerado polêmico por parte das ciências sociais e humanidades. O artigo traz a abordagem transdisciplinar como uma ferramenta metodológica e epistemológica para aprimorar as conexões entre as ciências naturais e humanas em uma nova perspectiva para enfrentar realidades (zonas de não resistência) que fundamenta a transdisciplinarização antropocênica.

Palavras-chave: Níveis de Realidade. Transdisciplinarização. Antropoceno. Crise Socioambiental. Pesquisa transdisciplinar.

Introduction

Since its publication by Crutzen and Stoermer (2000), the term Anthropocene has aroused the general curiosity and consequent concern of researchers with the future of the planet. It would be a time when humans became the most influential species, causing significant global transformations and structural changes in the land, environment, water, organisms, and atmosphere.

Years later, Oldfield et al. (2013) stated that some researchers still treated this geological epoch under construction with some distance but considered part of its underlying, regardless of whether or not they accepted the formal geological recognition proposed by the conceptual model. Seeking to resolve doubts, these authors suggested the methodology of transdisciplinary research for a better understanding of the Anthropocene. Apparently, Oldfield et al. (2013) directed their eyes to transdisciplinary research of the Anthropocene, but not to the core of transdisciplinarity itself.

Transdisciplinary research has been endorsed by several researchers discussing the challenge of the Anthropocene, e.g. Oldfield et al. (2013); Palsson et al. (2013); Lewis and Maslin (2015); Brondizio et al. (2016); Ellis et al. (2016) and Andrade Júnior (2020a).

Transdisciplinary research is characterized by a specific type of research that unites knowledge and non-knowledge in the transdisciplinary ideal. It transgresses formalities in favor of an educational model committed to concentrating concerted efforts in the construction of universalist knowledge that does not deny any form of diversity in the formation of undisciplined and capable thinkers (Morin, 2002; Carvalho, 2008) and is attuned to a new form of learning and problem solving that involves cooperation between different parts of society, including the “academy”, in order to face the complex challenges of society and nature. Through mutual learning, the knowledge of all participants is enhanced and this new learning is used to create collective solutions to intricate problems that are commonly intertwined in projects involving many disciplines (Roux et al., 2010; Hadorn et al., 2008).

Less discussed in the context of the Anthropocene and its research is the pressing question about disciplinary differences (Toivanen et al., 2017). The barriers brought about by disciplinary differences, judging by Haraway’s piquant commentary, include the social sciences and humanities in this debate:

Arguably, the Anthropocene challenges us to radically rethink what nature, both humans and politicians and the historical relationship between them could culminate, peppering its message of environmental destruction with the promise of renewal (and global survival) through transdisciplinary collaboration (Haraway et al., 2016, p. 535).

Transdisciplinary theory (TT) is a robust theory that addresses three types of research questions: (a) questions about the genesis and possible development of a problem field and about problem interpretations; (b) issues related to the determination and explanation of practice-oriented objectives, and (c) issues concerning the development of pragmatic means (technologies, institutions, laws, standards, etc.) as well as the possibility of transforming existing conditions (Pohl; Hadorn, 2007).

The main objective of this article is to contribute to the best advance of the transdisciplinarization of the Anthropocene. However, I do not augur only to present TT as a probable approach to the Anthropocene that crosses disciplinary boundaries or as a primary methodology for the Anthropocene to be convinced, since the model encompasses the planetary perspective. I try to show that the use of the transdisciplinary research tool by itself, as is being emphasized, is not effective in convincing the thinking of other disciplines. This only comes with the transdisciplinary joint effort that transgresses such disciplinary boundaries beforehand of the goodwill of the parties. I also argue that the ontology of transdisciplinarity should be better understood by different scholars of the natural, social and human sciences. And that it should be practiced through transdisciplinary actions in a “shared Anthropocene”, underlying a process of transdisciplinarization.

Probably, the actions to convince about the effectiveness of bringing the natural sciences closer to the social and humanities towards Anthropocene would be launched in three main directions with the objective of: (i) approaching and illuminating the transdisciplinary notion of levels of reality collaborating in the cross-interpretation of the conceptual derivatives generated from the problematization of the anthropocene model; (ii) to narrow the disciplinary spaces between the natural sciences, social sciences and other sciences (e.g. sciences of religion, philosophy) with their applications (e.g. philosophy of science, an applied ontology of nature, ethics, semiotics, quantum physics, nanotechnology, biotechnology, robotics, etc.) and (iii) to stimulate the integration of the major areas of science, art and the sacred with some transdisciplinary praxis in the Anthropocene, performing the expected transdisciplinarization.

The structure of the sections is as follows: I begin with a brief context of the Anthropocene and follow the influx of neologisms and derivations constructed and brought by the social sciences and humanities from the anthropocene model, in response to the planetary crisis. I presume this is a section to present some facets of the narratives that oppose the generalized model of the Anthropocene. Next, I present a brief ontology of transdisciplinarity for a destination of the TT model. I bring a perspective of articulating levels of reality that can be applied to the anthropocene model, and then show some challenging nuances to disciplinary thinking when it comes to conducting transdisciplinary research and transdisciplinarization. I differentiate what is a disciplinary methodology from what is a transdisciplinary methodology, drawing

attention to the transdisciplinary contradiction. Next, I present the TT concept of non-resistance zones and highlight transdisciplinary studies for different areas of knowledge. Finally, I discuss how the theme of sustainability can be explored as a transdisciplinary research exercise in a *shared Anthropocene* in TT's view.

The Influx of Neologisms and Derivations of the Anthropocene as a Response to the Planetary Crisis

The term Anthropocene had been used non-rigorously for some time, but it advanced abruptly from the moment it was used by Crutzen, winner of the Nobel Prize in Chemistry in 1995¹. The notion that we are entering a new era of Earth called the Anthropocene was suggested in an article published in the *IGBP Global Change Newsletter*. The authors of the paper, then-IGBP vice-president and Nobel Prize winner Paul Crutzen and Eugene Stoermer, presented the circumstances of the critical situation in planetary terms (Crutzen; Stoermer, 2000). Two years later, Crutzen published the article *Geology of Humanity* in the journal *Nature* (Crutzen, 2002) arguing that the last decades of the 18th century should mark the beginning of the Anthropocene.

The aforementioned phenomenon of the “Great Acceleration” (of degradation) caused by the human factor is marked by a series of graphs of socio-environmental trends from the period 1750-2010. The model suggests significant changes in at least 10 of 12 Earth System indicators that track the change in the main characteristics of the structure and its functioning: atmospheric composition, stratospheric ozone, climate system, water and nitrogen cycles, marine ecosystems, terrestrial systems, tropical forests, and degradation of the terrestrial biosphere. With the exception of the hole in the ozone layer and the concentration of methane in the atmosphere that showed some stabilization in the first decade of this century, authors claim that all ten other indicators of degradation are on upward exponential trajectories (Veiga, 2017; Steffen, 2015a; 2015b). Other “candidates” for indicators could be found, for example, in the percentage of Arctic Sea ice loss, but the goal demonstrated by Steffen et al. (2015a) was to show general and long-term trends at a broad systemic level.

Although the term Anthropocene is already widely used the validation of the model runs into an obstacle: the international stratigraphic table. This table is made by the International Commission on Stratigraphy (at geology domain). This commission composed of a vast team of researchers aims to assemble the table of geological time so that there is an academic consensus on the established times and ages, generating concise publications that follow a pattern². To establish the chronological table the commission follows the convention that there must be a significant difference in stratigraphy overall so that there is a new division (new stratigraphic category) in the table.

The notoriety of the *baptism* of the Anthropocene led the Stratig-

raphy Commission of the Geological Society of London to claim that the concept had merit to be studied in detail regarding an eventual formalization (Zalasiewicz et al., 2019). The contention made by some scientists that the human being can in fact significantly disturb not only the parameters of the “Earth System” but also, as a consequence, the course of the geological evolution of the Earth strongly confronted the widespread response of the geological community to the ancient suggestions of a “human age” (Steffen, 2011), which has always rejected it on the grounds that the great forces of nature operate on a wider scale and with effects in the longer term than any kind of human impact (Zalasiewicz et al., 2019).

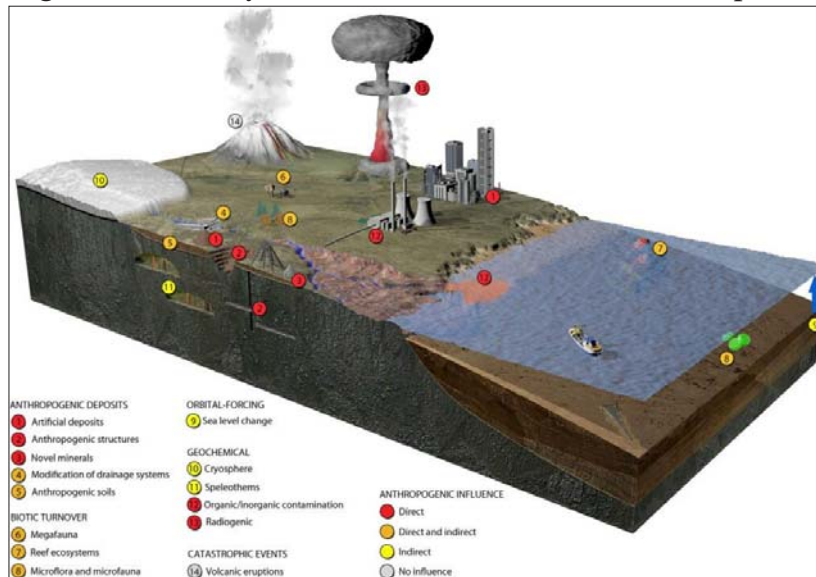
The last epoch of the stratigraphic table is the Holocene, which would have begun 11,700,000 years ago. Before that time, planet earth was in the Pleistocene. The boundary between these two times was established by the end of the ice age and the extinction of a megafauna. Due to this rule, it becomes a very difficult mission to delimit an exact time marker of the new conceptual epoch and in this there is the main setback. Among the various factors that can be used to characterize the Anthropocene, we can mention technofossils, the destabilization of reefs and the emergence of new minerals³.

As we have seen, not all natural science researchers – such as Waters et al. (2016) and Steffen et al. (2015a) – agree with the fact that these changes represent sufficient evidence to declare a new formal geological epoch with the name baptized Anthropocene, in which the human being is the main agent of transformation. Scientists around the world are still debating about it. Until this question is resolved we live in the Holocene.

But surely what can be recognized intuitively in the “Anthropocene” is that it is a troubled, globally wide-ranging period of problems and seemingly decisive for humanity.

However, a strong critique from history and the social sciences rests on the anthropocene model. For some environmental historians, the model starts from a scenario in which the:

Earth as a system seen from nowhere where there is a competition between the human species and the planet and from the perspective that societies are ignorant and passive masses that can only be guided by scientists, depoliticizing history [...] (Bonneuil; Fressoz, 2016, preface).

Figure 1 – Boundary markers between Holocene and Anthropocene

Source: Reconstituted by Oliveira (2022) from the work of Waters et al. (2016).

Haraway (2015) and Chakrabarty (2015) had already begun to discuss all this. Subsequently, weaknesses related to each of the likely approaches are discussed together by other anthropologists (Haraway et al., 2016). For Anthropology and Sociology focused on the plurality of cultures the fact that geoscientists insist on bringing to the forefront the guilt of the human species in general has enormous curricular consequences, reordering values and meanings (Latour, 2017).

De Freitas (2019) had stated that the *New Regime of the Anthropocene* already implies broad power for man because he is definitively marked by the geological record. Bonneuil and Frescoz (2016) promoted a deconstruction of the narratives of the Anthropocene by presenting historical narratives still little considered and discussed that encompass different dimensions of anthropocene study in a global context and at a planetary level.

In fact, there are many critical narratives in historiography according to Simon (2020), and this role of confrontation and resistance to the generalist model of the Anthropocene has been spearheaded by history and the social sciences, with emphasis on anthropology and sociology. The multiplicity of neologisms and derivatives of the explosion of the concept of the Anthropocene seems to be contribution to the state of the art of environmental political history in the reliable geo [+] political or geo [+] cratic sense⁴.

Such narratives also reflect disciplinary differences. There are several approaches that affirm the existence of (disciplinary?) “boundaries” of the Anthropocene, according to Haraway (2015) such as the Capitalocene (Moore, 2016), the cacophonous *Antrobscene* (Parikka,

2015), the *Chthulucene* (Haraway et al., 2016) and the *Plantationocene* (Tsing, 2017). Still, Swyngedouw and Ernstson (2018) call *Anthropo-Scenes* the fractured and heterogeneous narratives that depart from geoengineering and Earth sciences that place things, human and non-human alike inside a certain straitjacket prepared by some and used as necro [+] politics in others.

In the evolution of the discussion there is already a new configuration of *Plantationocene* (Murphy; Schroering, 2020, p. 403) in which the danger of conceiving the *plantation* as “a multispecies group without the proper theorization of colonial power” is presented. In invoking it, these authors have suggested that one of the main ways in which humanity is leading the planetary transformation is through plantations for economies of scale (Kenney-Lazar; Ishikawa, 2019), extremely degrading at the systemic-global level.

The intention so far has been to show that social researchers from different disciplines follow the problem. But, after all, what would be the role of the social sciences in the Anthropocene? How can they have significance in an age so dominated by natural or technological science?

To briefly show even more about the diversity of dimensions of competency analysis of the social sciences with criticisms of the model, I emphasize the ultra-recent summarization of Léna and Issberner (2022, preface, p. 2-7) through some excerpts:

- i. *on disciplinary alienation*. The notion of the Anthropocene unquestionably allows the social sciences and humanities to enter the territory of the natural sciences which requires a movement of insurgency against the disciplinary boundaries that have alienated us from the natural world. The insurgency movement proclaimed by the social sciences is against generalizations;
- ii. *on the acceleration of degradation*. It has become increasingly obvious that addressing each ecological crisis in isolation and seeking technical-scientific solutions in an endless quest is not up to the task. It is not a question of dealing with “external” effects affecting “nature” but of analyzing the way society functions that makes these degradations functional, as part of the system;
- iii. *on denialism*. Sustained by powerful interests and various forms of scientific denialism but also by the legitimate desire of the low-income population to achieve the much-promised level of well-being and consumption of the upper middle classes, “crescentism” is still in a hegemonic position. However, it is contested not only by scientists – see the latest reports by the Intergovernmental *Panel on Climate Change* (IPCC) and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) – but increasingly by members of international institutions, (minority) political parties and organised activists;
- iv. *on the warning of the global threat*. The “system” tries to take into account the alerts without abandoning the accumulation

model. The result is the so-called green economy. Profitable activities move to promising sectors such as solar panels and wind energy, but still follows the main degenerative pattern of the mass production of new commodities, increased extractivism and the occupation-appropriation of spaces;

v. *about domination*. Dualism is widespread and deeply embedded in western thought with several variants, one of which is the cleavage of man and nature. The “dualistic mentality” involves an implicit value of what is superior (man) *versus* what is inferior (nature) thus legitimizing domination and exploitation;

vi. *on inequalities*. In a concomitant and interconnected way there is the perception that the industrial-capitalist system is no longer in a position to realize the promises of modernity. We have witnessed the accentuation of inequalities, the multiplication of conflicts, an exacerbation of violence, the permanence and even the (recent) worsening of extreme poverty;

vii. *about the movements*. Faced with this impasse relying on the warnings of scientists, movements emerged in the early 2000s proposing demo-economic degrowth or warning of imminent environmental and civilizational collapse. They are internally heterogeneous but share most of the diagnosis with each other. There are debates about the possible scenarios, domino effect from the disruption of global supply chains (droughts, floods and/or wars), sudden change of the climate regime, conflicts, etc. They do not intend to create a new discipline, although initially formed mainly by intellectuals but a political project. The main task being to denounce the blindness of society in the face of the impending catastrophe and to influence the decision-makers. The rupture with the hegemonic model is total; and

viii. *on (de)coloniality*. (De) colonial thought has brought together a wide range of researchers from the global south who with a vast critical work rescue worldviews that have been hidden and marginalized by the colonizing logic. The term “decolonial” has been used broadly to refer to different schools of thought, such as post-colonial, subaltern, or cultural studies. In the view of this thought the model of universal knowledge consecrated as superior which supplanted other types of knowledge considered inferior, such as the knowledge of indigenous peoples, blacks, women, is exhausted.

A Brief Ontology for the Transdisciplinaryization of the Anthropocene

Prior to Nicolescu's⁵ formalization of the so-called “Manifesto of Transdisciplinarity” (Nicolescu, 1999), global level thinkers born in the first decades of the twentieth century organized the conceptual discussion and the implementation of the bases for the transformation of education in more realistic ways and at the planetary level. It was the time of an intense global political conflict. Erich Jantsch (1972), an astro-

physicist, would have formally presented his transdisciplinary version in the article *Inter and transdisciplinary university: a systems approach to education and innovation* in which he characterized that education systems and universities should be considered a system of education with integral innovation in order to increase society's capacity for continuous self-renewal.

It is around these 1970s that transdisciplinarity gains the discursive space of major international organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Organization for Economic Cooperation and Development (OECD) which began to support and promote debates, seminars and colloquia, drawing attention, precisely, for the need to improve the link between knowledge. As well as the relations between university and society in a context of epistemological crisis that would erupt in the light of a political and social crisis. Striking in this regard were the colloquium *Science Facing the Frontiers of Knowledge* the congress *Science and Tradition: Transdisciplinary perspectives for the twenty-first century*, the *First World Congress of Transdisciplinarity*, and the *International Congress of Transdisciplinarity* whose theme was "Which University for tomorrow? In search of a transdisciplinary evolution of the University". All of them were organized or supported by UNESCO between the 1980s and 1990s (cf. Sommerman, 2003)⁶.

For a Realistic, Defragmented, and Planetary Education

At the time, Jean Piaget had shown the tendency to defragment modern disciplinary thought. In its initial idea the emergence of the transdisciplinary would overcome the interdisciplinary, but according to Alvarenga, Sommerman and Alvarez (2005) what was observed in the future developments was a different movement resulting from the broad process of discussion held in various international meetings and congresses in the following decades, notably from the second half of the 1980s. In the official documents there is a recognition that interdisciplinarity and transdisciplinarity are closely related; that are not excluded and will not be excluded in the new process of development of science, nor will both exclude disciplinarity, multi and pluridisciplinarity. The justification for this is that these, in their own set, represent different degrees of possibilities of treatment of reality through the recognition of the existence of its different levels (Alvarenga et al., 2005).

Therefore, the aspiration for an articulation between the disciplines so that the teaching-learning process was closer to the real scenarios is not new. Transdisciplinarity has been used more commonly in teaching and in the field of education, precisely because of its reflective role on the disciplinary content and on the interrelation of educational themes (Pires, 1998).

The transdisciplinarization of research in favor of the Anthropocene

To problematize the limits of each discipline is to question it at its own freezing points and universality. In fact, in the transdisciplinary perspective we are bet for “[...] nomadizing the borders and make them unstable: to chaotize the fields, destabilizing them to the point of making them plans for the creation of other object-subjects” (Passos; Barros, 2000, p. 77). Transdisciplinary research provides this reflective beyond.

Transdisciplinary research exhibits this deconstructive peculiarity to construct again from meanings once despised. Lencastre (2008) states that studies on the adaptation of scientific knowledge to the public space show that the linear model of the transmission of so-called “pure” knowledge between experts and laypeople has been replaced by an idea of “negotiation of meanings” that takes place at various levels, at different times and involving people from different socio-cultural contexts.

In the meetings of negotiation of meanings so-called scientific references are also liable to be questioned by those outside the scientific educational system, based on the assumption that there are levels of reality to consider in all problems. They are exercises and clashes that will follow the process of knowledge production that will also influence the production of new content and new emerging disciplines.

Transdisciplinary research has already been applied to several areas of knowledge (Hadorn et al., 2008) with specificities and recognizable characteristics (Wickson; Carew; Russell, 2006), in the search for the recognition of the literature of what is transdisciplinary (Klein, 2008), questioning its expansion and methodological reason (Pohl, 2011), deciphering the structure of transdisciplinary thought (Pohl; Hadorn, 2007), oriented to public policies (Pohl, 2008), and as a methodological challenge (Pohl; Hadorn, 2008), in the direct direction of sustainability (Lang et al., 2012), as a potential link between health and social sciences (Rosenfield, 1992), in historicizing versions (Kessel; Rosenfield, 2008), in leadership (Gray, 2008) or as a methodological tool for transdisciplinary research projects (Roux et al., 2010).

The problematic of the Anthropocene points us to the unusual methodological destiny (trans) that allows the integration of perceptions, experiences, facts and data to assist in decisions. From the various narratives, we saw that there are many developments in the study of the Anthropocene, with its peculiarities. Belcher and Schmidt (2021) have recently signaled that industrialism, colonialism, wars, threatening technologies, genocides, slavery, nuclear power, and capitalism itself are articulated differently, but often related to the inequalities of social conditions that lead to planetary forcing.

The three pillars of transdisciplinarity: levels of reality, the logic of the included third and complexity

Nicolescu (1999) stated that the transdisciplinary theory was based on three pillars: the levels of reality, the logic of the included third and the complexity, which determined the methodology of transdisciplinary research and supported the epistemic-methodological principle of transdisciplinarity. It represented a severe blow to the classical view of the world, because it was obvious that, in order to understand something that presents itself as complex, it would be mandatory to have a complex and transdisciplinary epistemology⁷.

The first pillar: levels of reality

The first pillar of transdisciplinarity shows that reality is constituted by different levels, such as the material level and the virtual level. This presupposes that it is necessary to take into account that the biophysical and cultural reality is multidimensional and that it is a mistake to consider it in a simple and linear way based on a one-dimensional perception. Reality is multidimensional in its constitution.

According to Nicolescu (1999), a level of reality is a fold of the set of levels of perception and a level of perception is a fold of the set of levels of reality. The real is a fold of the imaginary and the imaginary is a fold of the real. And this perception of the different levels of reality produces and enables different levels of understanding.

Transdisciplinarity is complementary to disciplinary approaches and arises from new data, facts and interactions. Nicolescu (2008) says that the theory is marked by the presence of different levels of reality, in which not only the space between the disciplines involved in a problematization is full of information, emphasizing a methodological cross-border. Thus, the theory of transdisciplinarity refers to the transgression of boundaries between disciplines (Nowotny, 2006) for the integration of different forms of knowledge, practice and research, and leads to a better preparation to face the always complex socio-environmental crises recognized and announced by Leff (2006) which are explored synthetically in the text of Martins and Araujo (2021).

The consideration of the levels of reality is a fundamental input for the applicability of transdisciplinarity in science and everyday life and is its main ontological foundation. In transdisciplinary theory, reality is different from something to be experienced individually, spatially or temporally in the physical world, according to a single point of view. Levels of reality are analytical categories that must be discussed together based on the experience shared by all agents. Thus, the transdisciplinary ontology respects the complex and dynamic relationships between these different realities organized into three levels of reality:

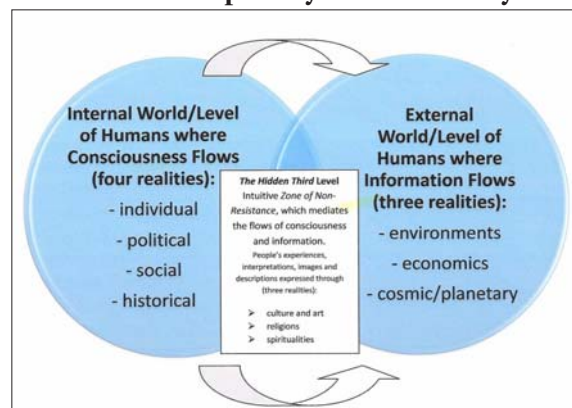
- i. the *internal world of humans*, in which consciousness flows - the transdisciplinary subject (including political, social, organizational, historical realities);

ii. the *external world of humans*, in which information flows - the transdisciplinary object (including environmental, economic, and planetary realities), and

iii. the *hidden third*. People's experiences, interpretations, descriptions, representations, images and formulas are on this third level. The interesting thing about the difference between non-transdisciplinary methodologies is at this point, since these analyze the phenomenon or the object within dimensional analytical frameworks such as social, cultural, environmental, political, etc. They may take into account the experience of the researcher (agent), but most of the time this is not shared. The validity of transdisciplinary actions is consistent with great secrets that may be involved in this third level of reality. For example, a strong analytical-methodological tool aligned with the recognition of the third level is interpretive ethnography, simultaneously minimal, existential, autoethnographic (Denzin, 2014), vulnerable, performative and critical (Denzin, 1999). This ethnography "[...] seeks to ground the self in the sense of the sacred, to connect the ethical and respectful self with nature and the worldly environment. In so doing, it recognizes the ethical unity of mind and nature. It seeks to embed the self in storied histories of sacred Spaces" (Denzin, 1999, p. 510). In this field approach is situated the transdisciplinary sense in which the third level of reality is exercised in the agent-subject-object relationship at the same time.

Figure 2 below adapts to the research model of the Anthropocene and points to the dimensions derived from the conceptual Anthropocene, signaling transdisciplinaryization.

Figure 2 – Synoptic diagram of the dynamics between the transdisciplinary levels of reality



Source: Adapted by the author from McGregor (2011b).

*Non-Resistance Zones*⁸

In this shared space, which I regard as a *shared Anthropocene*, people would lose resistance to truth informed by other realities and join those realities. There are transdisciplinary research challenges on transcendent themes of the Anthropocene that span the sciences of religion, music (Andrade Júnior, 2018), fine arts, theology, philosophy, quantum physics with metaphysics – and why not include deep ecologists to discuss the earth system, autopoiesis and self-regulation and the meaning of creation or evolution in the face of the imminent human responsibility that the Anthropocene presents?

Other issues are equally important, usually much more scandalous and remarkably undertheorized and which can be transdisciplinary. Some questions would still require a rejection of appeals to epistemology and maintain an analytical focus in research on the production of ignorance (intentional or not) in the Anthropocene as the probable uncertainty of the finiteness of the Earth or simply on the realities of an ignominious Anthropocene.

It is a challenge that presents itself because even philosophy, art and politics as disciplines fully conform to the intrinsic resistance of a level of reality, says Nicolescu (1999), creator of transdisciplinary theory. Even the “metaphors of God” insofar as they are integrated into a theology can correspond to a level of reality: theology is, after all, a human science like the others. However, religious experience and the experience of inspiration are difficult to assimilate into a single level of reality. They correspond much more to the crossing of different levels of reality through the “zone of non-resistance” (Nicolescu, 2012a). There are realities in this intuitive zone of non-resistance underlying culture and art, religions and spiritualities. The three levels of reality together would form the transdisciplinary ontology (McGregor, 2011a).

McGregor (2011a) provides an exemplified summary of the dynamics of transdisciplinarity. Each of the 10 realities exemplified on the three levels is characterized by its incompleteness. When these realities come together, they generate a new and infinite knowledge (Nicolescu, 2006). Transdisciplinary ontology would deal with the mediated flow of internal consciousness (perceptions) and technical information from different realities that lead to a meeting of minds from the zone of non-resistance – called the “hidden third” in the transdisciplinary model (Nicolescu, 2012b).

The second pillar: the logic of the included third

The second pillar, the logic of the third included, is manifested in the transdisciplinary understanding that is directly linked to the perception of the different levels of reality. In the reading of classical logic, the axiom of identity and the principle of non-contradiction do not allow the possibility of an included third party. Classical logic works explaining in binary form and not in connective perception and perspective of the third included.

Nicolescu (1999) would explain this classical logic that is transgressed by the transdisciplinary approach:

- i. the axiom of identity: A is A;
- ii. the axiom of non-contradiction: A is not non-A;
- III. the axiom of the excluded middle: there is no term T, which is A and not A.

In these axioms classical logic admits a single level of reality, since axiom number 3 excludes the possibility of articulation. Quantum logic introduces innovations, defining the inclusion of a third term. There is a third term T, which at the same time is A and non-A. The third term included always leads to another level of reality, unlike the previous level of non-contradiction, opening the possibility to a new vision (perspective) of reality (Nicolescu, 1999; 2008; 2012a).

The logic of the *included third* presupposes the appearance of other elements opposed to any level of reality and to any truth expressed by an agent of reality, in a single point of view. It's a never-ending process. In this sense, there is no ultimate and absolute truth. There will always be relative truths that are subject to change over time. Transdisciplinarity would imply transgressing the logic of non-contradiction, articulating subject and object, subjectivity and objectivity, matter and consciousness, simplicity and complexity, unity and diversity. Binary pairs (using the logic of the third term included) elevate the understanding of reality, assuming a broader meaning and always open to new processes (Nicolescu, 1999; 2008; 2012a).

The third pillar: complexity

The third pillar that of complexity is undoubtedly the broadest and the one that reveals, with greater vigor, the need for a transdisciplinary vision so that we can dialogue with the real. Without transdisciplinary perception and vision there is no complex knowledge, because the complex means that everything has to do with everything, everything is woven together, interwoven and interconnected (Morin, 1991). The paths that lead to an understanding of the present, biophysical and cultural world presuppose a perception and understanding from the cognitive principles of complexity theory. Now, if reality is complex and multidimensional, we need to make use of cognitive principles that allow us to produce pertinent knowledge to access and understand the complexity and multidimensionality of this reality. One cannot exclude the idea of the simple with the complexity nor can one exclude the idea of the complex with the simple, for complexity is the union of the simple with the complex.

Transdisciplinarity, in addition to relying on these pillars that go beyond and surpass some of the principles of classical science that produces the fragmentation of knowledge, replaces in the scientific scenario other models of knowledge that come from tradition, emotion, sensitivity and the imaginary, highlighting its importance and its role in the

construction of knowledge. It criticizes the advances of an increasingly encyclopedic, cumulative knowledge, produced at the expense of the growing impoverishment of being and the increase of inequality between those who possess it and those who are and are deprived of it. Morin (2002, p. 18), in making this criticism, places as imperative the formation of “[...] spirits capable of organizing their knowledge instead of storing it by an accumulation of knowledge”, which opens the door to the constitution of a complex knowledge capable of situating any information in its context (Martinazzo, 2020).

In practice, the problematization of the different disciplinary dimensions of the Anthropocene is permanently accompanied by the methodology of transdisciplinary research, a reason for a programmed encounter between several for a common future: people of academic formation and members of organized society (or not) meet to reflect on a complex problem. These problematic reflections prevent the establishment of a clear dividing line between pure science and disseminated science, creating a hybrid cultural space between science and society, in which scientific expertise is built together. Local debates have shown that there are no “right answers” and no single application of science in applied decision-making. Answers will depend on a local assessment of risks and benefits, in the context of ethical sensitivities and varied information from different sources, where the credibility of the actors is as important as their knowledge (Lencastre, 2008).

Real connections between themes related to the Anthropocene with many narratives contributing to the densification of history are allowed in deep abstract considerations. The ontology of the Earth System or life in it and how the *anthropos* behaves in its relationship to nature can also be discussed in multiple realities. Transcendental discussions about the tremendous polarization in normal science with impacts on generational educational references (Moore, 2005), such as creationism and intelligent *design* (Pennock, 2003; Numbers, 2006) vs evolutionism (Sanderson, 1997; Claessen, 2006), are also allowed in a transdisciplinary approach to the Anthropocene model, in which classical logic makes no sense.

Towards transdisciplinarization: a few touches

We have seen that the transdisciplinary theory presents, in fact, the proposal of transformation and an alternative education in the Anthropocene capable of reporting the different areas of knowledge, and of leading to respect for differences, through solidarity and integration with Nature.

It is noted that transdisciplinary solutions are already sought and this facilitates the organization of issues for the Anthropocene. Transdisciplinary practice shortens the boundaries between disciplines and considers the multiple faces of understanding the world in the joint construction of a wisely elaborated knowledge (Andrade Júnior; Andrade, 2020).

But sometimes the doubt predominates about what is transdisciplinarity and whether what is intended is really transdisciplinary. I consider it important to quickly emphasize certain distinctive elements that will facilitate transdisciplinary discernment on the intersecting themes of the Anthropocene, which are origin, description, binary pairs, and what goes beyond them. Such an understanding allows us to expand the disciplinary frontier in the search for knowledge.

Source. The origin of disciplinarization must be pointed out because multi-interdisciplinarity and interdisciplinarity derive from physics and the classical sciences. Conversely, transdisciplinarity derives from quantum physics and quantum cosmology, as well as chaos theory, living systems theory, the sciences of consciousness and religion, and other humanities (Nicolescu, 2010; 2012a). Its rationale is that the laws that govern the behavior of quantum entities differ from those that govern entities in the classical macrophysical world (Cole, 2006).

Description. Multidisciplinarity is a process in which knowledge is produced by combining different disciplines, but knowledge remains within the boundaries of these areas and is designed separately to solve a problem. In interdisciplinarity, knowledge is produced through the analysis, synthesis and connection of many disciplines into a coordinated and coherent whole. Through interdisciplinarity, new approaches and new methods can emerge as possible outcomes. In transdisciplinarity, knowledge is produced by bringing together the understanding of the natural, social and governance domains, in a way that transcends each of its traditional boundaries (Choi; Pak, 2006) and so it was identified as an epistemological field and essential methodological framework of the Anthropocene. Each domain must literally “wear the shirt of the others.” Thus, transdisciplinarity invites everyone to bring a new paradigm to solve the complex problems of the world (van Breda, 2008; McGregor, 2011a).

Binary pairs. It is accustomed to dealing intellectually with dialectical contradictions in social science research and we commonly associate the difference between subject and object to seek explanations, but this space is reduced to a microscopic level in the trans [+] disciplinary view, in which the difference simply disappears.

The words *three and trans* have the same etymological root: three means the transgression of the two, which goes beyond two. Transdisciplinarity is the transgression of duality that opposes binary pairs: subject/object, subjectivity/objectivity, matter/consciousness, nature/divine, simplicity/complexity, reductionism/holism, diversity/unity. As Nicolescu said (2012a, p. 61): “This duality is transgressed by the open unity that surrounds the Universe and the human being. In the transdisciplinary view, complex plurality and open unity are two facets of the same reality”.

The fusion of these binary particles that are concepts or elements points to the fact that the announced Anthropocene goes through a period of transdisciplinarization of knowledge, in which different levels of hidden realities can be revealed. A contextual explanation for this

would be that the planetary crisis causes a profound mutation in our relationship with the world and requires new forms of belonging to the nature and a new image of humanity (Latour, 2017). The transdisciplinary debate at all levels represents the emergence of a problematization that questions the entire system of modernity.

Each time we perceive more additions and neologisms derived from the search for meaning or the ontology of the Anthropocene, the explanatory complexity about this system of modernity increases. An attempt is made to explain within each discipline the specificities it knows. When one does not know, one tends to one of two attitudes: (i) recognition that the probable conceptual void depends on new concepts that did not matter and that it is necessary to add new realities or (ii) negation, in which one remains in the conceptual and dimensional cloister resulting from disciplinary limitations.

Progressively in the process of transdisciplinaryization to deal with these disciplinary limitations, the disciplinary *status* passes from multi [+] disciplinary to inter [+] disciplinary, in which episodes of conceptual and methodological aggregation occur from the disciplines that are led to work together in projects, characterizing a more synthetic exchange of formation and unification of concepts and methodologies of interdisciplinary research. Later in the process already in the transdisciplinary phase there is another fusion between the disciplines gathered that realize the *integrality that was missing for the problematization demanded together*. The methodology corroborates the integration of all of them, operating with questions, concepts, and methods not present in a specific discipline (Huutoniemi et al., 2009).

Research and Action transdisciplinary

Let's look at part of the process working in practice. Oldfield et al. (2013) proposed more transdisciplinary research in the epistemological effort of the Anthropocene. However, the desire to approach and respond to the appeal depends on each discipline, since each one has its primary competencies, with methodologies and forms of approach peculiar to face the socio-environmental problems.

In response to the appeal of Oldfield et al. (2013), Toivanen et al. (2017) proposed four approaches as branches of the Anthropocene: the anthropocene [+] geological and the anthropocene [+] biological in the disciplinary competence of the natural sciences; the anthropocene [+] social of the disciplinary competence of the social sciences and the anthropocene [+] cultural of the humanities. This would signal what I call an attempt at transdisciplinaryization with the aggregation of the derived particle [+] to the term anthropocene.

That's an important step. With categories of disciplinary thought brought together, one would no longer be confronting the natural and human sciences, but constructing a megadimension of analysis that allows one to include the hidden third, and then we will actually be aligned with the transdisciplinary research of the Anthropocene. In a

projected abstraction, the missing knowledge through this differentiated and transdisciplinary approach would finally be revealed, being useful for efforts against the planetary crisis. Thus, with a consolidated process of transdisciplinarization, it would be inappropriate to include the humanities in the control of the Anthropocene cultural vector and leave them out of the social vector, as suggested by Toivanen et al. (2017).

But how would this process of bringing together disciplines of the Anthropocene – by Crutzen and Stoermer (2000) – and the “anthropocenes” (Toivanen et al., 2017) play out in practice? I bring a transdisciplinary research exercise regarding the perception of integrality that is missing for a version of problematization of sustainability, with the purpose of leading the agents of research to a “shared Anthropocene”.

First, one of the main issues raised by the Anthropocene is sustainability *per se*. But it is not only the lack of sustainability in practice that worries us. The sustainability model, which is elaborated from different visions of reality, for example, environmental, economic, social, cultural, political, etc. (Sachs, 1993), demonstrates conceptual difficulties and gives the impression of a conceptual void. There are gaps that are hidden by the lack of a transdisciplinary attitude to solve the problems of each representative dimension. The hidden conceptual void did not go through the effort of being included in the appropriate dimensional realities with the support of knowledge, methodology, experience shared by each scientific face, and the scientific mind involved in the process of transferring the levels of reality.

Therefore, the term sustainability, which is still widely used, is poorly explained. It's misunderstood. There is talk of weak or strong sustainability (Ekins et al., 2003). It seems like a fashion accessory (Hasna, 2010) or common sense for everyone (Moldan et al., 2012), since it brings interpretations and applications inconsistent with high ambiguity of the concept, including an incomplete perception of the problems of poverty, environmental degradation, and the role of economic growth (Lélé, 1991; Mori; Christodoulou, 2012; Slimane, 2012; Sartori; Latronic; Campos, 2014). As the overall world situation has not improved so far, it remains a popular and brilliant slogan (Slimane, 2012), to the disgrace of the Anthropocene.

Secondly, the fusion of the development model with the word sustainable has led to what we now call sustainable development. It has evolved as an integrative concept under an umbrella, under which a set of interrelated issues can be uniquely organized. It is a variable process of change that seeks its own sustainability, but in practice it is inconceivable. There would be a lack of integration and sharing of the levels of reality involved. The concept of sustainable development remains contested due to the different positions adopted in relation to what can be considered fair (Todorov; Marinova, 2011). The mere adherence of the sustainable particle [+] to development already indicates a (probably hidden) effort of transdisciplinarization that is attempted to be resolved through disciplinarization, which results in its failure.

It is also worth mentioning the fragility of the so-called “tripod of sustainability”. Elkington (2018) had argued, after 25 years of creating the sustainability tripod model, that we should rethink it. He says that the model of sustainable development has been diluted and that – now he admits! – it can be valid if companies adopt radical systems of change, rather than incremental efforts. In practice, sustainable development is nothing more than a paradox and the tripod of sustainability is not a tripod but a trilemma (Martine; Alves, 2015), because it is contradictory and brings three conflicting options. The logic is that the increase in human activities puts more and more pressure on the planet making it difficult to reconcile economic growth, social well-being and environmental sustainability for those who have never had it (Martine, 2015).

In fact, the rupture between the poles of this trilemma is increasing. The more the hegemonic model of production and consumption advances, the greater the global risks of collapse. To achieve sustainability, sustainable development is generally used as an instrument of action (Prugh; Assadourian, 2003). This model perpetuates social inequality and degrades the planet (Andrade Júnior, 2020b). The model is so broad and generally applicable that its vagueness renders it inoperative and open to a conflict of interpretation (Dovers; Handmer, 1992). It does not explicitly cover future thinking, although almost all published definitions of the concept are based on principles of sustainability (Moldan; Janouaková; Hák, 2012) such as, for example, the long-term perspective, the importance of local conditions, and the understanding of the nonlinear evolution of environmental and human systems. However, this sense of the concept of sustainability refers to the existence of environmental conditions necessary to sustain human life at a specific level of well-being over future generations and is, in essence, ecological sustainability and not sustainable development (Lélé, 1991).

Third, “be sustainable” would mean recognizing that reality is a non-linear, continuous and systemic process, in which relations – social, natural and socio-environmental – occur simultaneously as a relationship of interdependence between the beings and resources that live in a given environment. Faced with the crisis announced by the Anthropocene, a transdisciplinary emphasis would be placed on maintaining the system of values, practices and symbols of identity that allows social reproduction and guarantees national integration over time. This includes, for example, the discussion to promote the constitutional rights of minorities and their incorporation into concrete policies of multilingual education, territorial demarcation and autonomy, migration referral, religiosity, security, community health, digital inclusion, etc., through the specific examination of each problematization. If the very propaedeutics of transdisciplinary theory were adopted from the outset and worldviews were respected, experiences shared with scientific humility would precipitate new solutions.

Conclusion

This study was developed with the main intention of collaborating in the understanding of the applicability of transdisciplinary theory to bring the natural sciences closer to the social sciences and humanities in the study of the Anthropocene, whose indication had been made due to its surrounding planetary context.

The tragedy announced by the Anthropocene and the delay in taking steps to reverse it should be rethought and rewarded urgently by transdisciplinary research and actions. Nicolescu (1999; 2006) had drawn attention to this, focusing on the state of crisis of world civilization.

Disciplinary barriers and the peculiarities of each scientific discipline were considered obstacles to transdisciplinary implementation. Some apply resistance to the Anthropocene model, based on their methodologies, experience and level of reality considered by each of them, separately.

The disciplinary way of approaching complex planetary issues is not fully satisfactory. With the proposal of transdisciplinarily dialoguing the Anthropocene, the disciplines brought together, little by little, will create dialogical spaces that will lead to new disciplinary compositions (fusions) of better efficiency that will have visibility in the process that I have called the transdisciplinization of the Anthropocene, developed in the different sections.

Transdisciplinary methodologies can help identify the nature of the problem through the different social, natural, and governance domains in which most of the problematizations of the Anthropocene reside. There are exceptions, as in the case of creationist theory, or another pure research theory such as life on other planets, which could be terraformed and colonized in the event of absolute failure of the Earth system (hypothetically).

Identifying the core of the problem and agreeing on solutions to solve it can be problematic, because the disciplinary division of each area of knowledge can be confronted. This shouldn't be personal. But for personal, non-academic reasons or preferences, some group members may not agree on how to frame the problem or what the real motivator behind it is – an ethical, cultural, political, religious problem, etc. Others may dispute the need for specific management measures as a solution to the problem. Disputes are the normal result of a transdisciplinary process and should be considered as part of a collective change and construction and not a reason to give up the intention. It's perfectly normal that at this point, they feel tired and resentful of the process. In addition, people need to understand that working to reach an agreement and a complete solution can be a long and controversial process. This should be explained at the beginning of the research sessions.

The disciplines of the natural and social sciences that seek consistent epistemologies in their areas of activity will share what they have

in the zone of non-resistance, collaborating by common agreement to build new discoveries that improve the proposal of the Anthropocene.

Only the prospect of a truly sustainable culture offers the universal possibility of human fulfillment (Prugh; Assadourian, 2003). Beyond effectively sustainable solutions, I must highlight a transdisciplinaryization by concentration on respect for the person and the ideas of others, seeking to enter the referential domain of each one. Effectively, everyone should be able to recognize the disciplinary limits of each member of the group and build together, from the smallest lesson to the completion of the joint research project within the framework of the Anthropocene.

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Notes

- 1 See Paul... (1995).
- 2 More information about the Anthropocene era can be found at *the following Welcome to the Anthropocene* website: <https://www.anthropocene.info/great-acceleration.php>.
- 3 In 2009, the Anthropocene Working Group was created with the objective of studying this proposed unit of geological time and seeking the necessary evidence that leads to the validation of the Anthropocene model. For more information, see AWG (2023).
- 4 I will use the [+] symbol occasionally in the text to identify the union between two words and improve comprehension.
- 5 Theoretical physicist Basarab Nicolescu was president and founder of the Centre International de Recherches et Études Transdisciplinaires (CIRET) in 1987. From the First World Congress of Transdisciplinarity, held in Arrábida, Portugal, in 1994, and the First International Congress, held in Locarno, Switzerland, both organized by CIRET and the United Nations Educational, Scientific and Cultural Organization (UNESCO), Nicolescu contributed significantly to build a theoretical-operationalizable framework for the reproduction of the “three pillars of transdisciplinarity”: the complexity, the existence of different levels of reality and the third included (with unfolding that will be seen later). The Center for Transdisciplinary Education (CETRANS) that was created in Brazil in 1998 is the transdisciplinary reference in the country, as you can see on the institution’s website: <http://cettrans.com.br/site>. The author of this article was an institutional signatory of the transdisciplinary chair of the II World Congress of Transdisciplinarity, held in Vila Velha/ES in 2005.
- 6 According to Nicolescu (2006), in this First World Congress, the word “transdisciplinarity” appears in the speeches of Jean Piaget, Erich Jantsch and André Lichnerowic. It also states that Piaget, in his communication, is attributed the reference to the proposal of a first description (or definition, for other authors) of the meaning of the word transdisciplinarity. The proposal is thus transcribed by Sommerman (2003, p. 100) “[...] At the stage of interdisciplinary relations, we can expect to see a higher stage succeed that would be ‘transdisciplinary’, which would not be content to find interactions or reciprocities between specialized researches, but would situate these links within a total system, with

no stable border between these disciplines.” According to Sommerman, it was this definition that served as the basis for the one adopted by the conference.

- 7 The Complexity of Edgar Morin (1991) and the Transdisciplinarity of Nicolescu (1999), despite being different in the type of approach, mate and complement each other. If Morin, throughout his works, prioritizes the analytical approach, highlighting the interlocutions between different human knowledges, extracting principles, Nicolescu places himself in the methodological perspective, formulating a new logic and a transdisciplinary methodology that deals with diversity and oppositions
- 8 Non-resistance: To gain new *insights* into complex problems, people would need to recognize and respect other points of view. Perceptions will emerge if people move their reference points back and forth between different realities (e.g., between academics, social actors, and politicians). See more in Nicolescu (2012b).

References

- ALVARENGA, Augusta Thereza de; SOMMERMAN, Américo; ALVAREZ, Aparecida Magali de Souza. Congressos Internacionais sobre Transdisciplinaridade: reflexões sobre emergências e convergências de ideias e ideais na direção de uma nova ciência moderna. **Saúde e Sociedade**, São Paulo, USP, v. 14, n. 3, p. 9-29, 2005. Disponível em: <https://doi.org/10.1590/S0104-12902005000300003>. Acesso em: 2 dez. 2021.
- ANDRADE JÚNIOR, Hermes de. Therapeutic effectiveness of music: a transdisciplinary view of health for teams, patients and companions. **Rev. enferm. UERJ.**, 26,e29155, 2018.
- ANDRADE JÚNIOR, Hermes de. Autoethnography (military, environment) as transdisciplinarization in anthropocene times. **Cultural Studies↔Critical Methodologies**, v. 20, n. 6, p. 575-587, 2020a. <https://doi.org/10.1177/1532708620912803>.
- ANDRADE JÚNIOR, Hermes de. The politics of food: The global conflict between food security and food sovereignty. **Journal of Consumer Culture**, v. 20, n.3, p. 366-370, 2020b. <https://doi.org/10.1177/1469540520927180>.
- ANDRADE JÚNIOR, Hermes de; ANDRADE, Tamar Prouse de. The (Trans) Disciplinary Alternative for Design. In: RAPOSO, Daniel; NEVES, João; SILVA, José. **Perspective on Design. Springer Series in Design and Innovation**. V. 1. Cham: Springer 2020. P. 39-54.
- AWG. Anthropocene Working Group. **Working Group on the ‘Anthropocene’**. Subcommission on Quaternary Stratigraphy, 2023. Disponível em: <http://quaternary.stratigraphy.org/working-groups/anthropocene/>. Acesso em: 12 set. 2021.
- BELCHER, Oliver; SCHMIDT, Jeremy. Being Earthbound: Arendt, process and alienation in the Anthropocene. **Environment and Planning D: Society and Space**, v. 39, n.1, p. 103-120, 2021.
- BONNEUIL, Christophe; FRESSOZ, Jean-Baptiste. **The Shock of the Anthropocene**. New York: Verso Books, 2016.
- BRONDIZIO, Eduardo et al. Re-conceptualizing the Anthropocene: a call for collaboration. **Global Environmental Change**, v. 39, p. 318-327, 2016. Disponível em: <https://doi.org/10.1016/j.gloenvcha.2016.02.006>. Acesso em: 12 dez. 2021.

CARVALHO, Edgard de Assis. Saberes Complexos e Educação Transdisciplinar. **Educar em Revista**, Curitiba, UFPR, v 32, p. 17-27, 2008. Disponível em: <https://doi.org/10.1590/S0104-40602008000200003>. Acesso em: 12 nov. 2021.

CHAKRABARTY, Dipesh. The Human Condition in the Anthropocene. **The Tanner Lectures in Human Values**. New Haven: Yale University, 2015. P. 139-188. Disponível em: <https://tannerlectures.utah.edu/Chakrabarty%20manuscript.pdf>. Acesso em: 12 set. 2021.

CHOI, Bernard; PAK, Anita. Multidisciplinarity, interdisciplinarity, and transdisciplinarity in health research, services, education and policy. 1. Definitions, objectives, and evidence of effectiveness. **Clinical and Investigative Medicine**, v. 29, n. 6, p. 351-364, 2006.

CLAESSEN, Henri. Developments in Evolutionism. **Social Evolution and History**, v. 5, n. 1, p. 3-40, 2006. Disponível em: <https://www.sociostudies.org/journal/articles/140524/>. Acesso em: 12 set. 2021.

COLE, Anthony. Motueka Catchment futures, Transdisciplinarity, a Local Sustainability Problématique and the Achilles-heel of Western Science. In: AUSTRALASIAN CONFERENCE ON SOCIAL AND ENVIRONMENTAL ACCOUNTING RESEARCH, 5., Wellington, NZ, 2006. **Annals [...]**. Wellington: A-CSEAR, 2006. Disponível em: <https://www.wgtn.ac.nz/sacl/about/events/past-events-temporary/past-conferences/csear2006/documents/cole-anthony-17rfc-v2.pdf>. Acesso em: 13 set. 2021.

CRUTZEN, Paul. Geology of Mankind. **Nature**, London, v. 415, n. 23, 2002. Disponível em: <https://www.nature.com/articles/415023a>. Acesso em: 23 set. 2021.

CRUTZEN, Paul; STOERMER, Eugene. The Anthropocene. **Global Change Newsletter**, v. 41, p. 17-18, 2000.

DEFREITAS, Elizabeth de. Science Studies and the Metamorphic Multiple Earth: Bruno Latour's risky diplomacy. **Cultural Studies ↔ Critical Methodologies**, v. 20, n. 3, p. 203-212, 2019. Disponível em: <https://doi.org/10.1177/1532708619880>. Acesso em: 21 set. 2021.

DENZIN, Norman. Interpretive ethnography for the next century. **Journal of Contemporary Ethnography**, v. 28, n. 5, p. 510-519, 1999.

DENZIN, Norman. **Interpretive Autoethnography**. Thousand Oaks: Sage, 2014.

DOVERS, Stephen; HANDMER, John. Uncertainty, sustainability and change. **Global Environmental Change**, v.2, n. 4, p. 262-276, 1992.

EKINS, Paul; SIMON, Simon; DEUTSCH, Lisa Michele; FOLKE, Carl; GROOT, Rudolf de. A Framework for the Practical Application of the Concepts of Critical Natural Capital and Strong Sustainability. **Ecological Economics**, v. 44, p. 165-185, 2003.

ELKINGTON, Jhon. 25 Years Ago I Coined the Phrase "Triple Bottom Line." Here's Why It's Time to Rethink It. **Harvard Business Review**, Boston, 2018. Disponível em: <https://hbr.org/2018/06/25-years-ago-i-coined-the-phrase-triple-bottom-line-heres-why-im-giving-up-on-it#:~:text=Capitalism-,25%20Years%20Ago%20I%20Coined%20the%20Phrase%20E2%80%9CTriple%20Bottom%20Line,become%20a%20mere%20accounting%20tool.&text=How%20often%20are%20management%20concepts,think%20of%20a%20single%20case>. Acesso em: 12 set. 2021.

ELLIS, Erle et al. Involve Social Scientists in Defining the Anthropocene. **Nature**, London, v. 540, p. 192-193, 2016. Disponível em: <https://www.nature.com/articles/540192a>. Acesso em: 12 set. 2021.

- GRAY, Barbara. Enhancing Transdisciplinary Research through Collaborative Leadership. **American Journal of Preventive Medicine**, v. 35, n. 2, S124-S132, 2008.
- HADORN, Gertrude Hirsch et al. **Handbook of Transdisciplinary Research**. Dordrecht: Springer, 2008.
- HARAWAY, Donna. Anthropocene, Capitalocene, Plantationocene, Chthulucene: making kin. **Environmental Humanities**, v. 6, n. 1, p. 159-165, 2015. Disponível em: <https://doi.org/10.1215/22011919-3615934>. Acesso em: 13 set. 2021.
- HARAWAY, Donna et al. Anthropologists are talking – about the Anthropocene. **Ethnos**, v. 81, n. 3, p. 535-564, 2016. Disponível em: <https://doi.org/10.1080/00141844.2015.1105838>. Acesso em: 13 set. 2021.
- HASNA, Abdallah. Sustainability Classifications in Engineering: discipline and approach. **International Journal of Sustainable Engineering**, v. 3, n. 4, p. 258-276, 2010.
- HUUTONIEMI, Katri et al. Analyzing Interdisciplinarity: typology and indicators. **Research Policy**, v. 39, p. 79-88, 2009.
- JANTSCH, Erich. Inter and Transdisciplinary University: a systems approach to education and innovation. **Higher Education**, v. 1, n. 1, p. 7-37, 1972.
- KENNEY-LAZAR, Miles; ISHIKAWA, Noboru. Mega-Plantations in Southeast Asia: landscapes of displacement. **Environment and Society**, v. 10, n. 1, p. 63-82, 2019.
- KESSEL, Frank; ROSENFELD, Patricia. Toward Transdisciplinary Research: historical and contemporary perspectives. **American Journal of Preventive Medicine**, v. 35, n. 2, p. S225-S234, 2008.
- KLEIN, Julie. Evaluation of Interdisciplinary and Transdisciplinary Research: a literature review. **American Journal of Preventive Medicine**, v. 35, n. 2, p. S116-S123, 2008.
- LANG, Daniel et al. Transdisciplinary Research in Sustainability Science: practice, principles, and challenges. **Sustainability Science**, v. 7, n. 1, p. 25-43, 2012.
- LATOUR, Bruno. Anthropology at the Time of the Anthropocene: a personal view of what is to be studied. In: BRIGHTMAN, Marc; LEWIS, Jerome (Ed.). **The Anthropology of Sustainability: beyond development and progress** (Palgrave Studies in Anthropology of Sustainability). London: Palgrave Macmillan, 2017. P. 35-49.
- LEFF, Enrique. **Racionalidade Ambiental: a reprodução social da natureza**. Rio de Janeiro: Civilização Brasileira, 2006.
- LÉLÉ, Sharachandra. Sustainable Development: a critical review. **World Development**, Great Britain, v. 19, n. 6, p. 607-621, 1991.
- LÉNA, Philippe; ISSBERNER, Liz-Rejane. Desafio das Ciências Sociais no Antropoceno: prefácio. **Liinc em Revista**, Rio de Janeiro, v. 18, n. 1, e6001, p. 1-7, 2022. Disponível em: <https://doi.org/10.18617/liinc.v18i1.6001>. Acesso em: 12 set. 2021.
- LENCASTRE, Marina. Transdisciplinaridade e Boa Ciência: o contributo de Bruno Latour para uma nova compreensão das ligações entre ciência, conhecimentos e sociedade. **Revista Portuguesa de Investigação Educacional**, Lisboa, UCP, v. 7, n. 7, p. 146-155, 2008.
- LEWIS, Simon; MASLIN, Mark. A Transparent Framework for Defining the Anthropocene Epoch. **The Anthropocene Review**, v. 2, n. 2, p. 128-146, 2015.

- MARTINAZZO, Celso José. O Pensamento Transdisciplinar como Percepção do Real e os Desafios Educacionais e Planetários. **Educar em Revista**, Curitiba, UFPR, v. 36, e66048, p. 1-17, 2020. Disponível em: <https://doi.org/10.1590/0104-4060.66048>. Acesso em: 12 set. 2021.
- MARTINE, George. Reviving or Interring Global Governance on Sustainability? Sachs, the UN and the SDGs. **Revista Brasileira de Estudos de População**, Rio de Janeiro, v. 32, n. 3, p. 631-638, 2015.
- MARTINE, George; ALVES, José Eustáquio Diniz. Economia, Sociedade e Meio Ambiente no Século 21: tripé ou trilema da sustentabilidade? **Revista Brasileira de Estudos de População**, Rio de Janeiro, v. 32, n. 3, 2015.
- MARTINS, Victor de Oliveira; ARAUJO, Alana Ramos. Crise Educacional e Ambiental em Paulo Freire e Enrique Leff: por uma pedagogia ambiental crítica. **Educação & Realidade**, Porto Alegre, UFRGS, v. 46, n. 2, 2021. Disponível em: <https://doi.org/10.1590/2175-6236105854>. Acesso em: 12 set. 2022.
- MCGREGOR, Sue. Demystifying Transdisciplinary Ontology: multiple levels of reality and the hidden third. **Integral Leadership Review**, 2011a. Disponível em: <http://integralleadershipreview.com/1746-demystifying-transdisciplinary-ontology-multiple-levels-of-reality-and-the-hidden-third/>. Acesso em: 13 set. 2022.
- MCGREGOR, Sue. Knowledge Generation in Home Economics using Transdisciplinary Methodology. **Kappa Omicron Nu FORUM**, v. 16, n. 2, 2011b. Disponível em: <http://www.kon.org/archives/forum/16-2/mcgregor2.htm>. Acesso em: 10 set. 2022.
- MOLDAN, Bedřich; JANOUKOVÁ, Svatava; HÁK, Tomáš. How to understand and measure Environmental Sustainability: indicators and targets. **Ecological Indicators**, v. 17, p. 4-13, 2012.
- MOORE, Jason (Ed). **Anthropocene or Capitalocene? Nature, History, and the Crisis of Capitalism**. Oakland: PM Press, 2016.
- MOORE, Randy. The Teaching of Evolution & Creationism. **The American Biology Teacher**, v. 67, n. 8, p. 457-466, 2005.
- MORI, Koichiro; CHRISTODOULOU, Aris. Review of Sustainability Indices and Indicators: towards a new City Sustainability Index (CSI). **Environmental Impact Assessment Review**, v. 32, n. 1, p. 94-106, 2012.
- MORIN, Edgar. **Introduction to Complex Thinking**. Lisbon: Piaget Institute, 1991.
- MORIN, Edgar. **A Religião dos Saberes: o desafio do século XXI**. Tradução e notas de Flávia Nascimento. Rio de Janeiro: Bertrand Brasil, 2002.
- MURPHY, Michael Warren; SCHROERING, Caitlin. Refiguring the Plantationocene: racial capitalism, world-systems analysis, and global socioecological transformation. **Journal of World-Systems Research**, v. 26, n. 2, p. 400-415, 2020.
- NICOLESCU, Basarab. Manifeste sur la transdisciplinarité. **Bulletin interactif du CIRET**, v. 10, p. 34-40, 1999.
- NICOLESCU, Basarab. Transdisciplinarity – past, present and future. In: HAVERKOTT, Bertus. **Moving Worldviews—Reshaping sciences, policies and practices for endogenous sustainable development**. Leusden: ETC/Compas, 2006. P. 142-165.
- NICOLESCU, Basarab (Ed). **Transdisciplinarity: theory and practice**. New York: Hampton Press, 2008.

NICOLESCU, Basarab. Disciplinary Boundaries – what are they and how they can be transgressed? In: RESEARCH ACROSS BOUNDARIES – ADVANCES IN THEORY-BUILDING, 1., 2010, Luxembourg. **Annals [...]**. Luxembourg: University of Luxembourg, 2010. Disponível em: <https://vdocuments.mx/basarab-nicolescu-disciplinary-boundaries-what-are-they-and-how-they-can-be-transgressed.html>. Acesso em: 10 set. 2022.

NICOLESCU, Basarab. **O que é a Realidade**: reflexões em torno da obra de Stéphane Lupasco. São Paulo: Centro de Estudos Marina e Martin Harvey Editorial e Comercial, 2012a.

NICOLESCU, Basarab. Transdisciplinarity: the hidden third, between the subject and the object. **Human & Social Studies**, v. 1, n. 2, p. 13-28, 2012b.

NOWOTNY, Helga. The Potential of Transdisciplinarity. **Helga nowotny**, 2006. Disponível em: <https://goo.gl/uw3kQL>. Acesso em: 10 ago. 2022.

NUMBERS, Ronald. **The Creationists**: from scientific creationism to intelligent design. Cambridge: Harvard University Press, 2006.

OLDFIELD, Frank et al. The Anthropocene Review: its significance, implications and the rationale for a new transdisciplinary journal. **The Anthropocene Review**, v.1, p. 3-7, 2013.

OLIVEIRA, Lívia. Antropoceno: a marca da humanidade no tempo geológico. **Igeológico**, 2022. Disponível em: <https://igeologico.com.br/antropoceno/>. Acesso em: 12 set. 2022.

PALSSON, Gísli et al. Reconceptualizing the ‘Anthropos’ in the Anthropocene: integrating the social sciences and humanities in global environmental change research. **Environmental Science & Policy**, v. 28, p. 3-13, 2013.

PARIKKA, Jussi. **The Anthrobscene**. Minnesota: University of Minnesota Press, 2015.

PASSOS, Eduardo; BARROS, Regina Benevides de. A construção do plano da clínica e o conceito de transdisciplinaridade. **Psicologia: teoria e pesquisa**, v. 16, n.1, p. 71-79, 2000.

PAUL J. Crutzen – Biographical. **Nobel Prize Outreach AB 2023**, 1995. Disponível em: <https://www.nobelprize.org/prizes/chemistry/1995/crutzen/biographical/>. Acesso em: 9 ago. 2022.

PENNOCK, Robert. Creationism and Intelligent Design. **Annual Review of Genomics and Human Genetics**, v. 4, n. 1, p. 143-163, 2003.

PIRES, Marília Freitas de Campos. Multidisciplinaridade, Interdisciplinaridade e Transdisciplinaridade no Ensino. **Interface – comunicação, saúde, educação**, v. 2, p. 173-182, 1998.

POHL, Christian. From Science to Policy through Transdisciplinary Research. **Environmental Science & Policy**, v. 11, n. 1, p. 46-53, 2008.

POHL, Christian. What is Progress in Transdisciplinary Research? **Futures**, v. 43, n. 6, p. 618-626, 2011.

POHL, Christian; HADORN, Gertrude Hirsch. **Principles for Designing Transdisciplinary Research**. Munich: oekom, 2007.

POHL, Christian; HADORN, Gertrude Hirsch. Methodological Challenges of Transdisciplinary Research. **Natures Sciences Sociétés**, v. 16, n. 2, p. 111-121, 2008.

PRUGH, Thomas; ASSADOURIAN, Erick. What is Sustainability, anyway? **World Watch**, v. 16, n. 5, p. 10-21, 2003.

- ROSENFELD, Patricia. The Potential of Transdisciplinary Research for Sustaining and Extending Linkages between the Health and Social Sciences. **Social science & medicine**, v. 35, n. 11, p. 1343-1357, 1992.
- ROUX, Dirk et al. Framework for Participative Reflection on the Accomplishment of Transdisciplinary Research Programs. **Environmental Science & Policy**, v. 13, n. 8, p. 733-741, 2010.
- SACHS, Ignacy. **Estratégias de transição para o século XXI - desenvolvimento e meio ambiente**. São Paulo: Studio Nobel; Fundap, 1993.
- SANDERSON, Stephen. Evolutionism and Its Critics. **Journal of World-Systems Research**, v. 3, p. 94-114, 1997.
- SARTORI, Simone; LATRÔNICO, Fernanda; CAMPOS, Lucila. Sustentabilidade e Desenvolvimento Sustentável: uma taxonomia no campo da literatura. **Ambiente & Sociedade**, São Paulo, v. 17, n. 1, p. 1-22, 2014.
- SIMON, Zoltán Boldizsár. The Limits of Anthropocene Narratives. **European Journal of Social Theory**, v. 23, n. 2, p. 184-199, 2020.
- SLIMANE, Melouki. Role and relationship between leadership and sustainable development to release social, human, and cultural dimension. **Social and Behavioral Sciences**, v. 41, p. 92-99, 2012.
- SOMMERMAN, Américo. **Formação e transdisciplinaridade: uma pesquisa sobre as emergências formativas do CETRANS**. Dissertação de Mestrado em Ciências da Educação. Faculdade de Ciências e Tecnologia, 353f, Universidade Nova de Lisboa, 2003. Disponível em: https://run.unl.pt/bitstream/10362/400/1/sommerman_2003.pdf. Acesso: 20 set. 2021.
- STEFFEN, Will et al. The Anthropocene: conceptual and historical perspectives. **Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences**, v. 369, n. 1938, p. 842-867, 2011. Disponível em: <https://doi.org/10.1098/rsta.2010.0327>. Acesso em: 11 ago. 2022.
- STEFFEN, Will et al. Planetary Boundaries: guiding human development on a changing planet. **Science**, v. 347, n. 6223, 1259855, 2015a.
- STEFFEN, Will et al. The Trajectory of the Anthropocene: the great acceleration. **The Anthropocene Review**, v. 2, p. 81-98, 2015b.
- SWYNGEDOUW, Erick; ERNSTSON, Henrik. Interrupting the Anthro-ob-Scene: immuno-biopolitics and depoliticizing ontologies in the anthropocene. **Theory, Culture & Society**, v. 35, n. 6, p. 3-30, 2018.
- TODOROV, Vladislav; MARINOVA, Dora. Modelling Sustainability. **Mathematics and Computers in Simulation**, v. 7, p. 1397-1408, 2011.
- TOIVANEN, Tero et al. The many Anthropocenes: A transdisciplinary challenge for the Anthropocene research. **The Anthropocene Review**, v. 4, n. 3, p. 183-198, 2017.
- TSING, Anna. **The Mushroom at the End of the World: on the possibility of life in capitalist ruins**. Princeton: Princeton University Press, 2017.
- VAN BREDÁ, John. Exploring Non-Reductionism and Levels of Reality. **The Global Spiral**, v. 9, n. 4, 2008. Disponível em: <https://metanexus.net/exploring-non-reductionism-and-levels-reality-importance-non-separability-discontinuity/> Acesso em: 13 set. 2021.
- VEIGA, José Eli Da. The First Utopia of the Anthropocene. **Ambiente & Sociedade**, v. 20, n. 2, p. 227-246, 2017.

WATERS, Colin et al. The Anthropocene is Functionally and Stratigraphically Distinct from the Holocene. **Science**, v. 351, n. 6269, 2016. Disponível em: <https://www.science.org/doi/10.1126/science.aad2622>. Acesso em: 12 set. 2021.

WICKSON, Fern; CAREW, Anna; RUSSELL, Wendy. Transdisciplinary Research: characteristics, quandaries and quality. **Futures**, v. 38, 2006.

ZALASIEWICZ, Jan et al (Ed.). **The Anthropocene as a Geological Time Unit: a guide to the scientific evidence and current debate**. Cambridge: Cambridge University Press, 2019.

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