Conceptual framework for spatio-temporal analysis of territorial projects

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CONCEPTUAL FRAMEWORK FOR SPATIO-TEMPORAL ANALYSIS OF TERRITORIAL PROJECTS

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ABSTRACT

System innovation for sustainability requires a systemic and interdisciplinary approach. To support these complex and long-term transitions, decision support tools are required but nowadays, assessment tools are disciplinary and consider mainly material flows with environmental or economical perspectives. These tools provide helpful quantitative information for system (re)-design but often miss the temporal or spatial dimensions of a project and do not sufficiently consider the value creation system they propose to evaluate.

This communication presents a conceptual framework for territorial project analysis. It enables the spatio-temporal analysis of stakeholder networks during a project. This framework considers tangible and intangible resources flows between the project's stakeholders and their territory to examine how an initiative can emerge, mobilise territorial assets and create sustainable values in return. This process takes place at the meso level (territory) and create dynamic interactions with the micro-level (organisations and individuals) and the macro-level (regulations and institutions).

This analytical framework aims at supporting decision thanks to a comprehensive vision of the value constellation implied in a territorial project. It was developed on a theoretical basis and partially tested on various projects (territorial bioraffinery, PSS, territorial repair network) that were presented in previous communications. Future work will integrate sustainability principles to this framework to assist both economic, political and civic actors in taking decisions whom contribute to system transition to sustainability during their territorial projects.

KEYWORDS: SYSTEM INNOVATION, SUSTAINABILITY TRANSITION, TERRITORIAL RESOURCES, SOCIAL AND TERRITORIAL IMPACTS

HIGHLIGHTS:

- *The Perimeter of action* depicts interactions at micro/meso/macro levels during a project
- This analysis framework considers multi-level, temporal and spatial dimensions

- It is based on territorial resources and dynamic stakeholder network analysis
- It explains how territorial assets are discovered/revealed/mobilised during a project
- A project can contribute to the strengthening of territorial assets

INTRODUCTION

In order to tackle the current socio-ecological[1] problems caused by the capitalist market economy (Schneider *et al.*, 2010; Buclet 2011), researchers from different fields (e.g. Brezet, Van Hemel, 1997; DeHaan, 2010; Gaziulusoy, Brezet 2015) advocate system innovation for sustainability[2]. They are "large-scale disruptive changes in societal systems that emerge over a long period of decades […] facing persistent sustainability challenges, and they present opportunities for more radical, systemic, and accelerated change" (Loorbach et al., 2017). In other words, system innovation is a multi-scale transition from one socio-technical system to another over time (Loorbach, Wijsman, 2013). Socio-technical systems are defined by Geels as "system that perform core functions for society (e.g. providing energy, mobility, housing) but also account for most of humanity's pressures on the environment […] Socio-technical systems are understood to be complex, multifunctional systems combining diverse elements, which evolve interdependently" (EEA, 2017). Given the complexity of such transformative projects, an interdisciplinary approach needs to be adopted, with input from multiple fields, such as design, politics, engineering, ecology, sociology, economy, etc. (Max-Neef, 2005), in pursuit of a shared objective (i.e. sustainability).

Organisations have now accepted the need for such fundamental changes and numerous initiatives have emerged at the global scale (e.g. COP21), at regional scales (e.g. industrial ecology strategies), in corporate value chains (i.e. Environmental Management System) or at product level (e.g. eco-design). These initiatives are not limited to environmental issues and take a systemic approach to both production and consumption (e.g. circular economy). Multiple systems analysis tools and methods have been deployed to support transformational decision-making (e.g. accounting and reporting standards, MFA/territorial metabolism, LCA…). Despite the considerable numbers of initiatives and the associated tools and methods, the decline of the global socio-ecological system seems to be accelerating, raising the question of whether these initiatives contribute to sustainability or just delay the inevitable collapse.

This article, while proposing a specific analysis framework, deals with two intertwined reasons for this: the technical vision that dominates academic literature and representations, and continuously pushes to elaborate new solutions without questioning the global system and the real sustainability of the actions undertook. This vision prevents humanity from apprehending the limits of the Earth. We then assume that it lacks an interdisciplinary assessment tool for project managers and stakeholders. It will offer the opportunity on the one hand, to integrate time, space and social relationships and on the

[1] (EEA, 2017) "A socio-ecological system can be described as a coherent system characterised by interconnections, mutual dependencies and dynamic relationships between humans and the environment." Socio-ecological problems include global environmental changes, risks on Human health and security…

[2] The terms system innovation for sustainability, sustainability transition or transition to sustainability are used as synonyms in this article.

other hand, to give an appropriate place to social and human sciences in the design and assessment dynamics of a project. The ambition is to contribute to a better understanding of how a territorial project emerge, mobilise resources, but also contributes to reveal/structure new resources for the area of implementation. This objective is based on specific conception of territory, independent of the administrative areas, and on particular attention to space and levels of actions.

Therefore, this article outlines a method to assist the design and the assessment of territorial projects with the objective to contribute to system transition for sustainability. Territorial projects are defined as projects that mobilise territorial resources (see § 2.2.1). The framework here displayed proposes to analyse the life cycle of this kind of project with a particular attention to its territorial grounding, as well as the tangible and intangible resources mobilised for the project. It considers both spatial (i.e. territory, influence range) and temporal resolution (i.e. structuring, deployment, project progress or decline) to define the *'perimeter of action'*.

This framework does not neglect the arsenal of analytical and assessment tools already existing. In fact, it attempts to strengthen them while forming a bridge between value chain approaches (Material Flow Analysis or Life Cycle Assessment) and more spatial frameworks (i.e. Territorial Metabolism or Territorial Ecology). The first section describes a state of the art for these different decision-support tools for industrial or spatial planning. The second section provides ideas and inputs for the construction of an original framework designed to enhance project analysis, considering simultaneously the micro- and meso-levels, the temporal and spatial dimensions, and the actors involved. The final section develops conclusions and explores some limitations noticed. This article focuses on the design of the analysis framework and does not display data generated by its implementation, it also provides precisions about future applications.

1 STATE OF THE ART

The following state of the art differentiates between tools and frameworks used to assess the impacts of a project or a product from a value-chain perspective or from a territorial perspective. In the former case, LCA/LCCA and SLCA focus on product life cycle and some of its externalities[3]. In the latter case, MFA and accounting/reporting tools focus on extended value chains, while territorial metabolism and industrial ecology consider socio-technical systems. Finally, MLP and 5D-STM take into account the whole system from a perspective of transition.

1.1 Value chain analysis

A value chain is a succession of activities that transform an input with a specific objective. These activities both create and destroy values (externalities). As an illustration, product creates both positive and negative externalities in multiple territories at each stage of its life cycle (Fig. 1).

[3] An externality is a positive or negative consequence of an economic activity experienced by unrelated third entities (human, natural…). Assessing them constitutes a challenge, so as to be able to tackle them, indeed to oblige their producer, when negative, to diminish them and to internalise their cost. When positive, it could be envisaged redistributing them.

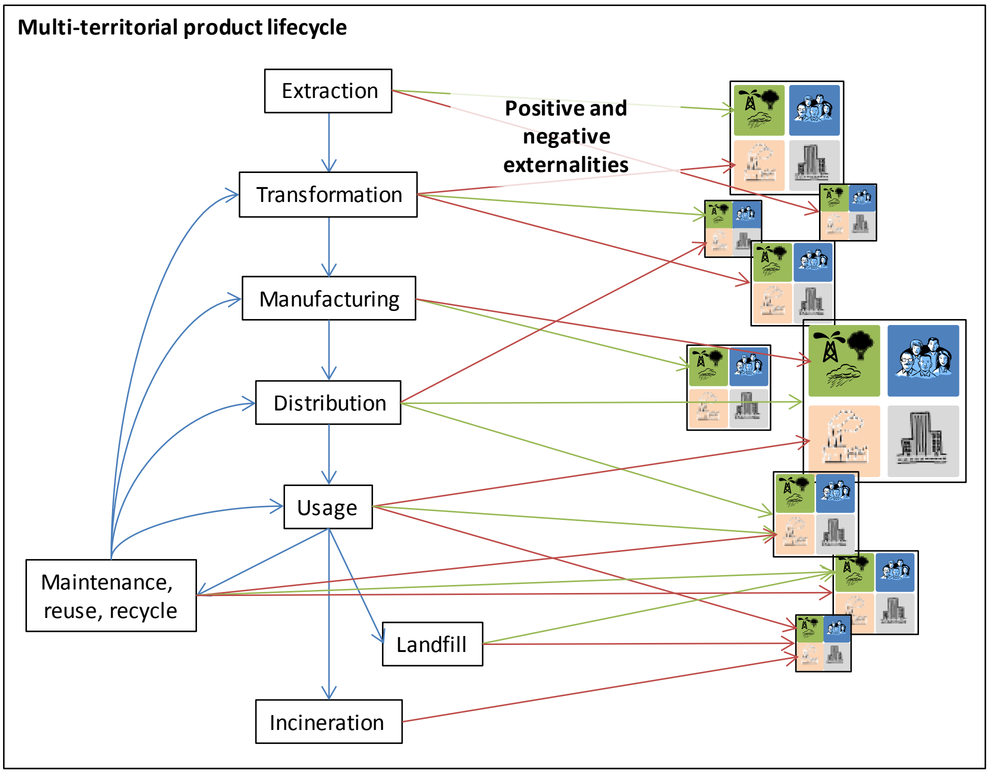

Figure 1 - Multi-territorial life cycle of a product and its positive and negative externalities

Amongst the numerous tools to assess these externalities, *"LCA addresses the environmental aspects and potential environmental impacts (e.g. use of resources and the environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave)."* (ISO14040, 2006). In addition to environmental impacts, Life Cycle Costing (LCC), environmental Life Cycle Costing (eLCA) or Social Life Cycle Assessment (SLCA) consider the social and economic aspects. For more details on these tools, see the *Guidelines for Social Life Cycle Assessment of Products* (UNEP, 2009) or (Nguyen *et al.,* 2016) for monetization of environmental impacts. This life cycle based assessment tools are useful in feeding into decision-making on alternative design choices but often neglect the multi-scalar and spatio-temporal dimensions. However, it is noted that researchers provide responses to these limitations. Potting *et al.* (2006) propose, with the EDIP2003 LCIA methodology, site-specific characterisation factors for spatial differentiation of LCIA. (Pu *et al.*, 2016) developed seventeen subcontinental regions characterisation factors for nanoparticles impacts on freshwater. Laratte *et al.* (2014) developed a dynamic LCA that considers cumulative and dynamic effects of a value chain on the environment.

Material Flow Analysis is *"a systematic assessment of the flows and stocks of materials (goods and substances) within a system defined in space and time. It connects the sources, the pathways and the intermediate and final sinks of a material"* (Brunner and Rechberger, 2004) (Fig.2). MFA operates at different scales[4] and over different timespans

[4] From a geographic point of view, scale can have three meanings: cartographic, analytical (size of the units in which phenomena are measured and data aggregated) and phenomenal (size at which geographic structures exist and overs which processes operate) (Montello, 2001). When the terminology is used by

(e.g., Cardiff local authority's waste collection system between April 2012 and March 2013 (Turner *et al.*, 2016) or steel stock and flows across Europe from 1945 to 2013 (Panasiyk *et al.*, 2016). Müller (2006) proposes a *"method for simultaneously determining national or regional resource demand and waste generation through estimations of the population and its lifestyle, which is manifested in the stocks of service providing goods, their composition and lifetimes".* It consists in a dynamic MFA to forecast future demands and externalities to support environmental policy. It was applied to concrete in the Dutch dwelling stock for the period of 1900–2100*.* In addition to material flows, costs and/or environmental impacts of substances, materials or goods could be assessed on an MFA basis and support multi-criteria decisions on existing systems or scenarios (e.g. national rollout of electric vehicles) for economic or political actors.

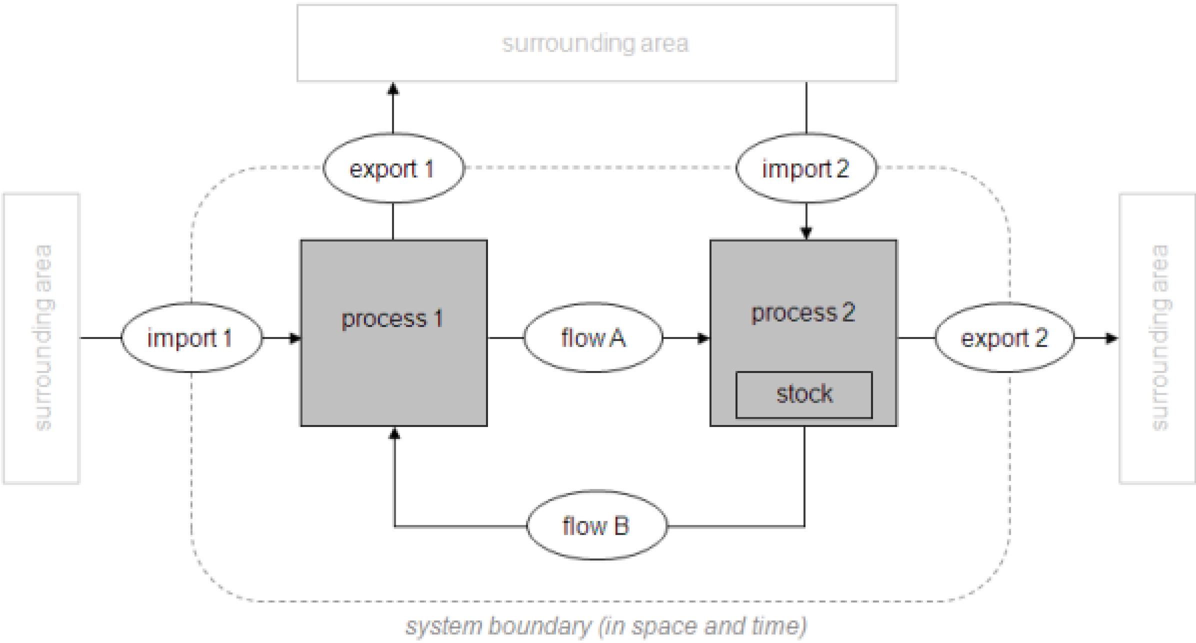

Figure 2 - Typical MFA model (Brunner and Rechberger, 2004)

Although LC-based assessment tools quantify potential impact and MFA evaluates stocks and flows between each physical element within the system (i.e. total impact is a sum of elementary impacts), it does not provide information on the quality of the assets that enables value creation. As an example, MFA or LCA consider the multiple transformations and externalities of a tree log from the forest to a carpenter but it misses the organisational and human activities that enable these transformations (R&D, marketing, partnership…) that are incorporated in the final product. These intangibles assets represent between 50 and 90% of the value of a business (Fustec *et al.*, 2011) and consequently need to be identified and assessed to support decisions for the (re)design or management of a value-chain (Allais *et al.*, 2017).

engineering sciences, the second meaning prevails. However, the second part of this article and the framework, interdisciplinary built, are based on the third definition, while it enables to recognize the importance of the social diversity which animates places, the different interaction which exist and thus to understand the project dynamics. So, we adopt a constructionist approach to scale (Marston, 2000); it is socially produced. Scales enables to understand how space is mobilised, used, by human and non-human entities at different levels of action and consequently to apprehend "spaces of engagement", "spaces of dependences"…

Financial and extra-financial assessment tools consider companies as systems that enable wealth creation through tangible and intangible assets (i.e. resources owned by the company). These assets are evaluated by an associated capital. Numerous taxonomies exists. The European MERITUM project (OECD, 2006) identify human, relational and organisational assets; the <IR> initiative (IIRC, 2013) split up financial, manufactured, intellectual, social/relational and natural capital; thesaurus Bercy (Fustec *et al.*, 2011) is a close list of ten intangible and two tangible assets that constitute the portfolio of assets that are necessary and often sufficient to create value. These assets and the associated capital are listed below. For a detailed description please report to (Fustec *et al.*, 2011).

Table 1 - Intangible assets and associated capital from (Fustec et al., 2011)

Assets	Associated capital	Assets	Associated capital
Teams	Human capital	Information system	IS capital
Brands	Brand capital	Customers	Customer capital
Natural resources	Natural heritage	Knowledge and know-how	Knowledge capital
Organisation	Organisational capital	Civil environment	Societal capital
Suppliers and partners	Partner capital	Current assets	Financial capital
shareholders	Shareholder capital	Investments	Tangible capital

This repository allows qualitative analysis and assessment of each factor of value creation through a large set of indicators (e.g. employees and managers are evaluated on their competencies, leadership, motivation, stability… and all these indicators are brought together under Human Capital to assess the quality of teams and their contribution to value creation). This tool is used both for accounting purposes (annual qualitative and quantitative evaluation of assets: "I have") and for management (i.e. decision-support tool for planning: "I do").

LCA, MFA or accountability tools provide information on the value chain (i.e. product life cycle, material metabolism or corporate value creation system) but take little account of the social environment in which it operates. In fact, the value chains considered in these tools are non-situated systems (i.e. systems disconnected from their environment).

1.2 Territorial transition analysis

Some analytical frameworks and methodologies include the socio-spatial dimension[5]: they study not only how stakeholders interact (or not),[6] how they enter into conflict or negotiation, create cooperation and shape networks, but they also take into account intangible flows like culture, organisational proximities, knowledge (and its potential transfer) or know-how. Moreover, these frameworks include the spatial dimension, since they analyse how human activities and representations apply to a specific area: the

[5] A framework is a "metatheoretical language for diagnostic or prescriptive study of phenomena" (Ostrom, 2007b; Schlager, 2007) that cannot in and of itself predict or explain outcomes. However, some frameworks have been distorted from their original purposes, becoming operational tools rather than conceptualised ways of describing and analysing a situation.

[6] Stakeholders are entities with agency (individuals, organisations, or unorganised groups) with a declared or conceivable interest or stake in a policy concern (and which intervene in the social or political arena without being organised in a formal structure).

territory[7]. Concomitantly, they examine how the characteristics of this territory influence the actions of human and non-human entities[8]. The paragraphs that follow outline two approaches – industrial ecology and territorial ecology – that are both based on territorial metabolism.

Whereas MFA focuses on goods, material and substances, territorial metabolism (TM) inventories multiple flows within a particular perimeter (e.g. nation, region, agglomeration, city…). Territorial metabolism is loosely based on an analogy with the metabolism of natural organisms and often requires the collaboration of planners, engineers, political scientists or ecologists. It examines a territory that make sense in terms of its human occupancy and its environmental conditions, and not a specific site, a value chain or product. TM takes account of cross-boundary material trade and the retention of materials as stock in the built environment (Kennedy and Hoornweg, 2012; Baynes and Wiedmann, 2012). It quantifies and qualifies all flows that supply or affect this territory and its activities (consumption, transformation, destruction…). The resulting inventories include local extraction, import and export (e.g. biomass, minerals, fossil fuels…) and outputs to nature (i.e. emissions into air, water, soil). According to Barles (2014) each territory has its own metabolism, consisting of social and natural features.

The result of this TM is not just a territorial snapshot; it is used to identify dependences and risks to territorial resilience and sustainability (e.g. the competition for land and resources in urban space, increasing consumption of certain materials…). For instance, urban metabolism may be implemented as a framework for the design of sustainable or low-carbon districts/neighbourhoods within cities. Within this framework, cities are then considered as "*complex systems that rely on their external environments for inputs of resources and for assimilation of wastes and create ordered structures at the expense of increasing disorder, i.e., environmental disruption outside of their boundaries*" (Clift *et al.*, 2015). Applied to the regional scale[9], this information could be useful to policymakers (e.g. for waste management policy, dematerialisation policy…) while revealing territorial dependency and each sector's contribution (e.g. food and farming, construction…) to this process. Political responses regarding the governance of flows and materials may be developed then as a roadmap to transition.

Territorial metabolism is employed for both territorial ecology and industrial ecology. However, MFA and TM approaches are based on the principle of mass conservation and on their own take little account of flows of intangible resources (Buclet *et al.*, 2015). To overcome this limitation, more integrative frameworks, such as industrial ecology, have emerged in recent decades. One of the central principles of industrial ecology is that

[7] The territory is here defined as a specific space, geographically characterised, where human and nonhuman entities act and interact. It is the support of representations that guide the action of these entities. This definition underlines that human activities are not determined by natural features but these features which may be constraints can be overcome or distorted according to the spatial appropriation of human organisations (Raffestin, 2012).

[8] The most integrative socio-technical frameworks do not limit their analytical scope to human entities with a strong and defined interest, but also include civil society (and therefore individuals who are not directly concerned and involved) as it may be affected in different ways by economic and industrial choices (negative externalities, societal changes expected from technical/organisational innovations…). Sometimes, as in ANT (Actor-Network Theory) (Callon, 1986), non-humans (artefacts, natural components) may play a major role in the definition of a system and its capacity to withstand shocks and to undergo transition.

[9] We use here "regional scale" to refer to the administrative perimeter of regions, which are often competent for the economic development.

industrial systems can develop mass efficiency and material cycling processes exhibited by natural ecosystems (Allen in Ayres 2002, Frosch and Gallapougos 1989). Biomimicry principle is combined with the aim of decarbonising or dematerialising economic activities (Erkman, 1998). According to Merlin-Brogniart (2017), industrial ecology is an evolving concept, as the original definitions focused more on limiting polluting emissions and reusing them in the production process. (IE) seeks and implements synergies between stakeholders to reduce the environmental impacts of human activities on ecosystems (Buclet, 2011). It often requires the quantitative and qualitative study of materials, by-products and energy flows generated by industrial and consumer activities, so that stakeholders are informed on what can be recycled, exchanged or pooled.

Symbiosis between different business entities are facilitated by geographical proximity (Chertow, 2007), but this is not a sufficient condition. In fact, symbiosis take place in a particular territory and cannot expand without regard to social practices (Boons and Howard-Grenville, 2009, Granovetter, 1985), cultural norms, the regulatory and legislative regime, and the actions of stakeholders (Brullot *et al.* 2014, Gobert *et al.* 2015). The challenges raised by the pooling and exchange of flows are not just technical but also human and organisational (Boons *et al.* 1997; Jacobsen, 2006). In fact, the main obstacle to achieving synergies is poor coordination between actors (i.e. lack of dialogue, common interests or trust between companies, local authorities or academics) (Buclet, 2011).

Thus, industrial ecology is based on a system of actors with common concerns striving to build collaborative solutions. Rather than developing an individual optimisation solution, the idea is that stakeholder entities will increase their range of action by cooperating with new stakeholders in a specific area to solve problems of resource supply or waste discharge and management[10]. In order to achieve effective synergies, the different partners in an industrial ecology project (e.g. business, local authorities) can disclose, utilise or generate different kinds of tangible and intangible resources: infrastructures, organisational and cultural capital, knowledge (Gobert and Brullot, 2017). However, industrial ecology has been diverted from its ecological perspective (i.e. dematerialisation and decoupling of economic and social well-being from resource use), and is often restricted to the development and implementation of synergies in very limited zones (e.g. industrial districts). The inputs and outputs of industrial ecology initiatives – and therefore their impacts on socio-ecological systems (e.g. external pollution, loss of biodiversity and ecosystem integrity) – are not sufficiently considered.

Other frameworks have emerged that seek to grasp these interactions. The frameworks for social-ecological systems or social-ecological-infrastructural systems consider more of the biophysical components. They are designed to provide common research tools for interdisciplinary investigations, linking urban metabolism with life cycle assessment to connect together the environmental footprint of cities, in terms of infrastructure, supply chain, water, energy, and greenhouse gas (GHG) emissions, and adopt a cross-scale perspective (Ramaswani *et al.*, 2012). Another approach, considered as a new field of interdisciplinary research in France (Barles, 2011; Madelrieux, 2017),[11] is territorial ecology, which seeks a better understanding of nature/society interactions (Debuisson, 2014), interactions that are notably embodied in energy and material flows. Territorial

[10] If they are able to tackle the challenge of closing loops in their own system, this process is not industrial ecology, but industrial optimisation.

[11] It can involve researchers in urban and rural planning, in History, in sociology, in biology…

ecology is aligned with industrial ecology, but pays greater attention to spatial consideration and impacts on nature (particularly outside the zone where synergies have been achieved). Cerceau (2017) explains: "*borrowing ecological principles and concepts, it proposes to analyse the territorial dynamics and trajectories by focusing on the circulation of tangible and intangible flows between human societies and the biosphere.*" In fact, territorial ecology considers both material and immaterial resources and the ability of stakeholders to develop cooperation, limit their emissions and exchange/pool their in/outflows.

This approach is built on two instruments: on the one hand, an understanding of the territorial system (exploring relations between stakeholders and the political, social and technical conditions in the territory), and on the other hand a close-grained analysis of territorial metabolism, in order to show the exchanges between the environment and humans.[12] The underlying idea is that a better understanding of territorial interactions will improve the collective capacity of local stakeholders to set new strategies together, to test synergies. Territorial ecology therefore aims to describe, analyse and even transform the metabolism of territories, while understanding the natural and social processes that both create and reciprocally influence flows of energy and materials (Barles, 2011).

Territorial metabolism, industrial ecology or territorial ecology all consider large and complex territorial systems, studying meso-level actions and their impact on the territory. Our proposition is to analyse the interactions between the micro- and meso-levels and the employment of local and territorial assets at different stages during a project.

1.3 **Sustainability transition analysis**

Transition research emerged within different scientific communities with multiple research approaches to understanding transformation in socio-ecological, socio-economic, socio-technical and socio-political systems (EEA, 2017) (Loorbach *et al.*, 2017). Socio-technical transition studies focus on historical cases in real-life contexts in order to understand causal links and non-linear processes over time in complex situations, such as the operation of societal functions (e.g. transport, housing, food and energy supply) (EEA report, 2018). Transition studies therefore consider a different temporal and geographical scale (i.e. 5-10 years for cities or local projects, 10-15 years for sustainability transition research, up to 30-50 years for national sectoral level historical studies) (Geels *et al.*, 2017).

The multi-level perspective (MLP) is an instrument for the analysis of socio-technical transition that considers three analytical levels: "niche" is the level where the innovation occurs (e.g. grassroots initiative), "regime" is the dominant and stable set of practices and rules in a societal system (e.g. culture, technology, policy…), and "landscape" stands for the exogenous context that influences the regime. The multiphase model of transition (i.e. predevelopment, take-off, acceleration and stabilisation) (Rotmans et al, 2001) adds a temporal component to the MLP for the understanding of system changes. In addition to these structural and temporal dimensions, Raven (2012) proposes explicitly to include the spatial dimension of socio-technical systems in the MLP and Debizet *et al.* (2016)

[12] "Territorial ecology is notably a way to study the societal dimension of metabolism through the study of the actors, but also of the governance of the processes that lie at the root of a metabolism." (Barles, 2011)

introduce socio-spatial factors to reveal local and non-local relationships between regime and niches in urban energy systems.

In addition to the MLP's analytical approach, transition management promotes a strategic management perspective on system innovation, with a major role for government in managing the transformation process (Kemp and Loorbach, 2003; Loorbach, 2007). Transition management consists in structuring the problem, developing coalitions and agendas, and mobilising actors for project implementation with a reflexive approach based on monitoring and evaluation (Loorbach, 2013). Sustainability transition therefore requires long–term vision and planning and includes the political dimension as a driver of change. From a complementary angle, Gaziulusoy and Ryan (2017) see transitions as a creative process of solving technical and political problems, which consist in "*imagining new systems, evaluating system concepts and developing those that are promising, and designing participatory deliberation processes to attend to the political nature of transitions*". The emergent field of transition design (TD) is at the intersection between transition studies and system design/design for sustainability (Vezzoli, *et al.*, 2008; Ceschin and Gaziulusoy, 2016; Gaziulusoy and Öztekin, 2018). As developed in the book *Transition Design* (2018), different tools stimulate the imagining of alternative, sustainable futures (Lockton and Candy, 2018), and the discussion of new paradigms for social, cultural, political, economic and productive systems with a strong focus on governance (Kossof, 2018; Irwin, 2018).

In line with these researches the Five Dimensions Sustainability Transition Method (5D-STM) (Allais *et al.*, 2017) is a development of the Framework for Strategic Sustainable Development (FSSD) (Broman and Robèrt, 2017), a principled backcasting method for designing a transition path to sustainability, which seeks to help industrial companies make the transition to sustainability. The FSSD is based on the seminal definition of sustainable development, while the 5D-STM is based on the heterodox definition of sustainability proposed by (Figuière and Rocca, 2008). It assumes a hierarchy between the human, environmental and economic dimensions and explicitly considers political and territorial dimensions. As tools for decision-making during the transition process, general governance principles from (Buclet, 2011), strategic and operational business governance principles from (Allais, 2017) and political principles from (Renault, 2011), complete the socio-ecological principles (Missimier, 2015) included in the latest developments of the FSSD (Broman and Robèrt, 2017).

In short, we consider that the objectives of sustainability (i.e. success in the system) must focus on human development, according to the human principles (i.e. no structural obstacles to health, influence, competence, impartiality and meaning-making). The governance principles contribute to human development through governance innovation both in the business value chain and in its interactions with its territory. Governance innovation is supported by the capability/empowerment principle that aims to maintain and develop the capacity of individuals/organisations to achieve their own goals, and the proximity principle that links the decision-making level with the level affected by the decision. This includes a large number of "traditional" stakeholders, such as consumers, producers, recyclers or local authorities, and others that are often neglected, such as civil society/citizens. Decisions must also take into account the concept of ecological boundaries, (i.e. no systematic degradation or emissions of substances from society or the earth's crust). In addition, the principles of geographical proximity and economic relocation may favour the integration of locally available resources, both tangible and intangible; the political decision must take precedence over the economic actors, (i.e. be taken by citizens or their representatives). The principle of governance by participatory democracy balances individual preferences and the public interest in meeting the challenges of sustainability, while the proximity principles promote the participation of those impacted by the decision. Territorial specificities need to be taken into account in adapting and implementing political decisions. Moreover, both positive and negative externalities must be relocated to eradicate globalisation problems. In consequence, local value creation (i.e. local resource use, local employment, local wealth creation) (Tyl *et al.*, 2015a) may emerge as a new regime.

This state of the art has provided an extensive but non-exhaustive overview of analytical tools and methods operating in different systems and perimeters. Some consider the value chain of products or industrial sites and others complex socio-technical systems such as territories. Some consider the global socio-technical system with political or design science approaches. Analytical and transformative tools for system innovation must consider sociotechnical systems in all their complexity (technical, organisational, political and stakeholder-related), and thus require interdisciplinarity. Moreover, the spatio-temporal[13] and multi-level [14] dimensions have to be explicitly considered.

The next section details our framework that can be used to analyse the emergence of a territorial project based on the spatial and temporal analysis of stakeholder networks and the pooling of their individual assets with territorial assets.

2 PROPOSAL: SPATIO-TEMPORAL STAKEHOLDER NETWORK FOR PROJECT ANALYSIS

This section describes the different dimensions recruited in the construction of our interdisciplinary framework. The time dimension incorporates different steps of the territorial project, considering existing links between stakeholders and the creation of new relations. The spatial dimension circumscribes the perimeter of action in which the project stakeholders operate and can use their skills and abilities.

Consequently, the perimeter for action, as a spatial and temporal construction, is evolving regarding needs, networks, resources... implied in the project. In order to launch an initiative, familiarity with the future project territory is often a prerequisite and a key of success. Stakeholders put assets into play and can gradually develop networks in order to realise their projects.

2.1 The different dimensions of project implementation

2.1.1 Dynamic action perimeter: the time dimension

Since our framework concerns the mobilization, by the actors – outside and within the territory – of territorial resources over time, the project shapes the perimeter of action through the stakeholder areas of competence (the firm for entrepreneurs, the

[13] Embeddedness in a specific territory and with different time phases.

[14] A project takes place in a specific area, but individuals and organisations that carry it out have other places of actions and influence.

administrative constituencies for public authorities) and their common readiness and capacity to influence project implementation (Gobert and Allais, 2016) and the scalar projection of their activities. The actors involved the objectives of the project and its changes over time define the action perimeter. It is not necessarily geographically continuous as the concept of the multilocal company illustrates it (Buclet, 2011).

Consequently, different phases have been defined:

- Time 0: upstream of the project. Specific local resources, stakeholders, networks that can be mobilised but are still 'latent', inactivated for the project, define the initial perimeter of action.
- Time 1: project launch. A need emerges or one or more stakeholders build a strategy (cf. time 0). They will seek to activate resources, create other relationships to find new partners possessing assets necessary for the launch of the project, such as founders (e.g. government, banks), external expertise (e.g. university, consulting firms). The perimeter of action will evolve in accordance with the project objective and the input of these new partners.
- Time 2: the project. The activation of territorial resources and the recruitment of the missing external skills (subcontractors...) for the realisation of the project will concretise the perimeter of action.
- Time 3: downstream of the project. This is an evolution of time 0: the network developed becomes a latent network that may be activated for a new project, or conversely, in the event of conflict or failure, may be broken up.

Thus, the perimeter of action is dynamic and embedded in a history: both inherited (i.e. previously constructed networks, geographical perimeter, sector ...) (time 0) and built during the structuring and realisation phases (times 1 and 2).

2.1.2 Territorial resources/assets: the spatial dimension

Space is an important part of the proposed framework. It is not considered a *terra nullius*, but a territory appropriated by human occupation and representations, political projections, infrastructure building, a specific culture and identity (Di Méo, 1996; Lévy, 1999). It was drawn up with a specific conception of resources, conceived not simply as an unlimited reservoir for human activities but as an encounter between stakeholders and a project.

In line with Boyle, Duffy, Whitfield (2009), we consider a project as a succession of activities whom are *"a physical or cognitive action that creates an output from a set of passive resources which are used by active resources to produce the outputs that should satisfy the [project] goals"*. They illustrate their proposal as follow: *"a finance manager (active resource) might analyse (activity) market data (passive resource) to identify potential markets for exploitation (output) to increase the financial performance of a company (goal)" (Ibid.).* Boyle, Duffy and Whitfield consider resources as production factors but they neglect the resource creation process itself, as they do not consider the spatial origin nor the social construction of a resource.

Geographical and economic sciences also consider *"a resource is the means available to an individual or group to carry out an action, to create wealth"* (Brunet et al., 1993). They also explain the emergence process of a resource: "*Thus, a resource exists only if it* *is known, disclosed and exploitable, that is if people attribute to it a value of use" (Ibid.)*. Pecqueur and Gumuchian (2007) underline the intentional transformation process from a "*recognized resource*", which is "*a potential, that stakeholders have not yet identify as possible resource*" to an "*accomplished resource*" which is implied in a production process. As an illustration, they wrote about the emergence of the "white coal" (hydropower industry emergence in the Alps). Any people recognized waterfalls as a physical component of their surrounding area. They are latent resources until Aristide Bergès, hydrolist engineer, imagine a hydropower system for paper industry. Waterfalls then become an accomplished resource, exploitable in industrial processes (i.e. mechanical or electrical power generation). We have to underline that stakeholders who recognize, reveal or integrate resources in their processes are not the same. A generic activation process is describe in Fig. 3.

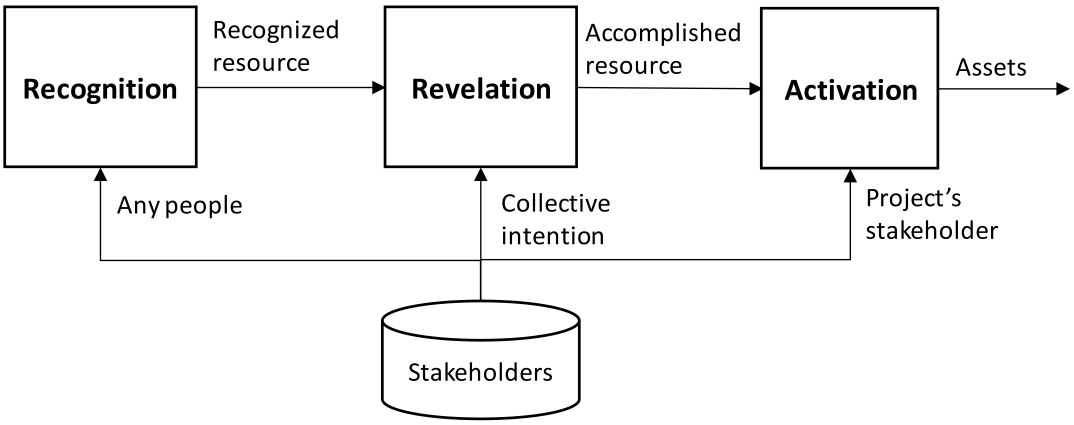

Figure 3 - Resource activation process

Bathelt and Glückler (2005) highlight the social process necessary to activate a resource: *"resources are used and/or produced in a relational manner, that is, in context-specific social processes".* To extend the contextual specificity of resources, Glon and Pecqueur (2006) propose the concept of territorial resource, defined as a constructed feature of a territory, intentionally built by actors from specific socio-cultural and historical contexts (i.e. territorial specificities). As an illustration, history and specific cutlery knowledge from the Aubrac in France was a core territorial resource for the renewal of this industry, threatened by low cost copy of traditional Laguiole knives (Allais et al., 2015). The following schema enables to grasp the variety of territorial resources/assets. "These factors [territorial assets] may include the area's geographical location, size, factor of production endowment, climate, traditions, natural resources, quality of life or the agglomeration economies provided by its cities, but may also include […] business networks that reduce transaction costs." (European Commission, 2005, p.15). We break down this resource into different kinds of sub-resources. Some are material (infrastructure), others immaterial (culture, relationships)[15] (Fig. 4). The conceptual background is fully explained in different papers (Gobert, 2015, 2016). Territorial assets as a whole are not owned by a specific stakeholder, although some parts (a facility) can be owned or operated by a firm, a local authority, an institution (university and scientific expertise) or a NGO.

[15] The territory may previously have been the arena of cooperation opportunities, requiring the mobilisation of actors and the establishment of networks.

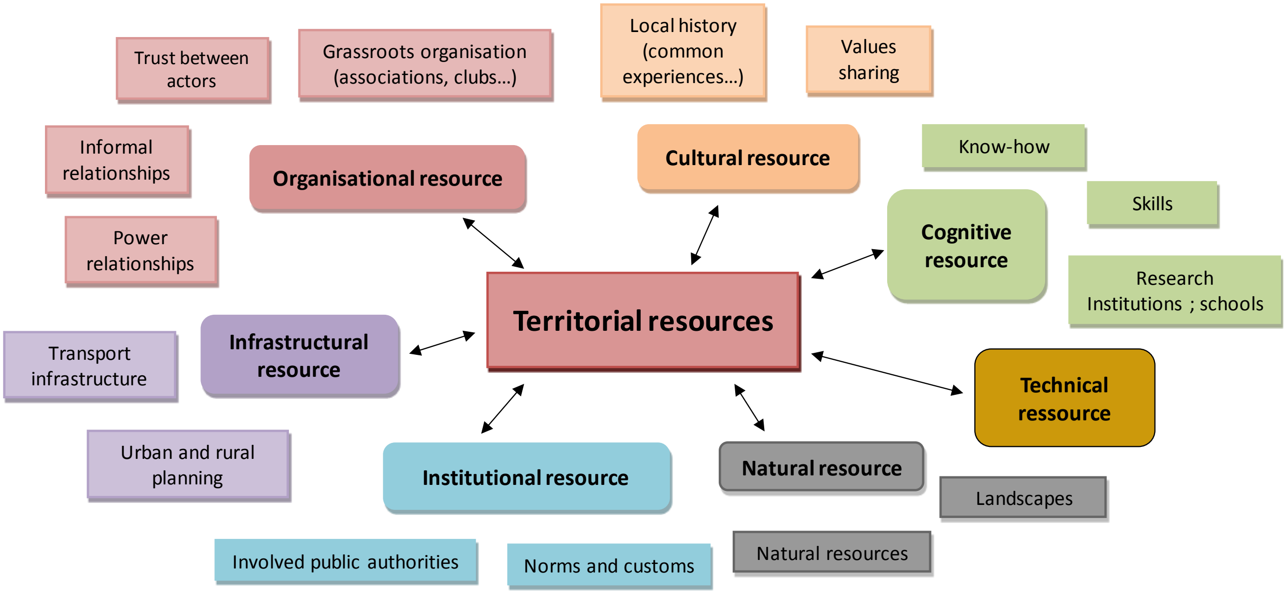

Figure 4 - The territorial resources (Gobert, 2015)

According to these definitions, resources are context-dependent elements socially constructed implied in a value creation process. Resources may be active or passive, tangible (e.g. wood or machine tool) or intangible (e.g. patent, knowledge), territorial (i.e. specific to a territory) or generic but they are all socially built.

When employed within a project, these resources are described as assets that may or may not be owned by the actors that use and process them (e.g. a company may own machine tools and patents but not its workforce; culture and some natural resources are common property). These assets do not exist absent the action and often the interaction of stakeholders. We consider "capital" here as the quantitative and qualitative value of the appropriation of these individual or collective resources. As an illustration, the presence of oil in the subsoil is the result of natural geological processes. Yet it has become one of the primary resources of our society, a fossil substance that found a technical use and a processing method. It was then exploited, along with a specific infrastructure and new business pathways, and became a source of wealth and dependency for countries that own it. Without the combination of sometimes conflictual technical innovations and a process of adoption/assimilation into the political, social and economic system, oil would not have become "black gold" (Mitchell, 2017; Jarrige, 2014).

In order to foster interdisciplinary research on these two ways of thinking about territory and stakeholders and to construct a relevant framework, we have striven to combine geographical, analytical and systemic ways of considering resources and interactions between entities, while incorporating time, scale and stakeholders. This does not eliminate the differences in ways of understanding reality but tries to combine them so that they enrich each other.

The focus of our proposal is the mobilisation and transformation of resources during a project at meso and micro levels.

2.1.3 Levels of action and interaction: the stakeholder dimension

We consider that a project is implemented and has an impact at different analytical levels, described here as micro, meso and macro levels (Fig. 5). These levels are the result of interbreeding between engineering sciences, economic sciences and political sciences.

The micro level corresponds to the "internal sphere" of stakeholders (legal entity or individual) and the internal organisation of a firm. Nevertheless, that does not prevent them being part of or acting at other levels (e.g. as a lobbyist at the macro-level, as a project partner at the meso-level). The decision to participate in a project with other partners can have an impact on this organisation, just as the implementation of a new strategy to decrease emissions and environmental impacts can require a meso-territorial intervention.

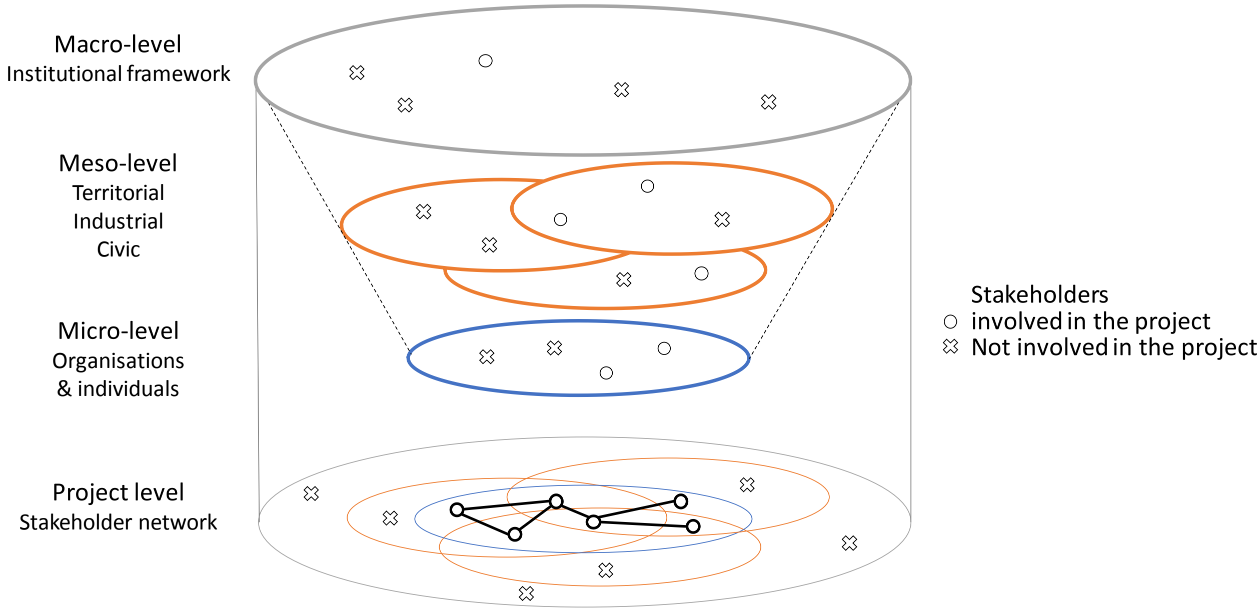

Figure 5 – Action perimeter as a projection of levels of actions and interactions

A careful analysis of the micro level facilitates the identification of internal resources that an organisation can use (tangible and intangible assets) (Allais, 2015). We can then know whether the stakeholder is able to mobilise those resources quickly or slowly, spot shortfalls between targets and capacities and then identify new assets needed for the project…

A stakeholder can also make solo use of territorial resources if they belong to them, if access to them is non-conflictual and free (public or common good), if the stakeholder has an operating licence or contract (from the public or private owner), or exploits them illegally.

The meso-level is an inter-individual sphere; it requires the involvement of two or more actors. Depending on the decision-making process and the governance of the project, different forms of meso-level interventions can be defined:

- The meso-territorial level: the action has a spatial basis, primarily due to coordination by local government(s) that may encourage or restrict the involvement of different socio-economic stakeholders. The project can relate to different sectors, depending on the competences of the public stakeholders involved, within a specific perimeter (Gaudin, 2004). For example, local government can put in place decarbonization strategies, incenting all actors living or making business in their area of competences to decrease their fossil energy consumption.

- The meso-industrial level: the main actor in this case is one or many economic entity/ies. The perimeter of action is firstly defined by the project's scope and the stakeholder's commitment. For instance, when firms decide to implement a strategy of industrial ecology and to create synergies between them.
- The civic-meso level collects grassroots initiatives from citizens, inhabitants and organisations, and involving more than one stakeholder. This is the case of social entrepreneurs or NGOs launching an initiative to promote reuse and repair on a specific place (repair café, repair and reuse workshops…).

At the meso level, the actors involved can activate both their own and territorial resources, depending on the needs of the project. They may also suffer from a resource gap that prevents them attaining their collective goal, and then import/create/find new resources.

At the macro-level, public actors set, regulate, check and promote legal priorities, guidelines and regulations, and oblige other stakeholders to implement them. At this level, national or international governments and, sometimes, regional authorities, are the main decision-makers (this depends on the national institutional frameworks and the distribution of powers). They build public policies through different tools (laws, economic incentives and guidelines)[16] but seldom make regulations directly operational, except when implementing within their own structure. The macro-level helps to set the socio-political regime; public environmental, economic and social policies or regulations are formulated at this stage.

Levels are not hermetic. Stakeholders at the meso-level may activate a political resource (e.g. personal acquaintance with a politician, or a political function held by a project actor) in order to obtain a change in regulations that facilitates the gradual integration of a localised project into the mainstream system. An action undertaken collectively at the meso-level is likely to require internal changes within an individual firm, i.e. at the micro-level (for example, a new waste collection process that converts waste into a resource for another firm).

2.2 Framework for (im-)material flow analysis

Our analytical framework highlights how immaterial and material assets at the individual (micro) and territorial (meso) scales are combined and activated.

We assume that a project is not only the result of the revelation, activation and mobilisation of resources, as depicted in 2.1.2. It depends also on the activation by stakeholders of their own resources (at the micro-level), on external resources which are not present or revealed on the project territory and on regulations and laws which frame, constraint or boost a project. The analytical framework (Fig. 6) is derived from Grin *et al*

[16] Drafting laws and regulations is a complex process, which entails reframing social issues (Campana *et al.*, 2007; Knoepfel *et al.*, 2006) in political terms. It entails arrangements between different interests and rationales. Some international cooperation between non-governmental organisations or between firms can also be negotiated at the macro-level, to create a global framework of constraint that influences the behaviours of other actors.

(2010), who argue that a project emerges from the will of one or many actors in a particular area where endogenous assets will have an influence on the form and success of the project (Gobert, 2015; Allais and Gobert, 2017).

This analytical framework, the outcome of a multiscale and interdisciplinary approach combining engineering sciences, planning, sociology and political sciences, was structured to facilitate analysis and action in the course of a project to answer the following questions:

- What resources are disclosed, created, mobilised and/or shared during the different steps identified in 2.1.1?
- Who brings these resources and how are they managed during the process? What form of relationships prevails between resources and stakeholders, and between stakeholders, for them to be activated?
- At what level are these resources activated and by whom?

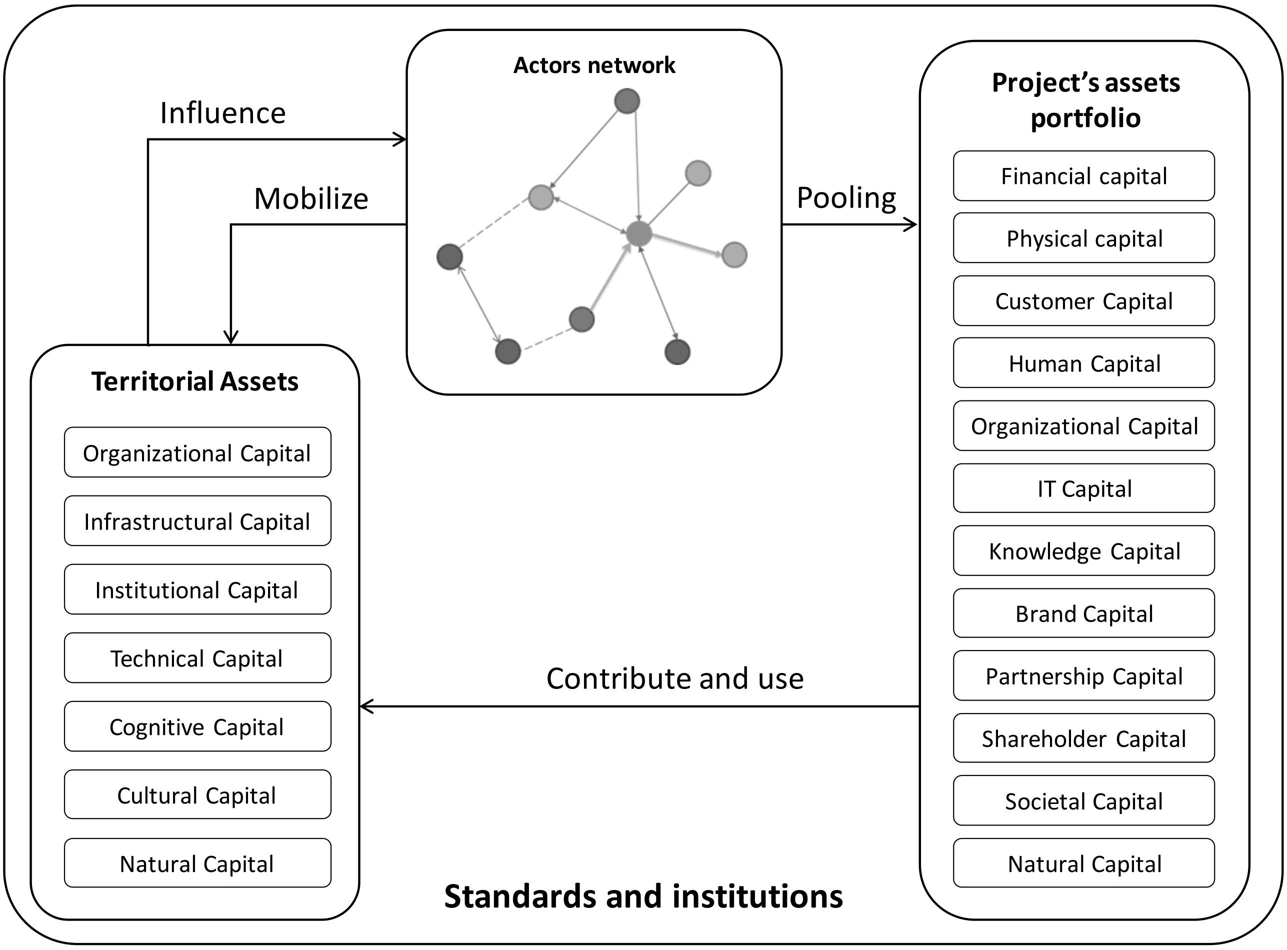

Figure 6 - Mobilisation of assets during a project adapted from Gobert (2015) and Allais and Gobert (2017)

The combination of these intangible capital frameworks permits a multi-view analysis and the integration of latent territorial resources into a project. Intangible capital provides micro-level information on the project network (i.e. elements and interactions), meso-level analysis (i.e. resources, culture etc. of the territory) and incorporates the macro-level with the institutional framework (e.g. regional, national or EU legislation). This information flow is crucial to facilitating project development and stakeholder cooperation. However, information is also a source of power, and the framework therefore does not underestimate the power differences that may exist between stakeholders, or the management of uncertainties, which may make project implementation difficult.

Our analytical framework can be used to analyse interactions between the meso and micro levels for social and environmental innovation projects, insofar as they are likely to be influenced by technical, metabolic and human dimensions. These initiatives are often “experiments” (a pilot before the upscaling of a project) or fairly limited in scope. We seek to study and support these innovation niches to help them become viable and potentially up scalable. To achieve this, we qualify not only material flows (through methodologies like MFA or territorial metabolism) but also intangible assets, because projects do not come into existence without human and non-human action, without earlier interactions between nature and culture. The spatial dimension, and particularly the role of territories, appears particularly relevant, because each region has its specific characteristics and histories.

2.3 Application of the framework for project assessment.

This framework was established for the socio-economic and environmental analysis of an experiment in business model transition, from selling products to a Product Service System, as part of the Eurêcook project funded by ADEME Bourgogne (Allais and Gobert, 2016; Gobert and Allais, 2017). In terms of sustainability assessment and “viability”, this project can be considered as a failure. In fact, due to the very low number of customers, economic viability was not reached and it appears that the renting service creates more environmental impacts due to the multiplication of transport rides. Nevertheless, this experiment provides interesting insights on the deployment of intellectual and territorial capital analysis framework during the experiment of a partial business model transition from selling to use-oriented product service system. At a conceptual level, it appears that the combination of intellectual capital and dynamic analysis of stakeholder network open opportunities for systematic project analysis. Through the activation of the framework, we also stated that the design and preparation phases did not take enough into consideration territorial and intangible assets; the implementation phase confirms the inability to have an adapted knowledge and management of the different capital, although they play a major role as success factors for PSS projects.

The framework is also being deployed in the Recyluse project (2018-2020) (funded by ADEME[17]) for the analysis of territorial repair networks and the development of context-adaptive living labs as intermediary objects to support system transition (Allais *et al*., 2018). This project is conducted in two areas of France and involves repair workshops at the meso-civic level, citizens at the micro-levels, local authorities and the meso-territorial level, and fund providers from both the meso territorial and macro levels. Territorial repair networks can be seen as emergent local alternative regimes arising from the coordination between numerous initiatives (niches) at different socio-technical levels. At regional scale (e.g. France), territorial repair networks will be considered as niches developed in opposition to the regime of over-production and over-consumption.

[17] The French Agency for Environmental Affairs.

Figure 7 illustrates the material and immaterial flows between the multiple stakeholders of a territorial repair network. Based on interviews and living labs, we aim at quantifying and qualifying both the diversity of stakeholders implied in the project and the flows of materials and information between these stakeholders. In a second time, we provide recommendations to initiate, develop and operate this kind of networks centred on repair activities but considering numerous stakeholders often neglected.

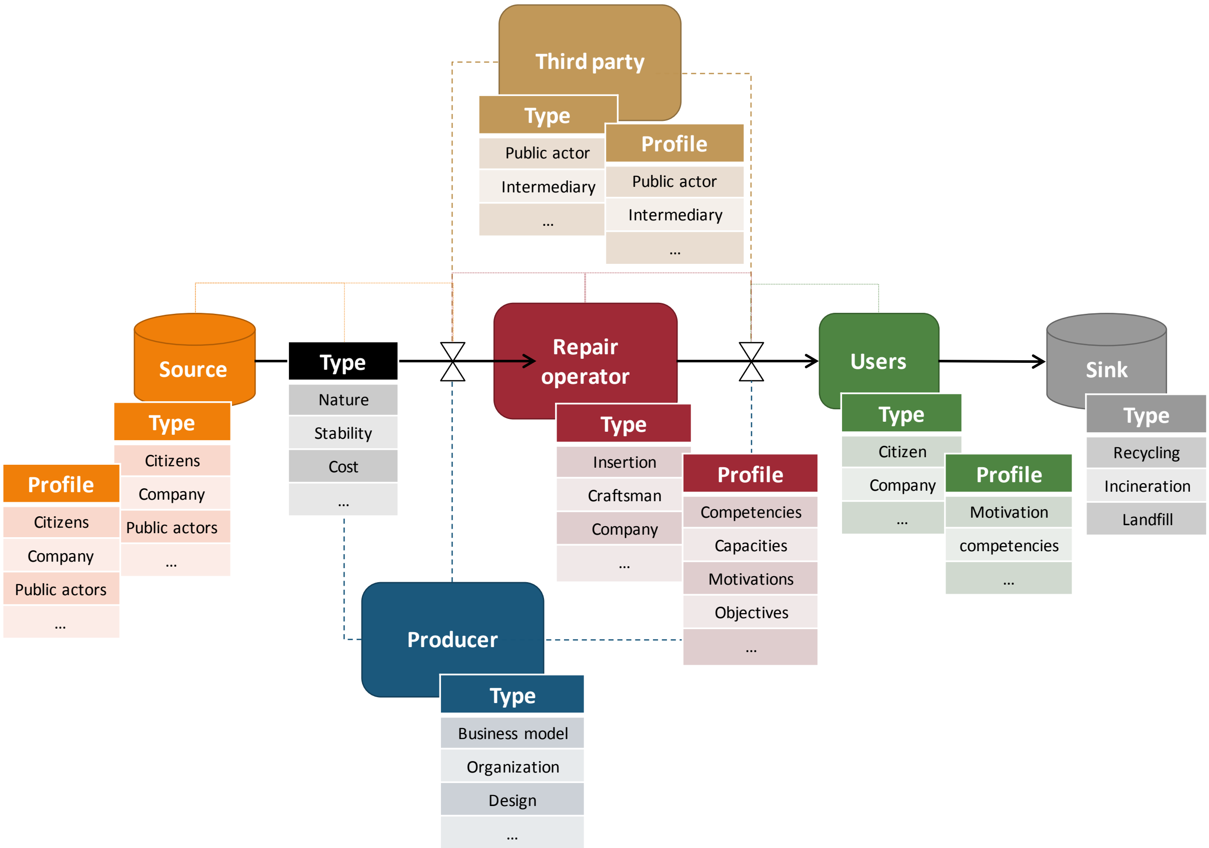

Figure 7 - RECYLUSE territorial repair network infrastructure (based on previous work of (Tyl et al., 2015) for the REVALUE project)

Future work will entail the integration of the 5D-STM sustainability principles, in terms of recommendations for the structuring of the perimeter of action and for operational components of the project (e.g. participatory governance, use of local/territorial resources…). This may contribute to the emergence of niches that are consistent with sustainability principles, followed by their dissemination or upscaling to regime status. A subsequent issue will be the ability of a niche to maintain the original values that guided stakeholder action (cooperation, fair business practices…) once upscaling occurs. To analyse this issue, we will deploy our framework to identify the territorial and external resources mobilised by the initiatives of repair/reuse and to define if the creation of repair and reuse networks could keep the "territoriality"[18] promoted by these initiatives: waste is

[18] Consistent with the previous development about territory and scale, territoriality illustrates a constructivist and social view of space. It "is a set of relations that finds its origins in a three-dimensional social space-time system and corresponds to the action of several social system agents in a certain geographical area and historical moment" (Marques, 2009, p. 3).

revalorised on its production area and the process creates local value by employing local workers, by diminishing rubbish etc.

CONCLUSION

This article presents a framework that considers socio-spatial and temporal dimensions for project analysis. It examines the pooling of tangible and intangible resources during the structuring of networks of actors and the mobilisation of territorial resources during territorial projects. Dynamic network analysis leads to the emergence of the concept of the perimeter of action, formed by the network of actors, their skills and resources, their shared willingness and capacity to influence and concretise the project. The perimeter of action is an evolving, non-continuous and multilocal innovation space that arises from the scalar projection of macro, meso (territorial-industrial-civil), and micro levels onto the project.

This framework is based on an interdisciplinary work, which combined engineering, social and human sciences (particularly, geography and sociology). We have adopted an interactionist and constructivist prism in order to introduce human and social agency and the territorial dimension, often neglected in other models.

This methodological presentation counts some limits that future research will tackle. First, to strengthen this framework and better understand the relations between territorial resources and the own resources of stakeholders, the levels of actions and interactions. Moreover, it is particularly relevant to analyse how the macro-level frames and influences new environmental initiatives and limits the alternative nature of some projects, so that they could match defined criteria of financial aids for example. This framework would as well enable researchers to more deeply address the issue of sustainability. Often, the projects that are hallmarked as environmental friendly do not correspond to a strong sustainability (i.e. which assumes the irreversibility of human actions on nature and Earth) and the need to couple resources extraction, transformation, mobilisation with the dematerialisation and decarbonisation of our societies and ways of consumption. When the project manager and stakeholders identify and choose resources for setting up an initiative, they could be aware of their impacts thanks to interdisciplinary frameworks like this one.

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