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# Introduction : interdisciplinarity, human ecology, the social and the environmental sciences

*Introdução : interdisciplinaridade, ecologia humana, ciências sociais e ambientais*

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# Special Issue

## Interdisciplinarity in the social sciences: human ecology and the environmental science

Dossiê

Interdisciplinaridade nas ciências sociais: ecologia humana e ciências do ambiente

# INTRODUCTION: INTERDISCIPLINARITY, HUMAN ECOLOGY, THE SOCIAL AND THE ENVIRONMENTAL SCIENCES

## INTRODUÇÃO: INTERDISCIPLINARIDADE, ECOLOGIA HUMANA, CIÊNCIAS SOCIAIS E AMBIENTAIS

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### THE DEVELOPMENT OF HUMAN ECOLOGY AND ITS SPREAD WORLDWIDE

Interdisciplinary subjects such as human ecology developed during the twentieth century, although forerunners of interdisciplinary thinking and knowledge integration can be found since early modernity. Human ecology, studying the relations between humans, their societies, and nature, is an example of knowledge practices, where social and natural scientific knowledge is integrated to find ways to solve complex social and environmental problems in the present, historical epoch of the Anthropocene, with an Earth system modified, dominated, and disturbed by humans (Folke et al., 2021). Interdisciplinarity as the intra-scientific crossing of disciplinary boundaries and transdisciplinarity as the crossing of the boundaries between scientific and non-scientific knowledge have been discussed epistemologically since the 1970s (Bernstein, 2015; Jantsch, 1972; Klein, 1990; Mittelstrass, 1989, 2011; Nicolescu, 2002; Piaget, 1972), when new interdisciplinary subjects spread, influenced through intensifying environmental research and the development of new social and environmental movements.

Subsequently, human ecology developed similar interdisciplinary subjects during the twentieth century, including cultural ecology (since the 1930s: Steward, 1956), and later, in the second half of the twentieth century, social ecology (Haberl et al., 2016) and political ecology (Perreault et al., 2015). Furthermore, an epistemological discourse about inter and transdisciplinarity developed in Europe and other countries with the discussion of new forms of knowledge production, including "mode 1" and "mode 2" (Gibbons et al., 1994; Nowotny et al., 2001), "triple helix" (Anderson et al., 2019), "science and technology studies" (Felt et al., 2017), "post-normal science" (Funtowicz & Ravetz, 1994), and included ecological knowledge production, the interdisciplinary subjects of ecological economics, sustainability science, and transformation research. New perspectives of inter and transdisciplinary sciences developed less in the academic sciences and more in newly developing, non-academic forms of science and knowledge production (Jamison, 2001).

The knowledge- and practice-problems to which inter and transdisciplinarity seek to find answers and solutions result from the inability of specialised disciplinary and subdisciplinary knowledge to grasp the complexity of problems that occur in society and nature. Human ecology and its global spread, since the 1970s, is part of the broadening of environmental research and synthesis of knowledge to understand the new environmental and social problems in late modernity through differentiated analysis of the relations between humans, society, and nature. Interdisciplinary knowledge production, integration and application create epistemological and methodological difficulties, which are discussed as part of the new forms of knowledge production (Flaherty, 2019; Goldman et al., 2019; Smith & Jenks, 2023;

Tretter & Löffler-Stastka, 2019; Walters & Vayda, 2020; Weimer, 2023). In human ecology, a plurality of research methods used in different social- and natural-scientific disciplines are found. Methods of knowledge integration and synthesis (Clark & Wallace 2015; Hoffmann et al., 2017; Karrasch et al., 2022; Rousseau et al., 2019) are discussed in various interdisciplinary sciences.

Julie Thompson Klein (Klein, 1990) saw interdisciplinary knowledge practices as existing throughout modernity, with different forms of justification – such as unified science, generalised knowledge, integration and synthesis of fragmented knowledge. Interdisciplinarity has been part of the development of modern society and sciences in Europe since the sixteenth century, along with the natural sciences, physics, and astrophysics, which destroyed the geocentric worldview, emancipating itself from the medieval, religion-dominated sciences. It took several hundred years after the scientific revolutions, connected with the names of Kepler and Newton, before the natural sciences became the dominant forms of modern science in universities. The breakthrough came with the Industrial Revolution in Europe. Modern biology only developed in the nineteenth century, although natural-scientific, biological, and ecological research was being done long before, for example, under the name of the history of nature. The natural sciences and their applied forms, for example, in medicine and hygiene, developed rapidly, often directly as part of industrial innovation, providing the knowledge and technologies driving industrial production and urbanised forms of living and working. Sociology, developed during the nineteenth century but established as an academic discipline only in the twentieth century, described these processes of modernisation systematically as economic and technological modernisation, urbanisation, and changes in social structures and modes of living.

Along with the development of modern medicine, natural sciences and the hygienic revolution of the nineteenth century, where mass diseases such as cholera or tuberculosis were finally overcome, the new science of human ecology was also developed in the USA; not at the Chicago School of Sociology, as is the dominant view, but before, in the scientific work of one of the few female scientists of the late nineteenth century, Helen Swallow Richards, a US-American chemist and founder of modern home economics. She was the first to use the term human ecology (Merchant, 2007, p. 181; Richards, 1907) and described it as focusing on the environment in a broad sense:

> Human ecology is the study of the surroundings of human beings and the effects they produce on the lives of men. The features of the environment are natural, such as climate, and artificial, produced by human activity, such as noise, dust, poisonous gases, vitiated air, dirty water, and unclean food. (Richards, 1907, p. v).

This description can still be used today to describe practical problems in the relationship between humans, their living conditions, and the natural environment.

The dominant form of early human ecology in the USA was the Chicago School of Sociology (Park, Burgess, McKenzie). The textbook by Park and Burgess (1921), known as "the green bible", remained the leading Sociology textbook for about twenty years, documenting the sociology of urbanisation as a foundational form of academic sociology in the USA. Its interdisciplinary approach is visible in the ecological terminology for describing modern urbanisation processes (with Chicago as a paradigmatic example). This showed that the newly emerging discipline of sociology did not yet have a terminology, methodology, or theoretical basis of its own; it developed by adopting natural scientific terms or imitating natural-scientific forms of knowledge production. In Europe, the genesis of sociology as a new discipline since the mid-nineteenth century, took place with names such as "social physics", or epistemologies such as "positivism", paradigmatically in the sociology of August Comte; the new social science aimed to become an objective science, following the model of the modern, natural sciences.

The Chicago School adopted the terminology of the academic discipline of ecology, a new branch of biology that developed in the late nineteenth century with the theory of evolution by Charles Darwin. The concept transfer from the natural to the social sciences is always at risk of misleading or of dubious reduction of social phenomena to natural phenomena, such as in parts of social-scientific functionalism which, after the Second World War, became the new, dominant form of sociological theory in the USA (Talcott Parsons) and was influential in European sociology (Niklas Luhmann). Parsons´ sociological theory shows the development of sociological thinking, diverging from the positivist tradition of early European sociology represented by Aguste Comte in France and the evolutionary sociology of Herbert Spencer in Great Britain, in the form of a genuine sociological theory of social action from a synthesis of European sociology and economics (Parsons, 1937, synthesising the theories of Max Weber, Emile Durkheim, Vilfredo Pareto, Alfred Marshall). This theory of social action developed later into an interdisciplinary and functionalist social-scientific theory of social systems, a traditional form of sociological theory that was challenged by the parallel development of a critical theory in Europe, especially

in the Frankfurt School of Sociology. Parsons´ theory, at the end of his scientific work, again came close to a synthesis with natural-scientific functionalist thinking (Loubser et al., 1976). The new human ecology in the USA has included, since the 1970s, the new environmental sociology (Catton & Dunlap, 1978) and interdisciplinary approaches as described by Borden in this volume.

Human ecology emerged during the twentieth century as a pluralistic, interdisciplinary science with different approaches, both social and natural--scientific, in various variants of a science of the relations between humans, the natural environment, and society, without merging into a unified and theoretically integrated science. Sociologically, psychologically, economically, geographically, biologically or ecologically and anthropologically oriented approaches can be found in human ecology, showing the influence that these disciplines have had on its development.

In Europe, the International Certificate for Human Ecology, a network of 12 universities, has significantly advanced the development of this field through innovative teaching and research initiatives (Pires et al., 2010). While the academic debate on human ecology initially stemmed from a mainstream, Western-oriented discourse, it quickly transcended disciplinary, geographical, and cultural boundaries. In Latin America, particularly in Brazil, Paraguay, and Mexico, researchers from diverse backgrounds have enriched the understanding of the interactions between human culture, behavior, and the natural environment. This has fostered the evolution of a human ecology approach deeply engaged with social and cultural issues, addressing topics such as small-scale fisheries management, indigenous knowledge systems, health ecology, environmental justice, social equity, and sustainable practices for small farmers (Lopes & Begossi, 2009; Moran, 1993).

Furthermore, the Radical Human Ecology book joins the contribution from academics as well as non-academics, such as indigenous or marginalized groups, exploring, in an inter-cultural and transdisciplinary approach, the power of indigenous and traditional peoples' epistemologies, both to critique and to complement insights from modernity and postmodernity (Williams et al., 2012).

The new human ecology that spread globally in the 1970s was not an isolated development of a single scientific school; it was from the beginning part of an interdisciplinary knowledge culture developed through environmental research which addressed new problems that appeared in the development of modern societies, especially the global environmental and resource-use problems discussed since the 1970s, such as "Limits to Growth", written by the Club of Rome (Meadows et al., 1972). Today, human ecology is part of the broader interdisciplinary discourse and practice in the social and environmental sciences, including similar forms such as cultural, social, and political ecology, where knowledge from different disciplines and fields of research is used, mainly from sociology, economy, anthropology, geography, biology ecology, and the rapidly increasing environmental research on climate change and other forms of global change.

Interdisciplinarity has not developed in academic sociology, or only in simple forms of concept and knowledge exchange with its neighbouring disciplines of psychology, political science, economics, or cultural anthropology. Two other processes were important in the development of sociology: first, its late establishment as an academic discipline in Western countries, from the early twentieth century; then, from the second half of this century, the progressing specialisation in sociological subdisciplines with environment-related research in agricultural or rural sociology, environmental sociology (Catton & Dunlap, 1978), and recently geo-sociology (Schroer, 2022). Subdisciplinary specialisation indicates the cognitive problems and the dilemma with disciplinary knowledge that triggered the newer forms of inter and transdisciplinarity; trying to deal with the rapid growth of knowledge that does not match disciplinary limits and boundaries. The problems studied in the sociological sub-disciplines increasingly required non-sociological knowledge to be understood and solved. However, academic sociology tried, instead of interdisciplinary knowledge production, to broaden the research within a disciplinary perspective, through additional specialisation in subdisciplines and not leaving "the disciplinary comfort zone". From this disciplinary perspective, interdisciplinarity is perceived as inexact, creating theoretical, epistemological, and methodological trouble, risks of knowledge production, and insecurity. Yet, interdisciplinary knowledge creation is better equipped to deal with the complexity and interaction of the present social and environmental problems.

The Gulbenkian Commission had, in its 1996 report "Opening the Social Sciences", discussed the situation in the social sciences, but had not given clear answers for their future development, as has been criticised in the sociological discourse (Wearne, 1998). What "opening" meant for the future social sciences remained unclear: it was not a clear plea for an opening towards inter and transdisciplinary knowledge creation and integration, that was already on the way at the time. Moreover, the report did not answer how the social sciences can, after the two secular liberations from religion and the state during modernisation, liberate from the third dependence that is dominant today, that of economic power, business, and markets, as Wearne writes.

This thematic issue aims to show and reflect the experience of the interdisciplinary opening of the social sciences since the Gulbenkian report, with human ecology as an example. The articles in this issue do not cover the whole spectrum of interdisciplinary research in human ecology. It is only a limited selection of articles that express the plurality of themes, concepts and methods in present human ecological knowledge production and application, with examples from different countries.

The new interdisciplinary knowledge practices were, from the end of the twentieth century, intensively discussed in the epistemological debates about "new knowledge production", mentioned above, especially interdisciplinarity, transdisciplinarity, and post-normal science. The joint feature of the new approaches in interdisciplinary science is knowledge integration and cooperation between scientists from different disciplines, practitioners, and citizens, forms of research spreading quickly in some fields, especially in environmental research. The necessity of the inter and transdisciplinary approaches can be justified with two arguments:

1) The limited perspectives of specialised academic research ("mode 1"), that does not deal adequately with such complex social and environmental problems as climate change, biodiversity loss, land use change, urbanisation, population growth and its management, exponential economic growth, globalisation and its social and environmental consequences, social inequality and the digital divide, or problems of sharing resources more fairly between the countries of the Global North and South countries, as discussed in the sustainability discourse;
2) Specialized academic knowledge does not sufficiently address problems that come with the transfer and application of scientific knowledge in social practices of resource use, environmental policy and governance, and other fields of action.

The social and environmental problems that require interdisciplinary knowledge creation and synthesis as practised in human, social, and political ecology, include the problems described as global social and environmental change, analysed, for example, in research on the Anthropocene (Folke et al., 2021). This includes the manifold problems and crises accompanying these changes, also described as global polycrisis (Lawrence et al., 2024). For such changes and crises in which local, regional, national, and global processes are tightly interwoven, new solutions need to be found through research integrated across the boundaries of natural and social sciences, and the spatial and temporal levels of scale.

## THE ARTICLES IN THIS SPECIAL ISSUE AS EXAMPLES OF THEMATIC PLURALISM IN HUMAN ECOLOGY

The articles in this issue illustrate the heterodox knowledge practices developing within human ecology as an inter and transdisciplinary science and as a scientific movement in the sense described above. Intra-scientific and trans-scientific knowledge practices include the social and natural sciences and the humanities, non-scientific, practical and normative knowledge, and knowledge created in the arts, especially in literature, insofar as it includes knowledge about social and cultural traditions of natural resource use. The examples show the practices of interdisciplinary teaching and research, theoretical reflections on human ecology and the application of knowledge in resource use practices, policy, and governance processes, especially for health and environment-related problems.

Richard Borden provides a personal description of the development of human ecology, where his scientific biography as a leading human ecologist from the USA merges with an intellectual history of the new human ecology as heterodox and critical thinking and engaged research about humans and nature. This personal essay is a first-hand testimony of a human ecologist, showing that human ecology is not only a science and knowledge practice but also becomes part of the personality of human ecologists, deeply influencing their thinking, beliefs and personal ways of living and working. The essay draws attention to the normative and ethical principles that influence human ecology and whose importance is reflected more in this subject than in the practices of academic science, where they are reduced to pre-analytic visions, values, and worldviews, but rarely reflect their influence on the knowledge created and applied. In US-American human ecology, this normative and ethical heritage includes the classical forms of North American environmentalism that can be traced back to the works of environmentalists such as Henry David Thoreau, Ralf Waldo Emerson, George Perkins Marsh, Ellen Swallow Richards, Aldo Leopold, and Rachel Carson. It shows that the history of human ecology cannot be simply understood as that of a school or a specific approach to knowledge creation; more than that it is a practice of a scientific movement, with critical philosophical and ethical thinking and action, analysing the self-destructive course of economic and technological modernisation that created systemic risks for humans, society and nature. Borden reflects on human ecology, focussing on its development in North America, where human ecology was also developing as part of the new environmental sociology (Catton & Dunlap, 1994). Other examples of scientific descriptions of human ecology during its global spread since the

1970s include: Tengström (1985), Young (1989), Bruckmeier (2004), and, connecting to the newer sustainability discourse, Dyball and Newell (2015), Rees (2023).

Portuguese human ecology is represented in several articles in this issue. A classical theme of human ecology is described in the research of Ana Luisa Luz; that of the commons or local common property as a traditional form of natural resource use and appropriation, widespread in human history, in pre-modern and agricultural societies and cultures, and existing in limited forms until today. Human ecology has, as demonstrated by Garrett Hardin (1968), Bonnie McCay and James Acheson (1987), and Elinor Ostrom (Becker & Ostrom, 1995), contributed much to not only keep the discussion about the commons alive, but also to revitalise it. For example, to analyse the global commons, such as the oceans, the atmosphere or the biosphere and to discuss their protection and devise the structural conditions to manage common pool resources collectively (Pires, 2016). The human ecological discourse showed, furthermore, how the concept of the commons was misinterpreted in the comparison of types of property rights, often in simplified typologies of property forms such as that of no property rights (or free resources for the use of everyone), commons, state property, and private property: the generalised forms of property rights tend to ignore the manifold cultural variations of property and appropriation rights and how they blend in human societies.

Luz analyses the "baldios" in Northern Portugal as historical examples of areas integrated into extensive agropastoral systems, managed by local communities through institutions created to ensure resource sustainability. Today, multiple interests influence these areas, with leisure and nature conservation activities gradually occupying former farming land, revealing the difficulties of transforming traditional institutions for sustainable resource use into modern ones, where agriculture is no longer a dominant form of land use and local interests of rural land use are overlaid through the interests of urban populations. Other examples of this research about a traditional form of property rights under conditions of late, modern, globalising society and economy include the research in the tradition of the Indiana School of political science by Elinor Ostrom and others about commons and common pool resources (Ostrom et al., 1994).

Another classical theme of human ecology is described in an interdisciplinary, historical study by Hans Eickhoff; that of the Chicago School of Sociology and its problematic relations with the social and economic reality and practices of the meat industry and the slaughterhouses of Chicago, early in the twentieth century. The author used an inter and transdisciplinary approach to expose a hidden controversy between the critical social sciences and the Chicago School. He discusses the social reality in the capitalist meat industry not with sociological research, but with a theatre piece, the drama of "Saint Joan of the Stockyards" by the German writer Bertolt Brecht. Such knowledge practices, using science and literature, can be useful to highlight the problem mentioned above, that of the normative background of scientific research that influences science more than it is reflected in pre-analytic visions or worldviews.

Such heterodox knowledge practices can draw criticism from mainstream academic science, put forward as methodological and epistemological mental reservations, instead of trying to reveal latent or hidden assumptions and forms of thinking in scientific research. Controversies about normative and ideological ideas and assumptions influencing scientific research (for example, in the controversy about social Darwinism, or more recently about the social biology of Edward O. Wilson and his view of human nature) are reserved not only for the Chicago School of Sociology but also for other forms of ecological and natural-scientific research. Critical reflection of scientific practices is developing with interdisciplinary research, as demonstrated by Andrew Jamison who analysed the social contexts and influences on science, revealing that academic sciences are also subject to manifold social influences that are not always reflected critically (Andrew, 2001). Another aspect of the development of human ecology, also illustrated in the text by Eickhoff, is the increasing importance of the humanities and the arts, especially literature, as sources of human ecological knowledge creation and integration. A more recent development is the study of nature and human relations to nature in modern literature, with the example of ecocriticism, analysed in the article by Ana Cristina Carvalho.

Carvalho, analysing two eco- and climate--critical novels by the Portuguese writer Carlos de Oliveira, refers to the ecocriticism discourse which has developed since the 1970s as an interdisciplinary approach in the literary sciences for the study of ecological themes in modern literature (with the foundational analysis of "literary ecology" by Meeker (1972); later acquiring the name ecocriticism (Rueckert, 1978)). Cheryl Glotfelty defined it as "the study of the relationship between literature and the physical environment" (Glotfelty & Fromm, 1996, p. xviii; for a more recent description, see the handbook edited by Garrard, 2014). Ecocriticism developed independently from human ecology in the broader environmental discourse since the 1970s, dominated by the new social and environmental movements, as an interdisciplinary approach in the

literary sciences, analysing literary texts and their use of ecological themes.

The article by Carvalho describes the critical debate of climate problems in Portuguese literature long before the present scientific discourse about anthropogenic climate change and before any attempts to initiate a critical debate about a dominant view in ecocriticism: that realistic literary texts are most useful to create environmental information about a place or landscape. This critical intention requires a broader debate about the differences between scientific and literary writing and how they differ, develop, and influence each other. This is a probable future work more for ecocriticism than for human ecology, as it requires critical analyses and reflections about the nature of literary writing, cognition, and the practices of literary criticism, which has only happened so far to some degree, for example, as part of a critical re-examination of literary theories and practices, for which Zapf (2008) analysed the ecological and ethical turn in cultural and literary studies. For further discussion of ecocriticism, also in Europe, see Gersdorf and Mayer (2005), Goodbody (2007), Zapf (2008, 2012), Ryson et al. (2014), Bühler (2016), Dürbeck et al. (2017), Schmitt and Stolte-Gresser (2017), Zemanek (2017), Bartosch (2019), Suresh and Samuel (2021). Ecocriticism and the study of ecological themes in literature is not a practice of conventional disciplinary research, nor environmental politics but it is certainly part of the manifold practices of social and environmental movements in supporting nature, landscape, ecosystem, and biodiversity conservation and maintenance.

A widely neglected theme in human ecology, as well as in the social sciences, is described in the research of Sonia Nobre; that of the situation of homeless women in Portugal, about which almost no empirical research exists. For public authorities, homelessness among women is practically non-existent. This is a consequence of the taboo surrounding this issue, which keeps it off the public agenda. The pioneering research of the author reveals the invisibility of homeless women and how the nondiscussion of their situation in science and public politics is a form of powerful "externalisation" of social problems, passive discrimination, and marginalisation through the alleged lack of scientific knowledge and data. This research draws attention to a widely neglected theme in conventional academic research; the latent structures of power, suppression, and marginalisation in modern societies, which include power over humans and power over nature. As described above, it requires such ethically and normatively committed research and knowledge practices, such as in human ecology or in forms of applied and action research, to bring to light a social reality that has been almost totally ignored.

Homelessness among women is not a conventional problem for environmental research, but an example of socially shaped and socially exclusive, society-nature relations in modern society. It is part of the larger externalisation practices discussed critically in sociology, critical environmental research, and in the discourse of sustainability – the shifting of the responsibility and burdens for present, non-social and environmentally damaging practices to other countries (of the Global South), other humans (especially women and the poor), and future generations. Other examples of such critical, heterodox research about ignored themes in mainstream science and society are found in feminist and ecofeminist research (Mellor, 1997; Merchant, 2018, 2020). The interdisciplinary perspectives of such critical studies show that they are examples of the manifold practices of knowledge integration and application that develop in the lifeworld, in the social and environmental relations of humans in daily life, in the social, cultural and ecological practices of living, working, consuming, and conserving natural resources, where it is always necessary to deal with inequalities, injustice, repression, discrimination, marginalisation, and social exclusion.

The study of Jorge Moreira, referring to Annemarie Mol and John Law, with actor-network theory and the assemblage concept for discussing complex and precarious relations between humans and non-humans, refers to sociological, geographical, and anthropological research; it is part of a controversial discussion on the complexity, multiplicity, and cultural relativity of the relationship between humans, society and nature. The materiality and the relationship between humans, their bodies, society, nature, power, politics, and space (Müller, 2015) analysed by Mol and Law are part of interdisciplinary practices of knowledge construction and integration, but not necessarily of human ecology. The article does not solve the difficulties of dealing with multiple environmental practices but instead describes the multiplicity. The aim to generate harmonious relations between humans and local nature oscillates between science and beliefs that cannot be verified through scientific knowledge, referring to the construction of ethically responsible social realities and practices that should "flow within us", to find a praxis of harmony and peace with nature, as the author writes in his conclusion. The article is part of a critique of modernity, modernisation and progress that culminated in the 1990s in the postmodernism discourse that is no longer as influential as it was at the time. The author does not reflect much on newer research on the global complexity of interacting social and ecological systems from a multi-scale perspective, as in Anthropocene research.

The text places more emphasis on the normative, ethical, and belief-bound practices as compo-

nents of human relations with nature, and less on the social and natural scientific research about the systemic complexity of global forms of social and environmental change to find ways to transform the societal and systemic forms of unsustainability and the assumed epistemological and ontological diversity. Many questions are left open when it comes to dealing with this diversity, integrating the plurality of worldviews and connecting the multiple and fragmented practices and relations to nature, finding ways of networking manifold culturally and locally specific environmental practices, developing pluralistic knowledge practices in science and governance, and dealing with manifold social and ecological crises under conditions of globalisation. The complexity, multidimensionality, and multi--scale forms of human relations with nature can probably be better analysed in other interdisciplinary approaches in human, social, and political ecology, in Anthropcene and transformation research that seek pathways towards sustainability. The fractal approach that the author suggests for rethinking and acting on socio-environmental problems remains unclear regarding these questions. Müller (2015, p. 27) goes a step further with his suggestion, that assemblage thinking and actor-network theory "would benefit from exploring links with other social theories, arguing for a more sustained engagement with issues of language and power, and affect and the body".

Non-Portuguese human ecology is represented in this issue in articles from North and South American human ecologists, from USA, Brazil, and Paraguay. The relationship between humans, their bodies, their health, and their relationship with nature touched on in the article by Amado are taken up in more specific forms in the article by Marcia Grisotti from Brazil. She discusses a classical and complex theme of human ecology – health – with different aspects of the surveillance of human and animal health from a global perspective – important in the context of global pandemics such as that of Covid 19 which might have also originated from human-animal contact. The article analyses the socio-political challenges of health and epidemiological risk surveillance systems in the context of zoonotic diseases (examples of abdominal angiostrongilyosis and tuberculosis of bovine origin). The interdisciplinary "One Health" approach to which the article refers is influenced by global political institutions that work with the health-related problems of humans, animals, and the environment (Food and Agriculture Organisation of the United Nations, World Health Organisation, World Organisation for Animal Health, United Nations Environment Programme), showing that human health can no longer be seen as isolated from animal health and the health of ecosystems.

The article shows in an exemplary way that health is an inter and transdisciplinary issue that cannot be dealt with in one specialised or disciplinary approach, neither scientifically nor practically in policy or governance processes, but requires different, integrated, or pluralistic approaches. In this way, it shows, furthermore, that science and governance are overwhelmed by the complexity of problems and cannot deal with them sufficiently, as the connected health problems and crises are part of complex and interacting social and ecological systems described in Anthropocene research: local, regional, national and global social and ecological issues and crises are tightly connected and interact with each other in manifold ways that require new approaches for which no historical and practical experience exists. In addition, the article provides an example of the specific nature of health issues and diseases. As highly scientised and specialised knowledge practices, the medical and health sciences need to learn to deal with complex and interacting health problems and depend on interdisciplinary cooperation and knowledge integration. Cooperation between scientists, decision-makers, practitioners in different forms, and citizens has become a new reality of environmental research as it has been paradigmatically discussed in sustainability science. The dilemmas, difficulties, and future challenges of such problems have become apparent in the recent global Covid-19 pandemic.

The study from Paraguay by Maria José Aparicio Meza, Amado Insfrán Ortiz, and Gustavo Hees de Negreiros shows a similar complexity of problems to that of the health ecology analysed by Marcia Grisotti. The authors take up a traditional theme in human ecology which becomes a new, separate issue with the challenges of global complexity prevailing today: food production, consumption and security under conditions of multiple social and ecological crises can no longer be achieved with local or national approaches. These need to become integrated components of multi-scale and global food governance. The authors reflect on the complexity and the global polycrisis in their analysis, concluding that dealing with complex, multi-scale, and global problems needs to be learned and trained, which is the main challenge for future academic science and universities as well as for policy and governance practices. Students need to be educated and trained for multi and interdisciplinary knowledge creation and integration for the solution of complex and interconnected problems; this cannot be learned sufficiently in professional or political practices, where it has mainly taken place up to now.

An appropriate theme for such innovative learning is the classical human ecological theme of agriculture and human nutrition, or food system development, for which the authors describe

a human ecology programme at the University of Asuncion – not from the industrial countries of the Global North, but from a poor country in Latin America. Food production and nutrition here have other significance and other problems compared with rich, Western countries, where the main issue is to reduce the overconsumption of resources and food waste in the imperial mode of living. The human ecology programme taught in Asuncion is an exceptional example of successful interdisciplinary teaching in a national university. The article shows why the human ecology programme could become efficient and succeed over a long time: it finds a balance between multiple requirements and components of interdisciplinary cooperation, including combinations of national and international scientific and theoretical literature, observational studies with qualitative and quantitative methods at family, community and society levels, adoption of new interdisciplinary approaches relevant for food and nutrition studies, such as agroecology, knowledge about human nutrition and health, and multi-scale problems of interconnecting local, national and global problems and crises. Moreover, it is all in a practice-oriented context of training. Human ecology has developed in Paraguay in close contact with the real problems, history, tradition, and culture of the country, in which the rural economy, development, and modes of living are important and have been studied from integrated and holistic perspectives. Developing a study of local problems in a global context of complexity and crises seems consequent for developing a future-oriented human ecology that can deal with the global change problems in given local and place-based conditions.

## CONCLUSIONS – SOCIOLOGY AND HUMAN ECOLOGY

What the heterogeneous examples from human ecological research and teaching in this issue show when they are discussed in the broader context of interdisciplinary ecology, including human, social, and political ecology, and the social sciences can be summarised in two points:

- Sociology remains an important knowledge source in human ecology, but not the only one; human ecology cannot rely only on its history and traditions and needs to develop knowledge practices for rapidly changing and deteriorating global ecological and social conditions; human ecologists need to study new problems and themes relevant to society and nature in the twenty-first century;
- Human ecology does not have a universal inter and transdisciplinary knowledge culture from which other interdisciplinary practices should learn, but needs to develop in contact with mutual critique and cooperation with other interdisciplinary approaches; to remain part of the broader scientific community of interdisciplinary subjects such as cultural, social, and political ecology, sustainability science, or transformation research, human ecology needs to share, and exchange knowledge with these approaches.

The present global reality of multiple, interconnected, and interacting problems, risks, and crises requires inter and transdisciplinary knowledge practices as discussed here for human ecology. More intensive interdisciplinary research, knowledge exchange, integration, transfer and application will be required in the future, with scientists, decision-makers, movements, and citizens all cooperating. Human ecology, with its different approaches, has throughout its history worked in this direction. However, in the past few decades, the situation of knowledge production and application has become, due to progressing globalisation, more complex and difficult and requires new concepts and ideas, broader interdisciplinary cooperation and joint learning of knowledge producers, bearers and users.

Human ecology describes in all its variants the human condition as one of changing relations with, and dependence on, nature. From this perspective, the dominant anthropocentric worldview or paradigm in the social sciences – the reasoning that humans were emancipated during modernity, thanks to science and technology, from the forces of nature, or have become independent from nature (critically reflected in the environmental sociology of Catton and Dunlap 1978 as the "human exce(m)ptionalism paradigm") – appears to be an illusion. Furthermore, in the present epoch of the Anthropocene, where humans seem to overwhelm the great powers of nature (Steffen et al., 2007), there is no real dissolution from nature, but rather changing forms of dependence and forms of maladaptation that result in functional disturbance of ecosystems and the Earth system that threaten the future development of society and human civilisation.

The polycrisis of Western modernity is not only one of ecological crises of climate change, biodiversity loss, overuse of natural resources and functional disturbance of ecosystems but also one of the multiple social crises that indicate a crisis of modernisation and progress; the guiding ideas of the industrial society. It will not only be a necessity for human ecology or for sociology but for all sciences, to critically rethink the ideas of modernisation, development, progress and more generally the modes of living; the "good life" and the "good society". This will not be possible without controversies and conflicts – in science, policy, and governance practices. Solutions to the limits to

growth, global scarcity of resources, and planetary boundaries or load limits of the Earth system have not yet been found, and the search for solutions will require much more effort in science, policy, and the practices of resource use.

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