UNIVERSITÉ CÔTE D'AZUR

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# LES CAHIERS

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En route pour la COP CLIMAT UNIVERSITÉ CÔTE D'AZUR

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*Bottes de riz – Cambodge, 2013 – Christophe Den Auwer*

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## *Editorial*

Thirty-three years separate the United Nations Conference on Environment and Development in Rio (June 1992) from COP30 in Belém. The summit in Rio "concluded that the concept of sustainable development was an attainable goal for all the people of the world, regardless of whether they were at the local, national, regional or international level."[1] During this period, the concept of sustainable development, declared in Rio to be a universal goal, gave rise to multiple institutional frameworks that were rarely integrated. Contemporary environmental governance remains marked by fragmentation: disciplinary fragmentation in research, institutional fragmentation in public policy and cultural fragmentation in the forms of participation. This atomization of knowledge, to use Edgar Morin's formulation,[2] hinders our understanding of socio-ecological systems, whose interdependencies transcend conventional categories of sector management. Faced with the triple crisis of climate change, biodiversity loss and pollution, traditional disciplines are proving insufficient to grasp the systemic complexity of interactions. As Morin reminded us, "*il faut relier ce qui est disjoint*" (we must reconnect what is disconnected),[3] while Bruno Latour emphasized that the separation between nature and society has only ever been an illusory modern construct.[4]

In today's environmental and climatic context, the systems we are trying to describe and understand are so complex that it is impossible to shed light on them from a single angle. It is our job first to ask questions, and then to promote methodologies that encourage considering multiple perspectives. In this way, we are trying to embody what Naess called "*le rejet de l'image de l'être humain au sein de l'environnement en faveur de l'image relationnelle de champ de vue total*" (rejecting the human-in-environment image in favor of the relational, total-field image).[5]

This change of focus calls for changes in our approach as researchers, but not necessarily exclusively. As long as scientists have sought to classify their disciplines, they have also thought about breaking down the barriers between them. Thus, a transdisciplinary practice as we see it appears as a means and not an end, a complement to disciplinary approaches, a methodology for formulating perspectives and solutions to the major environmental challenges facing our societies, caught up in that total-field image relationship so aptly described by Naess.

In its 2023 climate report, the IPCC reports that "Adaptation options that are feasible and effective today will become constrained and less effective with increasing global warming. With increasing global warming, losses and damages will increase and additional human and natural systems will reach adaptation limits. Maladaptation can be avoided by flexible, multi-sectoral, inclusive, long-term planning and implementation of adaptation actions, with co-benefits to many sectors and systems."[6] The word adaptation (or maladaptation) appears four times in this quote. We suggest adding a fifth, to highlight the adaptation of scientific practice itself. This has three dimensions: adaptation to cultural

[1] https://www.un.org/en/conferences/environment/rio1992, consulted 10/2025.
[2] E. Morin, La Méthode VI : Éthique, 2008, Seuil.
[3] E. Morin, Introduction à la pensée complexe, 1990, ESF.
[4] B. Latour, (1991). Nous n'avons jamais été modernes. La Découverte.
[5] A. Naess, Une écosophie pour la vie, introduction à l'écologie profonde, textes originaux 1973, Trad. Française, Ed. Le Seuil, 2017.
[6] IPCC CLIMATE CHANGE 2023, Synthesis Report, Summary for Policymakers, 2023.

contexts, by integrating indigenous knowledge and Global South epistemologies;[7] adaptation to systemic dynamics, fostering intersector research and integrated modeling of climate-biodiversity-society interactions; and adaptation to local realities, encouraging short cycles of experimentation, monitoring and participatory evaluation.

This fifth reference to adaptation assumes that knowledge is not only cumulative, but reflexive and situated, what Donna Haraway calls "situated knowledge."[8]

These challenges need to be approached from a variety of perspectives, as their complexity precludes any exclusively disciplinary approach. Exclusively, but certainly not partially. Edgar Morin, who was involved in the early days of transdisciplinary thinking, sums it up as follows: "*Les disciplines sont pleinement justifiées intellectuellement à condition qu'elles gardent un champ de vision qui reconnaisse et conçoive l'existence des liaisons et des solidarités. Plus encore, elles ne sont pleinement justifiées que si elles n'occultent pas de réalités globales*" (Disciplines are fully justified intellectually as long as they maintain a field of vision that recognizes and conceives the existence of connections and interdependencies. Furthermore, they are only fully justified if they do not obscure global realities).[9]

This issue of *Cahiers* features our collaboration with the MERI Foundation[10] at this new session of COP30, 2025, in Belém (Brazil). We hope to bring you different perspectives on how to think about our environment, its complexity and the complexity of the issues we face.

*November 2025,*
*Christophe Den Auwer, for the Academy "Space, Environment, Risks & Resilience" in the name of Steering Committee, Université Côte d'Azur*

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[7] A. Escobar, Designs for the Pluriverse: Radical Interdependence, Autonomy, and the Making of World, 2018, Duke University Press.
[8] D. Haraway, Staying with the Trouble: Making Kin in the Chthulucene, 2016, Duke University Press.
[9] E. Morin, in Carrefour des sciences, Actes du Colloque du Comité National de la Recherche Scientifique Interdisciplinarité , Introduction by François Kourilsky, Éditions du CNRS, 1990
[10] https://fundacionmeri.cl/en/

*Les Cahiers*
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*Highlight*

# Transdisciplinarity in environmental sciences, an example of implementation

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## Is transdisciplinarity a necessity?

Although the human and natural sciences have been catalogued and classified since antiquity, it was not until the nineteenth century that classifications with a more organized structure began to emerge (A. Comte's classification, for example). These classifications, and the disciplines arising from them, have always been the subject of controversy in epistemology and the history of science, and have obviously evolved over time. But whenever they are discussed, authors almost always refer – among other aspects, such as the homogeneity of techniques and methodologies – to a body of knowledge and the transmission of that knowledge, which is tied to its history (see, among an abundant literature, Apostel, 1972[1] or Fabiani, 2006[2]). Fabiani considers, for example, that the terms "discipline" and "science" are equivalent to designate the set of relations between objects and people that make up a specific field of knowledge or research program, but that "discipline" captures more clearly the degree to which a scientific practice has reached a distinct and stable form. The accumulated body of knowledge, including elements of language, techniques and tools for scientific practice, and pedagogical content, organizes and gives structure to the disciplinary field. Researchers in the same discipline form a relatively homogeneous socio-scientific group, united by identifiable practices and modes of communication. This is known as an epistemic community (Meyer and Molyneux-Hodgson, 2011).[3]

Defining disciplines in this way is essential in scientific research. It can be seen as the first step towards the hybridization of disciplines, although this hierarchy is certainly too simplistic, since according to Edgar Morin, "*toute discipline est déjà un point de rencontre d'autres disciplines, elle est le résultat du croisement pluridisciplinaire; elle demande une certaine transdisciplinarité et est elle-même rendue possible par une multidisciplinarité si ce n'est par une interdisciplinarité*" (Every discipline is already a meeting point with other disciplines and is the result of pluridisciplinary mixing; it requires a certain degree of transdisciplinarity and is itself made possible by multidisciplinarity, if not interdisciplinarity).[4]

[1] L. Apostel in L'interdisciplinarité : problème d'enseignement et de recherche dans les universités, OCDE, Paris, 1972
[2] J. L. Fabiani, A quoi sert la notion de discipline, in Qu'est-ce qu'une discipline, J. Boutier, J-C. Passeron, J. Revel, Enquête, Ed. EHESS, Paris, 2006.
[3] Morgan Meyer et Susan Molyneux-Hodgson, « « Communautés épistémiques »: une notion utile pour théoriser les collectifs en sciences ? », Terrains & travaux, vol. 18, no 1, 2011, p. 141
[4] A. Létourneau, La transdisciplinarité considérée en général et en sciences de l'environnement, in La nature des sciences de l'environnement : quels enjeux théoriques, pour quelles pratiques ? Vertigo, Octobre 2008, UQAM, CA.

Morin was quick to identify the need to move beyond disciplinary frameworks to understand a universe whose complexity often exceeds our capacity for analysis, and even more so the compartmentalizations we have defined. He states elsewhere that, "*les disciplines sont pleinement justifiées intellectuellement à condition qu'elles gardent un champ de vision qui reconnaisse et conçoive l'existence des liaisons et des solidarités. Plus encore, elles ne sont pleinement justifiées que si elles n'occultent pas de réalités globales*" (Disciplines are fully justified intellectually as long as they maintain a field of vision that recognizes and conceives the existence of connections and interdependencies. Furthermore, they are only fully justified if they do not obscure global realities).[5]

In this landscape, the hybridization of knowledge must be created from disciplinary islands. This decompartmentalization, often represented by bridges between islands, marks the first steps towards a more integrated approach to the issues at hand. Numerous authors have attempted to describe a hierarchical sequence leading to this higher level that could be described as interdisciplinarity.[6] It was at a colloquium in Nice that Jean Piaget proposed taking this decompartmentalization even further, *beyond the disciplines,* as Basarab Nicolescu would later describe it. According to Piaget, *"[...] à l'étape des relations interdisciplinaires, on peut espérer voir succéder une étape supérieure qui serait "transdisciplinaire", qui ne se contenterait pas d'atteindre des interactions ou réciprocités entre recherches spécialisées mais situerait ces liaisons à l'intérieur d'un système total sans frontières stables entre les discipline*" (…after achieving interdisciplinary relations, we can hope to reach a higher level that is "transdisciplinary," where connections are not simply interactions or exchanges between specialized research areas, but lie within an overall system with no fixed boundaries between disciplines).[7] Nicolescu quickly took up this notion and thereby defined a process that aims to transcend disciplinary boundaries to truly go beyond the disciplines through a process of transdisciplinarity. "[It] concerns that which is at once between the disciplines, across the different disciplines, and beyond all disciplines. Its goal is the understanding of the present world, of which one of the imperatives is the unity of knowledge."[8] This construction of transdisciplinarity defines, in a sense, a new epistemology that aims to reach a *plane* (or level) above disciplinary contributions. These reflections led to the creation of the transdisciplinary charter,[9] which Morin was one of the first to sign. In his conception of transdisciplinarity, Nicolescu defined a new philosophy described as a new transcendence of the subject-object pair: "The zone of non-resistance plays the role of a third between the Subject and the Object, an interaction term which allows the unification of the transdisciplinary Subject and the transdisciplinary Object."[10]

But from another, perhaps less epistemological perspective, transdisciplinary practice can also be seen as a tool for dealing with complex objects, *wicked problems*,[11] for which disciplinary perimeters are not necessarily clearly established or defined. This conception of transdisciplinarity, which could be described as pragmatic, has slightly different contours, and often focuses on environmental issues whose complexity precludes any exclusively disciplinary approach. This aspect was notably addressed at the United Nations Conference on Environment and Development in Rio, in 1992. J. T. Klein emphasized in this context the need for the scientific community to change its approach: "The binomial *complexity-transdisciplinarity* relationship means that the reality being investigated is a nexus of interrelated

[5] E. Morin, in Carrefour des sciences , Actes du Colloque du Comité National de la Recherche Scientifique Interdisciplinarité , Introduction par François Kourilsky, Éditions du CNRS, 1990
[6] Létourneau / E. Jantsch in L'interdisciplinarité : problèmes d'enseignement et de recherche dans les universités, 1972, Paris, OCDE.
[7] Jean Piaget in L'interdisciplinarité : problèmes d'enseignement et de recherche dans les universités, 1972, Paris, OCDE.
[8] B. Nicolescu, Methodology of Transdisciplinarity–Levels of Reality, Logic of the Included Middle and Complexity, Transdisciplinary Journal of Engineering & Science (2010), 1, 17-32.
[9] B. Nicolescu, The charter of transdisciplinarity, (1994).
[10] B. Nicolescu, Methodology of Transdisciplinarity–Levels of Reality
[11] V. A. Brown, J. A. Harris, J. Y. Russel, Tackling wicked problems through the transdisciplinary imagination, 2010, Taylor and Francis, London.

phenomena that are not reducible to a single dimension."[12] In this approach, developed in particular at the Zurich conference in 2000,[13] transdisciplinary practice appears as a means and not an end, a complement to disciplines, a methodology for formulating perspectives and solutions and also solving the major environmental challenges of our century.

As we can see, the transdisciplinary approach takes on a very special dimension in a context where the conceptualization of the Anthropocene era has marked a turning point for the environmental sciences and ecology in general. The start of the Anthropocene era (which some authors arbitrarily date to 1784, the date when J. Watt invented the steam engine) marked the beginning of the rapid shift of the Earth system away from the glacial-interglacial cycle, driven by humans (although this notion is still the subject of debate).[14,15] While we must be careful to avoid generalizations, the scope of certain environmental issues, or ecology more generally, makes it difficult to categorize them within their respective disciplines. Different perspectives are essential to encompass their full complexity, *beyond the disciplines*.

These different contours of transdisciplinary practice are summarized in the editorial by Scholz and Steiner, who also place this debate in the context of the intimate connection between humans and the environment.[16] This broader (and less epistemological) notion of transdisciplinarity extends to approaches that foster collaborative relationships between the academic community and civil society, the private and public sectors, and different levels of political decision-makers. Involving university students in these ventures, with this approach, is an essential part of the effort.[17]

**An original partnership**

The holistic approach needed to address environmental issues encourages the development of innovative ways of thinking, including partnerships. It is in this context that Université Côte d'Azur and the Filantropia Cortés Solari MERI Foundation wished to unite their expertise to encourage transdisciplinary discussions aimed at developing both philanthropic and scientific environmental diplomacy.

This collective endeavor can be seen each year at the COP Climate Change conference, where MERI leads the Science for Climate Action Pavilion, alongside the Intergovernmental Panel on Climate Change (IPCC) and the World Meteorological Organization (WMO), in partnership with Université Côte d'Azur (since 2023). As the only pavilion entirely dedicated to the role of science in climate action, it exemplifies the philanthropic sector's commitment to knowledge. Each year, the Pavilion brings together more than 250 experts to discuss the main climate change issues and their impact, creating a unique space for transdisciplinary exchanges between a wide range of stakeholders – including philanthropists, United Nations' representatives, researchers, political decision-makers, industry players and civil society leaders – that promotes dialogue and cooperation on concrete climate solutions. In keeping with this approach, the collaboration between MERI and Université Côte d'Azur goes beyond

[12] J. Thompson Klein, The discourse of transdisciplinarity : an expanding global field, in Transdisciplinarity : joint problem solving among science, technology and society, Ed. J. Thompson Klein, W. Grossenbacher-Mansuy, R. Häberli, A. Bill, R. W. Scholz, M. Welti,. Birkhäuser Verlag, Swiss., 2001.
[13] https://scnat.ch/en/uuid/i/fbb5711d-911a-5c40-83c6-d733c366e78c-International_Transdisciplinarity_Conference_in_Zurich, consulted 09/2025
[14] W. Steffen et al. *PNAS*, 115, 8252, **2018**
[15] See http://quaternary.stratigraphy.org/working-groups/anthropocene/ (March 2024) for the rejection of the proposal for an Anthropocene Epoch
[16] R.W. Scholz, G. Steiner, Sustain Sci (2015) 10:521–526
[17] J. M. Engebretson, Z. Piso, M. O'Rourke, T. E. Hall, Consultative or participatory ?: how environmental science graduate students envision transdisciplinarity, J. Environ. Studies and Sci. (2024), 14 , 193-201.

the COP conference, extending the shared endeavor to other international meetings, such as Monaco Ocean Week and the United Nations Conference on the Oceans (UNOC).

In addition, MERI and Université Côte d'Azur share the conviction that transdisciplinarity offers a unique and essential perspective for understanding and tackling climate challenges. It makes it possible to generate the knowledge needed to make informed decisions and raise public awareness – an issue that is more crucial than ever in the current climate emergency and crisis of multilateralism. In the current conditions of tension between science, politics and society, philanthropy can play a pivotal role. Its flexibility, local roots and ability to mobilize resources without needing political support make it an "experimental governance laboratory".[18]

**At Université Côte d'Azur**

As part of Université Côte d'Azur, the *Space, Environment, Risks and Resilience* Academy focuses on natural and human-made hazards and risks, effectively promoting a transdisciplinary approach. The research coordinated and supported by the Academy must therefore address complex questions on environmental issues that are also complex in both their nature and their diversity.

While questions about the advent of more sustainable societies are at the heart of current debates, the notion of risk also often underlies public discussions. The transdisciplinary approach discussed in the introduction is a necessary tool for exploring these issues, which are by nature complex and open to societal choices that remain to be decided or modified, and are always open to debate. The aim of this approach to environmental issues in the Anthropocene era is to gain a better understanding of the processes involved, to characterize their diversity and interconnections, and to define their social and environmental impact in a way that goes beyond the disciplinary methodologies discussed above. This is less an aggregation than a hybridization of disciplinary skills, as previously discussed. Thus, the proposed methodologies the Academy supports aim to address issues from a variety of perspectives and encourage the joint development of research projects upstream of their conception and not afterwards.

To illustrate this point, let's take the example of a project that highlights this need for a transdisciplinary approach: the joint development of agricultural scenarios in the Alpes Maritimes Department (Southern Region, France), a project supported by the Academy in 2022.[19] The 2020 pandemic and recent climate and geopolitical crises have highlighted the vulnerability of food systems to large-scale shocks and the need for a transition to resilient food systems. However, the transition to sustainable and resilient socio-technical systems is a topical issue that is mainly debated in the energy sector on a national or even larger scale. But recent advances in rural sociology, ecological economics and spatial geography on agri-food transformations show that local capacities also facilitate the implementation of new forms of public and private coordination involving agricultural players, civil society and public authorities. The aim of this project was to study the resilience of regional food systems, that is, the ability of stakeholders to create new collective endeavors that transcend current structures (aging farmers, erosion of incomes and difficulties of cooperation). The area studied was the Cap Azur metropolitan cluster, located at the western end of the Alpes Maritimes department, with a population of around 400,000. Its history shows a clear division between a densely populated coastal zone where agricultural land has been lost to urbanization, and a rural hinterland where land has been left fallow or preserved for extensive livestock farming (including for recreational purposes). Today, the challenge is to understand how such a region can support itself with a higher level of local autonomy, and it needs to be addressed through contributions from different disciplines and actors. The project was developed with the aim of increasing our understanding of the local conditions for improving the resilience of agri-food systems. It has

[18] Philanthropie Cortés Solari (FCS). (2023). *Effective conservation : Territorial Approach.* Santiago de Chile : MERI Foundation, 2023.
[19] N. Lazaric, TEFOR project, 2022.

provided new insights into the key factors and processes that represent tipping points at local level, and thus can accelerate the transition to resilience and sustainability. Although it is not yet clear if this transdisciplinary effort has achieved the high standards it aspired to, it illustrates the intersection of socioeconomic, historical, geographical and agronomic perspectives. The research team, made up of two geographers from the ESPACE laboratory, three economists from GREDEG, an agronomist from ISA and an expert in collaborative methods from OTECCA, worked towards the same goal: the joint development of scenarios for the future of agriculture in this region. Ultimately, the project aims to design tools to help public decision-makers and local players strengthen regional food resilience and raise public awareness, notably through participatory workshops, with the introduction of educational and learning tools such as "serious games." The aim is to involve local communities, public decision-makers and citizens in the development of future local agriculture, by showing them the choices and contradictions involved in the different scenarios envisaged.

**At the MERI Foundation**

The work carried out by Filantropia Cortés Solari in Chile, through the MERI Foundation, illustrates the same type of coordination in a multidimensional response model, called the *Effective Conservation Model*, that integrates environmental, social, cultural, economic and institutional aspects in a regional approach.[20] Multidimensional actions enable scientific research to coexist with ancestral knowledge, local governance and public decision-making. Filantropia Cortés Solari's three emblematic territories in Chile – the Atacama Desert, the Andes mountain range and the Patagonia region – are living laboratories where science, education and culture come together.

Here, philanthropy acts as a vital bridge between the public and private sectors, taking on start-up risks that public institutions are unable to carry on their own. It thus creates a space for co-creation, where scientific legitimacy is combined with social legitimacy.

The Chilean experience invites us to go beyond transdisciplinarity as a discourse, and think of it as an operating procedure. This model is based on four key stages:

1. Regional co-diagnosis. A combined analysis of a region's biophysical, socioeconomic and cultural dimensions forms the basis of any action. This approach is based on the IUCN's *Global Standard* methodology (2020), and on the active participation of local communities when carrying out regional diagnoses.
2. Co-design of multiple benefits pathways. This means drawing up conservation plans associated with each ecological, social and economic objective, in different time frames. This approach incorporates local knowledge into decision-making, similar to Nature-based Solutions.
3. Experimental implementation. The Filantropia Cortes Solari Elemental Reserves serve as pilot sites for testing innovations in environmental education, ecological restoration and community governance.
4. Learning and feedback loop. In line with Habermas's "communicative rationality,"[21] results are subject to collective deliberation, which encourages the continuous adjustment of policies and the shared responsibility of actors.

Projects such as *The Blue Boat Initiative* (protecting cetaceans and regulating maritime traffic in Patagonia) and Andean species conservation programs demonstrate the effectiveness of this polycentric, adaptive governance.

Horizontal cooperation between scientists, public authorities, companies and communities ensures joint decisions are considered legitimate, an essential condition for effective conservation.

[20] Filantropia Cortés Solari (FCS), Effective conservation : Territorial Approach. Santiago de Chile : MERI Foundation, 2023.
[21] J. Habermas, Théorie de l'agir communicationnel, 1987, Fayard.

This approach reflects what Nicolescu called "living transdisciplinarity": a movement between disciplines, beyond disciplines and grounded in reality.[22] Observation of local dynamics confirms that institutional fragmentation often mirrors cognitive fragmentation. Elinor Ostrom's work on governing the commons[23] has shown that sustainability cannot be imposed vertically: it is co-constructed based on local rules, learning and mutual trust.

**Conclusion**

Transdisciplinarity, as we see it, is not just a cognitive tool, but a relational ethic. It links the global and the local, the rational and the symbolic, the data and the narrative.

Inspired by Arne Næss's "deep ecology,"[24] it invites us to move from knowledge to care, to reconsider the human being as an integral part of the living world. This move from diagnosis to responsibility corresponds to a civilizing paradigm shift, in which science becomes the mediator of a regenerative relationship with the Earth. This joint contribution by the Université Côte d'Azur and the MERI Foundation reflects our shared ambition: to reconcile science and society through transdisciplinary methodologies capable of responding to the complexity of contemporary challenges.

In a divided world, an approach to environmental governance that combines philanthropy, scientific research and instruments for disseminating information, offers a space for institutional innovation where cooperation becomes the primary form of knowledge.

[22] B. Nicolescu, *La Transdisciplinarité : Manifeste.* Rocher, 2008
[23] E. Ostrom, Governing the Commons : The Evolution of Institutions for Collective Action, 1990, Cambridge University Press.
[24] A. Næss, Ecology, Community and Lifestyle, 1989, Cambridge University Press.

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***Highlight***
***Invited paper, Universitat Barcelona, Spain***

# Citizen Science initiatives in climate-vulnerable neighbourhoods: a new transdisciplinary approach to tackle sustainability challenges?

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According to the Spanish State Meteorological Agency (AEMET), the summer of 2025 (June 1–August 31) was exceptionally warm across Spain, with an average temperature of 24.2°C on the mainland. This value is 2.1°C above the seasonal average for the reference period 1991–2020. It was the warmest summer since records began in 1961, surpassing the previous record set in 2022 by 0.1°C .
Barcelona and its metropolitan area, located along the Catalan coast, have been particularly affected by rising summer temperatures, a situation exacerbated by the urban heat island effect (Ward et al., 2016; Zhao et al., 2018). On 16 August 2025, a temperature of 38.9°C was recorded at the Fabra Observatory , one of the city's four official meteorological stations. This value exceeded the previous August record of 38.8°C, registered in 2023. Furthermore, according to an international study (Barnes et al., 2025), Barcelona reported the third-highest number of heat-related deaths among European cities during the summer of 2025, surpassed only by Milan and Rome.

While extreme heat has become an increasing concern in Barcelona and its metropolitan area, its impacts on well-being are unevenly distributed, disproportionately affecting specific, more climate-vulnerable social groups and neighborhoods (Mashhoodi, 2021). These disparities link thermal inequity to broader issues of climate (in)justice (Kotsila et al., 2025). However, how residents experience heat at the micro-local scale remains largely understudied across the Barcelona metropolitan region, which encompasses neighborhoods with markedly diverse socioeconomic characteristics.
It is clear that a new transdisciplinary and participative approach is needed to address this complex real-world urban sustainability challenge. As articulated in the foundational paper by Lang et al. (2012) on transdisciplinary research in sustainability science, such challenges require new knowledge production and decision-making methods and the involvement of actors from outside academia in the research process. Lang et al. (2012) define transdisciplinarity as "a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge."
Lang et al. (2012) propose a model that conceptualizes transdisciplinary research in sustainability science as an "interface practice that originates from societally relevant problems that imply and trigger scientific research questions," and that "relies on mutual and joint learning processes between science and society embedded in societal and scientific discourse." The authors also outline twelve design principles for transdisciplinary research that include building a collaborative research team, developing a shared understanding of the problem, and devising a methodological framework.
This participatory and reflexive orientation of transdisciplinarity closely aligns with Citizen Science (CS) practices. CS can be broadly understood as the active engagement of the general public in scientific

research tasks (Vohland et al., 2021). It can contribute to sustainability transformations by shaping research agendas, mobilizing resources, and fostering socio-technical co-evolution, while simultaneously generating new forms of interdisciplinary scientific knowledge (Sauermann et al., 2020). A recent systematic literature review (Bonhoure et al., 2025) further highlights the contribution of CS to sustainable urban transformation, bringing new research methodologies and scientific results to research topics such as air pollution (Lu et al., 2022; Mahajan et al., 2024; Perelló et al., 2021), participatory urban planning (Fermeglia and Pedrosa, 2022; Franco and Cappa, 2021; Pitidis et al., 2024) and One Health (Bhandari, 2024; Ellwanger et al., 2022; Manikam et al., 2020).

Refocusing on the issue of urban extreme heat, an increasing number of studies have employed citizen science methodologies to investigate this phenomenon (Calhoun et al., 2024; Kim et al., 2024; Kousis et al., 2021; Lehnert et al., 2021; Leichtle et al., 2023; Rosso et al., 2022). CS is a powerful way to place urban citizen views, perceptions and lived experiences at the center of the research. Another recent review (Freschi et al., 2024) highlights the growing potential of Citizen Science (CS) to inform climate governance and action and confirms its capacity to contribute to climate change research in urban contexts from multiple perspectives and thematic angles. This is particularly evident in the framework of citizen social science, in which participatory research is co-designed and directly driven by citizen groups united by shared social concerns (Albert et al., 2021; Bonhoure et al., 2023). When targeting urban issues such as heat, this framework highlights the active role of co-researchers—residents who possess local, experiential knowledge of their neighborhoods and who share a collective concern about urban heat—in shaping both the research questions and outcomes.
In this context, the Heat Chronicles CS project (Cròniques de la Calor in Catalan) was implemented in 2023 and 2024 across five neighborhoods in the Barcelona metropolitan area. The project forms part of the Universitat de Barcelona Hub for Global Sustainability , a transversal research alliance that brings together academic and technical staff from various research groups across 15 different faculties. The Hub strives to intensify efforts to overcome current crises by strengthening interdisciplinary collaboration within the university community.

In Heat Chronicles, neighborhoods were selected based on their residents' heightened vulnerability to extreme heat, primarily associated with socioeconomic and urban-structural factors (Garcia-Sierra et al., 2022). In each neighborhood, a collaborative research team was established, bringing together 14 partner organizations, including educational institutions (kindergartens, primary and secondary schools, as well as specialized education centers), civil society organizations (e.g., NGOs working with children and young people in situations of social vulnerability), and community facilities (such as public libraries, community centers, and neighborhood assemblies). Collaboration with these local institutions facilitated a deeper understanding of the specific challenges associated with extreme heat, further enriched through a series of walking explorations conducted by the research team across the participating areas.
In total, nearly 500 residents participated, sharing their experiences as primary and secondary school students, families with toddlers, young users of civil society organizations, public library users or self-organized groups of elderly people.
The citizens' groups first identified and characterized the most relevant public spaces in their neighborhoods and then took part in collective "thermal walks." During these walks, continuous geolocated temperature data were collected using customized low-cost sensors (see Figures 1a and 1b). At each of the previously identified public spaces, participants paused to individually and anonymously report their perceptions of thermal comfort and sensation (see Figures 1c and 1d).
The results were collectively interpreted within each neighborhood, while the overall dataset was analyzed at a metropolitan scale. In total, 52 thermal walks were conducted, covering 211 public spaces and yielding approximately 3,000 thermal comfort votes and 2,000 thermal sensation responses.

a. 

b. 

c. 
d. 

**Figure 1**. Heat Chronicles' collective thermal walks:
(1) Collection of a continuous geolocated set of temperatures (a and b), and (2) individual anonymous thermal votes on thermal comfort and sensation (c and d).

At the local scale, the findings revealed that accessing basic facilities—such as health centers (Figure 1d) or metro stations—often requires walking routes that are fully exposed to extreme heat. Similarly, leisure facilities such as football pitches were frequently found to be unusable under current climatic conditions, while access to cooler areas like urban forests proved challenging. The project also highlighted residents' strong willingness to engage in the research process and to be recognized as knowledgeable members of their communities. Older adults valued the opportunity to share their lived experiences during heat waves and, despite mobility limitations, expressed a desire to participate in the collective thermal walks. Children and teenagers likewise emphasized their sense of belonging to the community and sought to challenge adult-centered urban design paradigms.
At a broader level, the data generated by Heat Chronicles provided a unique opportunity to examine how heat perception is influenced by factors such as gender, age, and residents' personal relationships with their neighborhoods. The physical characteristics of the urban spaces visited—including use, Sky View Factor, Normalized Difference Vegetation Index (NDVI), shade, and wind conditions—also played a decisive role in shaping both thermal sensation and comfort. The nuances and complexities of this multidimensional issue call for sophisticated data science techniques and challenge the limitations of disciplinary research approaches. The crowd-sourced data collected are motivated by residents' concerns and might not meet the expectations of professional scientists, and vice versa. There is also the need to find new ways of bringing together complementary discourses to make the voice of groups of residents stronger and to deliver scientific outcomes which lead to effective sustainability transformations.

Returning to the concept of transdisciplinarity, Heat Chronicles embodies many of the principles outlined by Lang et al. (2012) for conducting transdisciplinary sustainability research. Addressing a real-world problem and generating socially robust knowledge, the project is transdisciplinary by design, organically integrating disciplines such as meteorology, urban planning, Geographic Information Systemsand data science, and ethnography. It employs diverse methodologies—including community and participatory mapping, co-creation processes, and exploratory walks—that foster collaboration between scientific and societal actors. Heat Chronicles has also fostered a shared understanding and

collective definition of the problem to be addressed, through collaboration with diverse institutions and citizens' groups, in the spirit of mutual learning. The project also developed a new methodological framework, informed by experience from previous CS projects (Perelló et al., 2021), in which citizens determined the locations of measurements based on their expert knowledge as users of public spaces.
To conclude, CS initiatives implemented in climate-vulnerable neighborhoods offer a valuable opportunity to fully embrace a transdisciplinary perspective, transforming conventional scientific methods and protocols while simultaneously enhancing the societal relevance and impact of research.

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***Highlight***

# Advancing Environmental Hazard Resilience through Transdisciplinary Education

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Environmental hazards and disaster events now appear regularly in global news, occurring in all regions of the world. Disasters are estimated to have caused nearly 100,000 deaths[1] and around 500 billion US dollars in economic losses[2] in 2023 alone. These figures do not account for the millions of people injured, displaced, or otherwise affected.

Beyond their human impact, these extreme events are placing additional pressure on already severely degraded ecosystems, leading to further habitat destruction, species loss, and reduced ecological resilience. The wildfires that devastated Australia in 2019–2020, for example, are thought to have killed over three billion animals[3]. This occurred in a context where ecosystems were already destabilized by invasive species. Similarly, the triple planetary crisis of climate change, pollution and biodiversity loss is expected to further increase the frequency and intensity of environmental hazards. Land use, including agricultural expansion, urbanization, deforestation, is a major driver of this crisis that is often overlooked. It took tens of thousands of years for the human population to reach one billion people around 1800, and only two more centuries to reach over eight billion today[4]. This demographic surge has led to major land transformations, and in just sixty years, roughly one-third of the Earth's surface has been significantly altered[5]. More than 2.5 billion additional people are expected to live in urban areas by 2050[6]. As land-use pressures intensify, resilient land-use planning is becoming increasingly essential.


Environmental hazards are thus inherently complex, driven by multiple interacting factors and resulting in wide-ranging impacts on socio-environmental systems. As such, effective disaster risk management requires integrated, multidisciplinary, and evidence-based approaches. The IPCC's Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (2012) introduced a comprehensive risk framework that defines disaster risk as the outcome of the interaction between three key components: hazard, exposure, and vulnerability. Understanding and addressing each of these dimensions is essential

[1] https://ourworldindata.org/natural-disasters
[2] https://www.statista.com/statistics/612561/natural-disaster-losses-cost-worldwide-by-type-of-loss/
[3] https://wwf.org.au/news/2020/3-billion-animals-impacted-by-australia-bushfire-crisis/
[4] https://www.worldometers.info/world-population/world-population-by-year/
[5] https://www.nature.com/articles/s41467-021-22702-2
[6] United Nations, Department of Economic and Social Affairs, Population Division, 2019. World Urbanization Prospects The 2018 Revision.

for developing effective strategies to reduce risks and enhance resilience in the face of increasingly frequent and intense extreme events.


Within this framework, education, and particularly higher education, is essential. Effectively managing environmental hazards and disaster risks requires comprehensive, transdisciplinary training that integrates scientific knowledge, technical expertise, and systems thinking. Universities can play a critical role in training future professionals in environmental risk management, as well as researchers capable of developing innovative models to better understand, predict, and reduce risks.

One recent initiative is the Master of Science in Environmental Hazards and Risks Management, developed by the Academy of Space, Environment, Risks and Resilience at Université Côte d'Azur (Nice, France), within the framework of IdEx (Initiative of Excellence). The degree is designed to prepare students to understand and manage a wide range of environmental risks in the context of rapid global change.

The program adopts a deliberately broad scope. It covers natural hazards such as earthquakes, tsunamis, floods, wildfires, harmful algal blooms, landslides, and also land-use related processes. These are taught alongside cross-cutting topics such as climate change and crisis management, as well as early warning systems, in order to provide a more integrated understanding of the challenges for multi-hazard risk management. Teaching is organized around intensive modules: after an initial semester for general orientation, each hazard is studied in focused four-to-five-week blocks. Project-based learning and group work are central to the pedagogical approach.

In addition to real-world field examples, the use of digital tools is also a key element. Students are trained in GIS, remote sensing, and programming (in Python and R). With the growing availability of spatial and environmental data, the challenge is increasingly how to manage and interpret large datasets. For instance, the National Institute of Geographic and Forest Information's BD-TOPO database digitizes information on more than 50 million buildings in France. Climate datasets recently made public by Météo France include over two million hourly data points for a single department over a ten-year period. Due to sustained public investment, France now has one of the most advanced geospatial data infrastructures in the world.

The MSc RISKS program began its seventh academic year in September 2025. Entirely taught in English, it has welcomed students from thirty different countries from all continents. This international environment adds a valuable dimension to the learning experience, particularly for students discovering France for the first time. The location in the PACA-SUD region of southeastern France is also relevant: the area presents a unique concentration of environmental risks in a relatively small territory, providing opportunities for field-based teaching and research.

Graduates of the program move into careers in environmental consulting, risk analysis, GIS and remote sensing, working for private firms, local governments, and NGOs. Others continue with doctoral research, sometimes within the university's own research units. Such professionals are likely to play an increasingly important role in anticipating, analyzing, and responding to complex risk processes in both human and ecological systems.

By equipping the next generation with the tools and knowledge to reduce exposure and vulnerability and implement evidence-based decision-making at all levels, University Côte d'Azur is supporting the development of more resilient and sustainable socio-ecological systems.

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***Highlight***

# Scientific diplomacy and the climate emergency: Young researchers' perspectives on the COP

A position paper from Nawel Belkessa[1], Abir Khribich[2]

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One year ago, the Conference of Parties on climate change COP29, held in Azerbaijan in November 2024, highlighted the deep divisions and inconsistencies within the multilateral climate framework. Today, thirty years after the first COP in 1995 marked the beginning of global commitments to reduce $CO_2$ emissions, negotiations continue to reveal the structural weaknesses of the United Nations Framework Convention on Climate Change (UNFCCC) and the limitations of a process where economic interests often dominate scientific priorities.

The year 2024 marked a major turning point in the global climate crisis. After an exceptionally hot 2023, when the global average temperature exceeded pre-industrial levels by 1.45 ± 0.12°C, 2024 became the first year in which the +1.5°C threshold was unambiguously crossed. The threshold, deemed critical by the Paris Agreement, was intended to limit the most severe risks and impacts of climate disruption (Belkessa and Khribich, 2025). This unprecedented observed rise was accompanied by record concentrations of greenhouse gases, intensified extremes in air and ocean temperatures, and a proliferation of devastating climate events: destructive wildfires, catastrophic floods, and unbearable heatwaves. Among the most notable in 2025 were: wildfires in Southern California (January), massive floods in Bolivia (March), Cyclone Remal in Bangladesh and India (May), deadly floods in South Africa's Eastern Cape province (June), wildfires in İzmir, Turkey (June–July), fires and storms across the Balkans (June–July), floods in Pakistan (June–July), a heatwave in Western Europe (June–July), a heatwave in eastern China (July), and catastrophic flooding in Central Texas (July), causing hundreds of deaths and tens of thousands of displaced people (Voices Earth, 2025).[1]

The mismatch between effort and outcomes should prompt serious reflection. The climate challenge is not "magical" or "automatic" (Laurent, 2023); it calls for coordinated transformations, bold political choices and a collective awakening proportionate to the crisis.

It is hard to square today's realities with yesterday's labels. For example, China is now a top industrial power and the largest annual greenhouse-gas emitter; allowing it to hold onto a blanket "developing" status strains fairness and effectiveness because it blurs who should shoulder which responsibilities. We think a better approach would be to match obligations to current capabilities and responsibilities, that is, who has the resources and who contributes most to emissions today. On that basis, China should be among the countries that are expected to provide stable climate finance, support climate adaptation in

[1] https://voices.earth/insights/the-top-10-climate-catastrophes-of-2025-so-far/.

vulnerable states, and accelerate technology transfer. What is necessary is to align roles with present-day power and impact so the world can move faster and more fairly toward its climate goals.

This example illustrates, in our view, the urgent need to reform the United Nations Framework Convention on Climate Change (UNFCCC) to reflect current economic and environmental realities.

The imbalance between industrialized and developing countries complicates the situation. Wealthier countries, historically responsible for the majority of emissions, tend to preserve their economic models while offering insufficient support to vulnerable countries that are nevertheless bearing the brunt of climate impacts. This raises fundamental questions of climate justice, whether in terms of more equitable financing or potentially the targeted degrowth of advanced economies.

Across much of the world, basic needs (subsistence, protection, and freedom) are largely met. But this is far from universal: The United Nations estimates 731 million people still struggle to satisfy the most elementary needs.[2] Meanwhile, in high-income countries, many who have secured the basics are shifting toward hedonic consumption (Liao, 2021).

The link is stark: higher living standards, higher environmental pressure. Globally, the richest 10% generate nearly half of greenhouse-gas emissions, while the poorest 50% account for just 12% (Chancel et al., 2022).

Shifting our development models demands much firmer commitments, not just praising "good" behaviors such as purchasing electric cars or eating vegetarian diets; we need an environmental architecture that blends binding rules with smart incentives, calibrated to real economic and social disparities. Policy must widen access to sustainable options so they do not become the preserve of a privileged few (Khribich, 2024).[3]

Gender equality has also emerged as a contested theme, with some states resisting its integration into climate policies despite clear evidence of women's heightened vulnerability. Scientific research consistently shows that women express more favorable attitudes toward the environment than men (Ahmad et al., 2021; Eagly, 1987; Rainisio et al., 2022). Yet our present-day relationship to technology and the environment is shaped by a long history of gendered role assignments. The result? Women, despite being highly engaged with environmental issues, are routinely sidelined from decision-making on sustainable development and the uptake of green technologies. Persistent stereotypes that equate "tech" with masculinity continue to reinforce this exclusion (Sovacool et al., 2022; Standal et al., 2020). These findings make one point unmistakably clear: countries that still resist embedding gender equality in policy are undermining their own climate response. Climate change is universal in its reach; a storm does not pause to ask who it harms. Ensuring women's full participation is not only fair, it is a necessary prerequisite for effective, lasting climate solutions.

Beyond these structural issues, the role of science remains marginal in the face of the weight of geopolitical and economic agendas. While scientists emphasize tipping points and irreversible impacts such as melting ice caps, ocean acidification, and biodiversity collapse, negotiations often focus on compromises designed to preserve the competitiveness of states. Findings such as large-scale permafrost thaw, and Amazon rainforest dieback rarely translate into binding diplomatic commitments. Instead, negotiations tend to prioritize state sovereignty, economic competitiveness, and energy security, leading to diluted compromises rather than transformative action. According to Lenton et al. (2019), crossing several tipping thresholds could trigger cascading and self-reinforcing feedback processes, yet these warnings are often sidelined when they conflict with short-term national or industrial interests. The

[2] https://www.un.org/en/exhibits/page/sustainable-development-goals.
[3] Khribich, A. (2024). Peut-on être trop heureux pour se préoccuper du climat ? The Conversation. https://theconversation.com/peut-on-etre-trop-heureux-pour-se-preoccuper-du-climat-220429.

strong influence of lobbying groups, especially from the fossil fuel industry, weakens the credibility of climate negotiations that should be guided by science (Brulle, 2019). As a result, we notice that COP agreements often represent minimal compromises between geopolitical blocs instead of reflecting the ambitious action that scientists recommend. It is therefore urgent to strengthen the link between science and diplomacy, for example, by improving collaboration between the IPCC and the UNFCCC, creating independent expert panels, and using science-based criteria to monitor progress. These measures are essential to rebuild trust and ensure that climate governance is grounded in solid scientific evidence.

As the international community now turns toward COP30, to be held in November 2025 in Belém (Brazil), expectations are particularly high. Situated in the Amazon, the summit carries both symbolic and practical weight: it will not only test the capacity of negotiators to deliver more ambitious Nationally Determined Contributions (NDCs) and operationalize the new climate finance framework, but will also place forests, biodiversity, and the rights of vulnerable communities at the heart of global climate diplomacy. COP30 coincides with a new cycle in which countries are required to submit updated and more ambitious NDCs under the Paris Agreement (2015). Current pledges remain insufficient to align with the 1.5°C trajectory. The summit is therefore expected to deliver not only greater national commitments but also a clearer and more equitable framework for international cooperation.

At COP29 in Baku, governments agreed to a new collective quantified goal (NCQG) for climate finance. Set at $1.3 trillion annually by 2035, with at least $300 billion dedicated to developing countries (WRI, 2025), the challenge will be not only to mobilize this unprecedented sum but also to ensure fair access, transparency, and a balance between mitigation, adaptation, and loss and damage funding.

Reflecting on the outcomes of COP29, we believe that real progress will only come when science truly shapes political decisions rather than being constrained by them. We hope COP30 in Belém will mark a turning point, as an opportunity for renewal, a chance for countries to move beyond symbolic commitments and embrace genuine cooperation grounded in equity, transparency, and shared responsibility.

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***Opening***


# A Poet's Letter to Researchers

## Dear Researchers,

You are searching.
It's the flow of your profession.
In the world and in the waves, you dive and you probe.
You search, you study, and you advance, following the stream of your research that comes to you in waves, and sometimes you find something.
Every now and then, you return to shore to tell us about it.
You come back to tell us about it when the conditions are right. And you go on to set out signposts for bridges of knowledge and pathways of action leading to improvements. You come back to tell us about it when it's important to strengthen those bridges and to educate or encounter other living beings on the planet, underwater and in the stars.
Or, at the very least, you tell those right next to you, you tell them what you're doing, what you're passionate or enthusiastic about, what's come to your understanding, what's not working, what they need to be aware of: to be protected, to avoid, or to anticipate, because you're working on new things, and you're shaping minds.

Word for word, here's what a diver once said: "To go slowly, is to go fast."
From our respective decompression stops and bubbles of reflection, don't you think it makes sense to take a moment to draw oxygen from these words and let them buoy us, before diving back, after a few moments, into the heart of our life and our activities, undoubtedly driven by the fervor of kaleidoscopic research and new avenues to explore?

Dear Researchers,
Between you and me, it's a matter of finding blue time.
I am a singer and poet. I sing and write in blue ink in the world of lines, and I interpret them in different formats. To achieve this, I sail away, cast off my anchor, linger, and float for a short, medium, or long period depending on the type of research, and make frequent trips back and forth to what I call blue time, where I go to mull things over, to find and bring back concepts until they materialize.
Like you: "I am made of long silences and long journeys," as Cécile Coulon so fittingly writes in a poem.[1]

[1] Excerpt from the title page of the poetry book ***Noir volcan*** by Cécile Coulon, published by Le Castor Astral, 2020 "

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The most beautiful poems, the most incredible musical waves, the most daring inventions probably nestle in the bed of the sea, in the crash or at the crest of its waves.
Following its oscillations and flows.

You are students and teachers, and each and every one of you is a researcher. This letter leads us to both the blue waves of learning and those of evolving knowledge.

Poets, researchers, scientists, writers, artists, artisans, and humans: I am one of those who believe that we have much more in common than can ever be enclosed in our islands of reflection and our archipelagos of thought.

I am one of those who believe that what we have in common is an opportunity, an opportunity to build.

Let me quote Daniele Finzi Pasca, a cross-disciplinary creator and founder of the Finzi Pasca company, who travels the world several times a year presenting solo or monumental performances. He says that we humans are made of water like other living beings: we are made of water and stories. "Poets, painters, and musicians are busy inventing and remembering stories. Clowns bring water, musicians bring wine, painters bring sunshine. Poets bring spices and flowers."[2]
I would add and associate the research community to his sentence:
Researchers bring the compass, and they bring improvements through the unexpected.

When we venture to let our ideas sediment on the beach of our blank pages,
in this blue time that can last minutes, hours, sometimes months, or years, with handfuls of shaggy hair, we go far away to seek and find invisible ideas. We venture out, shaking our haggard gazes, our pens, our keyboards, and our dictaphones on a shore that holds the possible and the impossible, and where everything seems immense at first.
In our blue times, we each immerse ourselves in a massive effervescent bubble for non-quantifiable time loops.

And when we're on the other side of the lock—You know—
At the crest of other worlds, ready to clear away rubble and advance reflection—You and me—
What brings us closer on our beaches, to name but one, is musing: the immense ebb and flow of thought.

An ingenious and powerful means to tame it, is to draw nearer to the sea.
In periods of stagnation, it reassures me to consider with disarming simplicity the sea's endless musing, repeated over and over. I accept this elegant daily performance as a breath of fresh air blown on my heated rough drafts. I learn to delve deeper and sift through my ideas in towns and places a stone's throw from the sea, and to connect the contemplations. The result is more acceptable, although often more modest: three steps back for every two steps forward. Here is a key of mine that I am sharing with you on paper and that sustains me in my search: it's to be close to the sea in its musing back and forth on the shore.

And you, as you experience the ebb and flow of your daily research: What do you think? How do you live it?

Lou MILS

[2] Excerpt from the book "Daniele Finzi Pasca, Le Théâtre de la Caresse," by Facundo Ponce de León, published by FPH, 2013

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*Interview*

## Thierry Menissier – Professor of Philosophy in Human Sciences and Innovation, IAE Grenoble (University of Grenoble Alpes)


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## APPENDIX TO A POET'S LETTER TO RESEARCHERS

### Author credentials

Lou Nils, French poet and explorer, is a member of the *Société des Poètes Français* (Society of French Poets). Leader in the *Nouveau Romantisme d'Action* (New Romanticism of Action), she founded *La Poèmerie* in 2020 — a poetic research laboratory and independent author's house. Her action spans a wide range of styles, from complex written compositions to pure, distilled lines, and experiments with new poetic and musical forms.
From 2023 to 2024, her short-form poetry has been selected and purchased at the *Espace Créateur* of the *Comédie Française* in Paris, in an evolving collection of handwritten mini-scrolls entitled *La Pensée Magique* (Magical Thinking).
Since 2010, conceptual projects and modern adventures have emerged along her artistic path as she seeks to build bridges between art, science, and technology. Drawing creativity from her travels, she roams through France and around the world, creating works that capture the pulse of the present.
The french national newspaper *Le Monde* has described her art as "combining reality and imagination, making the impossible possible in a 'sur'realistic way."
In May 2025, Lou Nils was welcomed as a full member of the *Société des Explorateurs Français* (French Explorers Society).

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