

Major Research Program **TERRAE**
«Transition Environnementale par la Recherche, la Recherche-Action et l'Enseignement»

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1- INTRODUCTION

It is widely recognized that transition pathways toward a more environmentally and socially resilient world are urgently needed. The five institutions supporting TERRAE, with a community of around 150 researchers, offer a platform to address the pressing challenges of climate change, biodiversity loss, and related social issues. Each institution has already launched several interdisciplinary research and education initiatives focused on environmental concerns.

TERRAE specifically aims to consolidate, amplify and structure research at PSL for the design of social and ecological transition pathways, relying on all the research sectors within PSL including **Geosciences, Biodiversity and Health sciences** as well as **Social and Human sciences**.

Given the need for a **systemic** approach to transitions and a **rapid** implementation of transition strategies, **TERRAE** seeks to :

- **(Goal #1)** Build bridges between PSL's research groups
- **(Goal #2)** Identify and develop impactful research that have a strong impact on society and environment, to accelerate the social and ecological transition: a **strong-impact, transition-oriented research**.

This research will be more impactful through ongoing engagement and dialogue, from the outset of each project, with **stakeholders** who will serve as a source of research questions and challenges, as well as partners and advocates in implementation and dissemination.

TERRAE will conduct transdisciplinary research through four "Transition Hotspot projects," focusing on specific transition objects and their trajectories, such as a territory, sector (e.g., energy), practice (e.g., mega basins), or challenge (e.g., water scarcity). These projects address different transition challenges, involve various scientific fields, and are developed in collaboration with relevant actors. The first two hotspots, launching in early 2025, will focus on droughts (Freddy Bouchet) and the agroecological transition (Corinne Robert). Funding is also planned for two additional hotspots and 6 to 8 smaller "mini-projects."

TERRAE also aims to link research with innovative teaching/training for transitions, in particular with the opening **PSL master's program in Sustainability Science**.

2- COMPOSITION OF THE PARTNERSHIP

The five institutions composing **TERRAE** provide a credible platform to engage impact-oriented research seeking to deal with the current and future challenges of environmental crises and the related social issues. They also have long experience in interdisciplinary research activities and teaching on transition issues (CERES ENS, Dauphine Durable, dimENSion durable, Institut de la transition 1.5...).

3- RESEARCH PROGRAM GOALS

Addressing global change challenges demands a systemic approach and multiple scientific fields—climate science, biodiversity, agriculture, economics, law, sociology, and more. PSL offers fertile ground for impactful research on global change but still needs an environment that fosters true transdisciplinary collaboration with stakeholders.

To meet the need for a systemic, transdisciplinary approach and the rapid, concrete implementation of transition strategies, TERRAE has two primary goals (see Fig. 1):

- Goal 1. **Connect and coordinate research groups** focused on environmental processes, global change and transition solution, uniting diverse disciplinary backgrounds.
- Goal 2. Leverage **TERRAE to amplify research impact on transition** by scaling up transdisciplinary, transition-oriented research. Funding will prioritize projects involving several fields (interdisciplinarity) and stakeholders (transdisciplinarity).

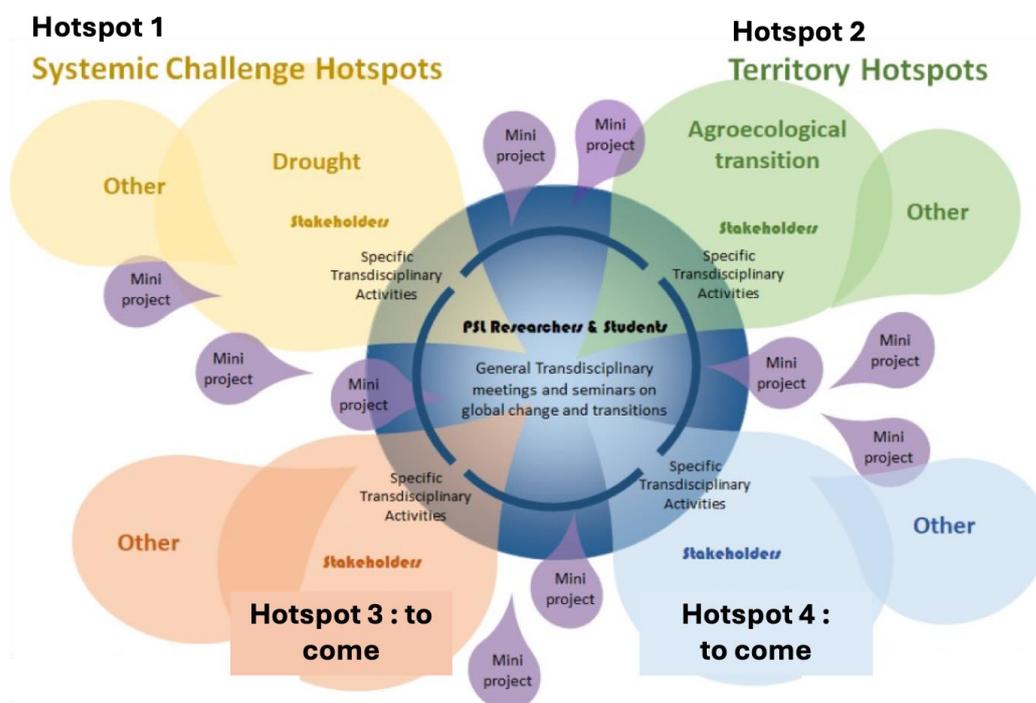


Figure 1: General structure of TERRAE. The central blue circle represents TERRAE's Goal #1: uniting and engaging the PSL scientific community around the interdisciplinarity and transdisciplinarity. The petals symbolize Goal #2: the implementation of large-scale "transition hotspots" and small-scale "mini-projects" research, involving TERRAE researchers and various stakeholders. Cross-disciplinary activities between hotspots will foster collective reflection on transdisciplinary research in collaboration with stakeholders.

4- TERRAE GOAL1: Connect and coordinate transition research at PSL

Goal #1. Connect and coordinate transition research at PSL

To build a transdisciplinary research community, TERRAE will host regular **scientific events for its researchers**, including recurring seminars to foster mutual understanding of each other's work. At least **two events per year will be held** with proposals selected by the Steering Committee.

Each year, two types of seminars will be organized: (i) one general conference and (ii) one or two project-focused seminars to discuss ongoing work (see Fig. 2).

(i) The general conference (Event A in Fig. 2) will bring together all TERRAE researchers, regardless of their involvement in Transition Hotspots or TERRAE-funded mini-projects. These conferences may be organized around themes such as:

- Cross-cutting themes, such as "from fundamental research to action-research" or "temporalities in action and research."
- Engagement with transition actors to discuss topics and methods from diverse perspectives.

- Collaboration with partner programs (e.g., PEPR) or research teams with objectives that complement or inspire TERRAE's work.

(ii) Some seminars will serve to collectively identify key topics for TERRAE and the projects to be funded, such as *Emerging Hotspot Workshops* (Event B in Fig. 2). Special events will support the development of two Transition Hotspots and 6-8 mini-projects. Additionally, *Transversal Hotspot Workshops* (Event C in Fig. 2) will be held to promote cross-fertilization among funded projects.

5- TERRAE GOAL2 : Strong-impact, transition-oriented transdisciplinary research

Goal #2. Strong-impact, transition-oriented transdisciplinary research.

The second goal of TERRAE is to foster high-impact, transition-oriented research. Achieving meaningful impact requires a systemic understanding of transition challenges, given the complex interconnections among societal, natural, and physical systems. This approach helps avoid partial solutions that might lead to unintended negative consequences.

This requires understanding the constraints, interactions, and feedback loops between system components. Timing is also crucial, as the transition must be viewed as a dynamic trajectory with various patterns and effects, such as resilience, robustness, tipping points, and sensitivity to parameters and initial conditions. Both interdisciplinarity and transdisciplinarity are essential for this research. Transdisciplinarity is particularly critical, as sustained engagement and dialogue with transition stakeholders significantly increase the likelihood of research making a strong impact.

TRANSDISCIPLINARY RESEARCH PROJECTS : “the hotspot and the mini-projects”

Two types of research projects are built:

5.1 Four “Transition Hotspots »

These projects focus on a clearly defined research object and its trajectory. To receive the "hotspot" label, a project must address a transition challenge, involve multiple scientific fields, and be developed in collaboration with relevant actors. Expected duration: 3-4 years. Budget: around 1 doctoral fellowship, 1 postdoctoral fellowship, master's internships, participatory facilitation, and running costs.

Two Transition Hotspots will start at the beginning of TERRAE :

Hotspot #1 – Drought as a systemic example for transition and adaptation challenges

This is an emblematic example of a “**systemic challenge**” type of transition hotspot. Meteorological, hydrological, agricultural, socioeconomic and ecological droughts are all likely to worsen due to climate change and the ever-increasing pressure of human activities on land.

Extreme drought will most likely be among the most impactful climate related stress in the coming decades in France. Droughts are deeply connected with other extreme climate events (heat waves, marine heat waves, megafires) and **can perturb all the elements of the water resources/agriculture/food/energy production** nexus, with wide and systemic economic impacts. As illustrated by recent social conflicts (for instance mega basin or water resource allocation conflicts), finding transition pathways at the scale of the national or territory scale, which are compatible with mitigation goals and the future of other living beings is challenging.

Hotspot #2 – Activating and massifying the agroecological transition at territorial level

Despite broad consensus on the harmful effects of intensive pesticide use, extensive research on alternative practices, and three successive "Ecophyto" plans, the agroecological transition has been slow. It is now clear that significant pesticide reduction can only be achieved through a systemic change in the agro-socioecosystem, taking into account the specificities of each territory.

The project aims to promote agroecological transition pathways through participatory workshops on agriculture, biodiversity, and food, with the goal of shaping new perspectives on a pesticide-free world and encouraging changes in farming practices. It will examine the role of farmers' and agricultural advisors' perceptions in this transition, particularly concerning pesticide reduction. The project will test a methodology designed to shift these representations, exploring the interactions and complementarities between traditional socio-technical levers and the views held by farmers and advisors. Adopting a territorial transdisciplinary approach, the project will bring together farmers, technicians, agricultural advisors, consumers, NGOs, elected representatives, researchers, and engineers involved in the territory.

Two additional hotspots will emerge from the TERRAE research community and its activities :

As mentioned, original events will be organized to support the development of the two Transition Hotspots and 6-8 mini-projects, as well as to facilitate cross-fertilization among funded projects. A collaborative space will be established to coordinate the proposal process for new hotspots or mini-projects.

5.2. Six to eight "mini-projects"

TERRAE will issue an annual call for 6 to 8 "mini-projects" (see Fig. 1). These projects are designed to encourage interdisciplinary and transdisciplinary research in a more flexible format than hotspots. They should involve at least two distinct disciplines and one stakeholder to ensure practical applicability and societal impact.

Expected duration: 2-3 years; (project around 1 doctoral or postdoctoral fellowship, running costs). The mini-projects may act as potential precursors or catalysts for future hotspot initiatives, or collaborate with existing hotspots.

Figure 2 : TERRAE timetable with the different actions: general seminars at PSL level (Events A), seminars to help new hotspots emerge (Events B), cross hotspot and mini-project seminars (Events C), positioning of the four hotspot projects and the seven mini-projects.

