Title:

Analyzing the sustainability of agricultural transitions on a territorial scale: a framework combining territorial metabolism and resilience

Extended Abstract

Introduction

Today's agricultural territories are faced with a complex set of changes, of multiple natures, on the scale of both farms and the sectors in which they operate: rising input costs, price variability, regulatory constraints, climate change, and so on. A large number of studies highlight the limits of the agro-industrial model, in particular its negative externalities in environmental, social and health terms. Faced with these challenges, a diversity of actors engaged at different scales are attempting to design and implement new transition strategies towards more sustainable agricultural systems [1]. However, these approaches, often circumscribed to the scale of a farm, cooperative or sector, generate economic, environmental and social impacts that go beyond these action frameworks, without their initiators always being able to measure their scope.

In this context, new conceptual and methodological tools are needed to understand the sustainability of ongoing agricultural transitions and their effects on a territorial scale. This article proposes to lay the foundations for a participatory, multicriteria and multiscalar framework for analyzing the sustainability of agricultural transitions. This theoretical framework will then be applied to an initial field study in spring 2025, with the aim of testing its empirical relevance and presenting the initial results.

Literature review and conceptual framework

An integrative literature review [2] was conducted using different combinations of keywords relating to sustainability, transition, transformation, agriculture and agricultural systems. This review focused on publications in the field of sustainability transition studies applied to agricultural systems, and paid particular attention to geography transition studies to identify discussions on the spatiality and territorial dimension of transitions. We mobilize publications identified via the Scopus database.

The works selected for this review stand out for their conceptual contributions, combining different existing frameworks or proposing new ones to analyze the sustainability of agricultural transitions.

We propose to discuss the contributions of socio-ecological approaches, which mobilize in particular the concept of resilience, and those of territorial metabolism, which have emerged as central to the analysis of agricultural transitions. Through this discussion, we propose to highlight their advantages and limitations, in order to identify possible avenues of articulation for analyzing the transitions underway in agricultural territories.

The articulation between socio-technical and socio-ecological approaches, two of the main approaches of sustainability transition studies, is already being explored by some authors. Lamine et al. [3] focus on ecological transitions in agri-food systems, proposing a framework combining the socio-technical approach, pragmatic sociology and food regime theory. Duru et al. [4] propose a participatory methodology for designing agroecological transitions on a local scale, integrating the notion of farming systems with both the socio-technical and socio-ecological approaches. However, several authors

point out that these frameworks in terms of analyzing the spatial dimension of these transitions [5,6] or even in terms of analyzing the territorial dimension [7].

In French-language literature, some authors propose to seize on the notion of *territoire* to enrich sustainability transition studies. There, the concept of *territoire* is defined as a socially constructed geographical space, which is therefore not limited to administrative boundaries linked to the exercise of power, but integrates dynamics of appropriation and governance [8]. Pachoud and Koop [9] propose a framework for analyzing territorial transformations based on three dimensions: ideal, material and institutional. The ideal dimension refers to the imaginations and visions held by actors in relation to the space they occupy. The material dimension encompasses the biophysical properties and infrastructures of the *territoire*, as well as territorial resources [10]. The institutional dimension corresponds to the formal and informal institutions that structure territorial governance. This framework appears particularly well-suited to analyzing the transition dynamics underway in *territoires*.

The territorial metabolism approach is another relevant contribution to complete this framework. It aims to analyze material and energy flows of a *territoire*, as well as the governance logics that underpin them [11]. This approach has already been mobilized to study the material flows involved in territorialized agri-food systems [12] or to design a framework for analyzing agroecological transitions [13].

Buclet [14] enriches this approach by introducing the notion of territorial capability, defined as "situated individual and collective capability that takes into account both the autonomy of actors anchored in a *territoire* and the ecological balances resulting from human activities within the *territoire*". It is enhanced by the maintenance and creation of territorial resources, and by the autonomy of stakeholders in the evolution of the flows that structure territorial metabolism. This territorial capability can be analyzed through resilience [15]. Resilience is a central concept in socio-ecological approaches to transitions, where it is defined as the ability of a system to cope with change and eventually transform its goals and functioning [16]. This notion has already been applied to specialized farming systems [17] and bioeconomy approaches [18]. Some of the literature proposes indicators for assessing the resilience of farming systems [19], while other authors consider that it is not a question of mobilizing resilience as a goal by seeking to assess it in order to maintain or strengthen it, but of integrating it into an analysis of the adaptive and transformative capacities of systems in the face of disturbances [20]. Work combining resilience and territorial capability is still emerging. Nicault [21] combines institutional analysis and capability theory to explain the resilience trajectories of a territory in Réunion. Here, we propose to strengthen this link by combining analysis of the resilience of agricultural systems with the notion of territorial capability, to analyze the sustainability of ongoing territorial transformations.

Application of the framework and methodology

Based on this literature review, we propose a framework for analyzing the transformations of agricultural *territoires*, integrating territorial metabolism and resilience approaches into the territorial transformation framework. This framework will provide decision-support elements for the stakeholders involved in these transformations, by providing them with other analysis criteria, notably linked to impacts on the rest of the *territoire*. This framework will be tested in 2025 on two agricultural systems in transition located in the Aube department (France):

- An agricultural methanization unit developed by a cereal cooperative.

- The development of the hemp industry.

Applying this framework will require two series of semi-directive interviews with stakeholders directly involved in these transitions, as well as with other local stakeholders. Collective workshops will be organized to co-construct a shared representation of territorial metabolism, enabling participants to build a common base of knowledge concerning the materiality of the *territoire* and to envisage its trajectories. The aim will also be to identify the visions and imaginaries held by stakeholders, and to highlight the interactions between the scale of the transition under study and other territorial dynamics. A second workshop will establish a diagnosis of the region's resilience based on the results of the first workshop.

Conclusion

This article proposes a theoretical and methodological framework aimed at better understanding the transformation processes of agricultural *territoire*s by articulating three approaches: territorial transformation, territorial metabolism and resilience. The aim is to provide decision-support tools for stakeholders involved in these transitions, in order to steer territorial trajectories towards greater sustainability. Testing this framework on concrete cases in 2025 will enable us to refine its contours and assess its robustness.

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