

Vähäkari Noora, Lauttamäki Ville, Tapio Petri, Ahvenainen Marko, Assmuth Timo, Lyytimäki Jari, Vehmas Jarmo (2020) The future in sustainability transitions - Interlinkages between the multi-level perspective and futures studies. *Futures* 123: 102597
<https://doi.org/10.1016/j.futures.2020.102597>

Abstract

This article focuses on a key framework of sustainability transition studies, the multi-level perspective on socio-technical transitions (MLP), and its potential and relationships with futures studies. We propose that there are various co-benefits in creating convergence between the two fields of study. Out of established frameworks in sustainability transition studies we focus on MLP due to its popularity and flexibility in analysing the dynamics of societal changes. Our analysis shows that there are various conceptual, content-based and methodological connections between MLP and futures studies that have been under-represented in both fields of literature. There are considerable similarities between scenarios and development pathways; weak signals and niche innovations; megatrends and landscape pressures. So far, MLP has been underutilized to analyse the variety of alternative futures. The MLP framework gives a structure on the systemic dynamics in societal change and futures studies provide apt methods to construct alternative pathways to societal transitions. We conclude that futures studies and the MLP framework, along with other theories and approaches in transition studies and management, have a high joint potential and thus contribute to better understanding of the dynamics of change for more sustainable futures. Realization of this potential requires further convergence of the approaches.

Keywords: sustainability, socio-technical transition, multi-level perspective, futures studies, interdisciplinary research

1. Introduction

Futures studies and studies on sustainability transitions share many similarities. The overarching goal for both fields of scientific inquiry is to increase understanding on the complex forces that shape the development of socio-ecological systems in order to be able to make better decisions towards preferred futures (Bell 1997; Markard et al. 2012). Both areas of study face challenges due to the nature of the problems (often wicked) and solutions (often tentative) (Daviter 2017). Future orientation creates methodological challenges regarding the confirmation of projections, the evaluation of their significance and the limits to claims for objective truth (van Vught 1987). Both fields underline the significance of examining emerging trends with an interdisciplinary approach, and focus on the interactions and interlinkages instead of the reductionist core of a problem in question (Chang et al. 2017; Aligica 2004). Thus, systems approach is the foundation of both fields. Instead of a single dominant theory or model several tools and frameworks can be applied to better understand individual cases.

There are several prominent frameworks within transition studies, which allow for comprehensive examination of long-term transformation processes of socio-technical systems. The key approaches include transition management, strategic niche management, multi-level perspective, technological innovation systems, arenas of development (Markard et al. 2012; Chang et al. 2017), and comparative policy process analysis and multiple streams frameworks (Beland & Howlett 2016). The frameworks differ in their purpose, disciplinary backgrounds, ways to construct explanations and interpretations, the actors considered, and definition of the actions to concentrate on when addressing transitions. They generally focus on technological, economic and social aspects while paying less attention to cultural underpinnings and ecological processes.

In this paper we focus on one of the most referred of these frameworks, the multi-level perspective (MLP). The choice to concentrate on the links between futures studies with just one of the frameworks within sustainability transitions, instead of the whole field of sustainability transitions, was made for several reasons. Firstly, the field of sustainability transitions and futures studies are multifaceted, problem-oriented fields that are often operationalized through context-specific cases. That makes the assessment of the conforming or differing characteristics between these fields, beyond goals or adopted world view, very difficult. In light of that observation, we feel that the most fruitful way to approach possible links and avenues for further collaboration is through choosing an established framework from the field of sustainability transitions and use it as a lens that will allow illustrating how ideas, concepts and methods familiar also in the field of futures studies might provide opportunities for synergies. Out of the established frameworks within sustainability transitions, we decided to choose the MLP due to its explorative nature, openness, flexibility and the ability to map non-linear long-term developments. Despite these characteristics that are also fundamental for futures studies, there are not many examples on attempts to bind these two approaches together. Our aim is not to compare different future oriented approaches but to discuss whether there are possibilities for fruitful combinations of fields of futures studies and transition studies. Our concern is in issues linked with operationalizing and creating futures component to MLP, and

vice versa, and to identify avenues for further collaboration. When choosing to focus on MLP we acknowledge that in order to understand full potential between futures studies and sustainability transitions similar examinations would be necessary for other prominent sustainability transition frameworks as well, but this is beyond the scope of a single article.

MLP can be viewed as a system model of how interaction between multiple analytical levels can influence a development process. MLP typically portrays a chosen topic, historical development or action, and the elements and interactions that are linked to it. The need to include power relations and politics in the framework has been increasingly acknowledged (e.g. Geels 2014; Avelino & Rotmans 2009; Meadowcroft 2009). MLP aims to conceptualize and explain processes where multiple configurations of actors, resources, institutions and rules in different contexts create stability, as well as windows of opportunity for change.

As a field whose core is in understanding and influencing development towards more sustainable systems, sustainability transitions display strong futures orientation. However, despite the recent signs of increasing attention, the links with academic futures studies in sustainability transitions literature have been rather weak and scattered. For example, only few recent contributions in utilizing MLP within futures studies has been published by Futures (e.g. Papachristos 2018; Mäkelä et al. 2020). This article attempts to fill that gap by exploring the interlinkages and new approaches of intertwining futures studies and MLP. Specifically, we explore the key concepts of both fields in order to understand how the interlinkages of MLP and futures studies can provide new approaches to detect and foresee development processes, and thereby support new sociotechnical innovations. Thus, the first research question asks:

RQ1: What are the key interlinkages of the MLP and futures studies approaches?

The paper aims to outline the ways alternative futures and transition patterns are integrated in the MLP in a broader sense (cf. Geels & Schot 2007), and open up discussion on where and how wider scale societal transitions could be acknowledged related to the conventional understanding of the MLP approach. Traditionally, MLP studies have focused on describing how historical development of a sector and emerging technologies have progressed (Geels et al. 2017; Savaget et al. 2019), although recently the ways in which MLP is used in transition analyses have broadened (Köhler et al. 2019). Few attempts to link potential development paths of the future to the MLP framework have been made (Konrad et al. 2008; Hofman & Elzen 2010), but these have not used the full potential of the concepts and methods developed within futures studies. Secondly, this paper thus investigates:

RQ2: How can MLP contribute to futures studies methodologies in providing a suitable analysis for long-term transition patterns?

To clarify these questions, we first introduce the background of sustainability transition studies and chart MLP's position among relevant analytical frameworks in Section 2. Section 3 describes the thought and function of MLP in socio-technical transitions in more detail. Section 4 explores theoretical links between futures studies and sustainability transition studies, justifying the comparative elaboration of the two and identifying key methodological

challenges. Section 5 then presents an attempt to combine elements of MLP and futures studies approaches to transitions into a joint framework, with particular regard to time, scope and epistemic aspects. Section 6 discusses the challenges and opportunities the shared basis of the two fields hold. Section 7 concludes the analysis and discussions.

2. Theoretical backgrounds of sustainability transitions

Sustainability transition studies, and linked theories and concepts, have been developed under this explicit term over the past 25 to 30 years in order to respond to the need to better understand structural transitions in societies and to support sustainable development (Loorbach 2007; STRN 2010). Understanding of the complexity and broad nature of sustainability challenges has increased, and simultaneously the focus of socio-environmental studies has started to lean more towards interdisciplinary research, since in sustainability transition studies the approach is typically wider than a single problem or a single disciplinary perspective. Moreover, due to the need to take into account the interactions between research, practice and society as a whole, and in addition to those links between disciplines, sectors and their problems, and due to the resultant complexity of such accounts, transdisciplinary approaches have gained increasing interest (Keune & Assmuth 2018).

Sustainability transitions, here including mainly transitions towards greater sustainability through technological or social innovations, are often represented as processes with multiple actors and simultaneous processes, non-linear development in the system, and continuous interaction with the surrounding environment (Loorbach 2007; Lyytimäki et al. 2018). Consequently, it is crucial to acknowledge also the context in which a certain innovation or technology is functioning, as this is sometimes the reason it is not taken up. Socio-technical systems transform slowly, and their infrastructure, institutions and other constituents are often tailored, or only inadvertently evolve, to maintain the existing technologies (Lyytimäki 2019). Such path-dependent development is partly the reason why radical transitions rarely happen. A great challenge in promoting solutions that support sustainability is their long-term actualization as attention and priority is often given to short-term benefits (Markard et al. 2012; Farla et al. 2012). However, sudden changes are often assumed and consideration of continuity is limited especially in popular and media representations of societal transformations.

The fundamental idea of the MLP, and other sustainability transition approaches generally, is that no innovation or technology and its development process can be understood only from a single point of view. The assessment must consider the surrounding socio-technical system where the innovation aims to succeed in (Verbong & Geels 2007). Socio-technical systems combine various actors, networks of enterprises, organizations and individuals, institutions, norms, rules and standards, and physical, financial and human capital (Markard et al. 2012). These human systems moreover are embedded in, impacting and impacted by ecological systems (Tapio & Willamo 2008). A transition or change therefore takes place as a result of the complex web of interactions. Neither MLP or futures studies propose a linear causality of transitions, but underline the complexity of systems and alternative development patterns where emerging transitions are born from co-evolution and simultaneous reinforcement of suitable conditions (e.g. Grin et al. 2011; Geels & Schot 2007).

A major challenge for sustainability transitions is the dominance and stabilized position of technologies, actors and supporting societal structures (i.e. the regime) developed over a long period of time. Strong position of incumbent technologies, actors or ways of operating may act as an obstacle to new, more sustainable solutions (i.e. niches) break through. Development where old, often inefficient technologies sustain their position in the markets due to lock-in structures that reinforce or reproduce themselves, is often called path dependent (Tiberius 2011). Factors that sustain the current structure include various actors, institutions, investments in built infrastructure and support networks, established market position of companies, and knowledge of past experiences (Geels 2002; Markard et al. 2012; STRN 2010). When drafting solutions to current sustainability issues via innovation development, it is therefore critical to understand the setting that is constructed by these factors and the stabilized norms, habits, standards and technologies that they uphold (Raven & Geels 2010). Such stabilized systems that reinforce one another are called *regimes* in sustainability transition studies (Raven & Geels 2010). An innovation system producing the systemic change is not a predetermined structure or a chronological pursuit towards certain types of innovations, but rather a combination of a social structure, pool of actors and institutions typical for a certain time and place that directly or indirectly have an impact on innovation development and diffusion (Hekkert et al. 2007).

3. Multi-level perspective (MLP) on sociotechnical transitions

Often, transition theories aim to understand development patterns in areas such as environmental management, markets, society and technological change (Chang et al 2017; Geels et al. 2017) thus binding homogenous elements with futures research. Also MLP shares much history with evolutionary economics, science and technology studies and sociology. MLP consequently provides a feasible framework for understanding how transitions unfold within an industry, a technological field or an activity. Futures studies rarely concentrate on an innovation journey of any technological field or activity as such, but rather the wider context surrounding it and the interactions and linkages involved. In addition to MLP transition studies include a wide repertoire of approaches and frameworks that are not discussed here.

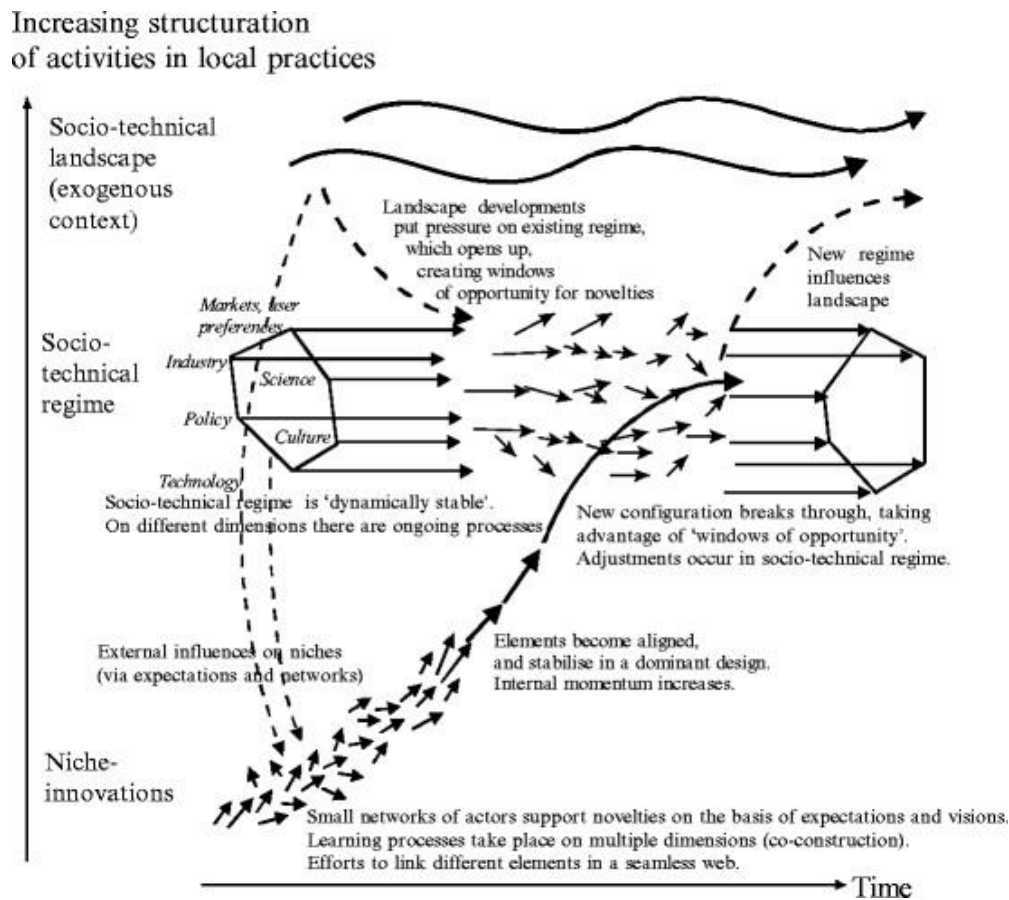
MLP considers both the structures that have an impact on transitions and also linkages, reflection mechanisms and nonlinearities of different levels of a phenomenon. MLP has often been utilized in presenting the development of a certain environmentally friendly technology or practice under conditions of strong path dependencies, stability and dominance of current solutions or technologies (Verbong & Geels 2007; Sutherland et al. 2015; Dzebo & Nykvist 2017). MLP can be applied to describe a pathway towards ecological sustainability from the perspective of ecological carrying capacity, but it is limited in depicting a sustainability transition of a whole society as it lacks the criteria and concrete examples of how sustainability should be determined in specific cases. The criteria for socially or culturally sustainable societies are inherently more value-based, ambiguous and contestable than criteria for ecological sustainability. Yet applications in multiple edges and approaches of socio-technical development processes have aimed to position MLP more strongly in the field of social sciences (Geels 2019).

MLP describes transitions unfolding from an interplay of factors from three levels: *niche*, *regime* and *landscape* (Figure 1). Landscape represents the broader sociotechnical context, like a background that cannot be influenced in a short-term perspective (Geels 2002). Contextual landscape factors beyond immediate developments have a long-term impact on the regime. Major shocks can nevertheless disturb it fundamentally, providing a window of opportunity for niche innovations to break through. Variations in the exogenous environment can be assessed by addressing different factors. Phenomena or processes in the landscape level can be very slow, such as climate change or long-term social processes like those of industrialization and demographic changes. However they can also include faster trends like digitalization, or abrupt shocks such as wars, pandemia, or oil crises (Geels & Schot 2011). Suarez and Oliva (2005) categorize environmental change in the landscape level based on four dimensions: frequency, amplitude, speed, and scope. Combinations of these four attributes produce multiple types of change in the operational environment. However, this categorization was originally developed to assist companies that function in a limited organizational environment, and might not be directly applicable to broader societal change.

The second level, building to some extent on evolutionary economics, history of technology, sociology and political studies, is the socio-technical *regime*. It incorporates the socio-technical structure: the dominant technologies and their institutionalized norms, rules, production modes and functions (Rip & Kemp 1998). Geels (2004) acknowledges three categories of rules: cognitive, regulatory, and normative. These together with physical infrastructures and ecosystem structures create stability in the structure of transitions. Regime level networks include different actors - users, producers and facilitators of technology and services; policy-makers, enterprises and citizens; and communities of practice (Geels & Schot 2011). There are constant changes within the regime, yet these are usually minor and collectively agreed upon.

Niche is the third analytical level of the MLP. On the niche level, experimentation and radical innovations can be developed outside of the immediate pressure from the regime (Geels 2002). Such protected environments can be borne from R&D projects, or from activities in a non-competitive and non-regulated sector. Compared to the regime level, functions in the niche level are less stabilized and less predictable. Networks on the niche level are usually rather small, and constant activity is required from the actors (innovators and entrepreneurs most often) to sustain the *niche*. Typical activities include 1) the construction of actor networks for knowledge sharing and innovation development; 2) learning processes where innovations are improved and sociotechnical structures invented; 3) the articulation and harmonization of visions and expectations concerning the innovations or topics in question (Verbong & Geels 2007). In time, niche level innovations either remain, flourish or collapse. Perceptions on when and on what preconditions certain innovations are ripe to enter markets differ according to the context. Geels and Schot (2011) suggest a few factors based on which one can identify or deduce a possible breakthrough: stabilization of actor networks, increased focus on one dominant innovation, improvement of price-performance relation, and popularity of the innovation in a specific market segment of at least 5% market coverage.

Figure 1: Multilevel perspective on sociotechnical transitions (Geels & Schot 2007¹)



The levels described above are not isolated, and understanding of transition processes requires comprehension of the interconnections and interaction of all three levels (Geels 2002). Due to the complexity of these interactions, the initial phases of the formulation process of a new radical phenomenon are blurred with uncertainties. Niche changes emerge to challenge and shape regimes and even landscape developments. Actor networks interpret the signals and develop images of the possible futures relevant to further development (Figure 1). Despite of all the work, inventions only rarely develop into innovations that become mainstreamed (Walrave et al. 2018). Reasons vary from unfit current regime, lengthy overall development process, or active opposition by key market dominants.

4. Futures studies approaches in relation to MLP

Futures studies aim to detect and understand expected societal changes, and in this way help people to prepare and react to them (Bell 1997). Transition and transformation, inherent in these changes, are thus at the heart of the foundations of futures studies. It differs from other social sciences by deliberately aiming towards change and by contributing to transition

¹ Reprinted from Research Policy, 36, Geels & Schot, Typology of sociotechnical transition pathways, 399-417, Copyright (2007), with permission from Elsevier.

processes (Wilenius 1999). Thus, futures studies contains a transformative aspect. Even though we cannot reliably predict the future or know the true impacts of our actions, it is certain that our decisions and even our outlooks will implicate changes.

Discovering the synergies of MLP and futures studies can reveal new tools for answering some of the major tasks of futures studies, outlined by Bell (1997, 75-97). Especially interesting among the tasks is “*interpreting the past and orientating the present*”. Often in future-oriented studies the focus is (obviously) in issues related to potential future developments, but even though recognized as necessary for understanding long-term development, the history of the issue is not often examined carefully. Using MLP would provide an improved understanding on characteristics and change dynamics of past development. This is critical for a thorough analysis of possible futures. Looking at Bell’s list refinements for MLP applications might be found particularly from item “*integrating knowledge and values for designing social action*”. These features are not much discussed in the MLP literature nor in other prominent approaches of sustainability transitions, even though they are important for bringing the discovered information into action. Specifically, they can bring new insights for understanding and advancing sustainability transitions. In futures studies underlying changes in social groups and societies are considered in e.g. studies applying Causal Layered Analysis (Inayatullah 1998) or Soft Systems Methodology (Checkland 1985), which are often applied in problem-oriented futures workshops (Lauttamäki 2016).

The systems approach (e.g. Ison 2010) has laid an important ground for both futures studies and transition studies, by examining the multiple interactions and linkages of a phenomenon instead of focusing only on its reductionist core. Huutoniemi & Willamo (2014) call this approach “looking outside”. Due to its broad nature (depending however on the framing of the system and of the perspectives on it), systems approach is conducive to an interdisciplinary take on the topic under focus. Narrowing down the analysis and only addressing relevant parts, while retaining multiple perspectives, is a challenge. Partly therefore, a systemic approach does not have to utilize predetermined models or theories but may rather adjust to suit the phenomenon the circumstances and the goal in question. Thus, fixed models or theories are not necessary, often not even desirable or possible. However, appropriate systemic approaches can provide essential novel information on large complex issues using perspectives that would otherwise be disregarded (Assmuth et al. 2009).

Amara’s (1981) classical distinction of three types of futures – probable, preferable and possible – is interesting from the MLP point of view. MLP has traditionally been used to describe past transitions (probable past), but it can also be used to describe potential scenarios. As the point is to analyze sustainability transitions, the preferred future is relevant. The backcasting approach (Robinson 1990; Vergragt & Quist 2011) in futures studies outlines a preferred (sustainable) future and then builds various scenarios from the present to the preferred future. While the MLP framework is a rather loose and flexible regarding its dynamics, we have not seen analyses predicting the probable future using MLP. However, opening up alternative possible images or scenarios is one of the key tasks of futures studies, and in this task the MLP approach would provide interesting solutions. Based on several criteria such as timing and nature of interaction (Geels & Schot 2011, Geels et al. 2016) between three

analytical levels empirical research has produced archetypes of development paths describing transition mechanisms. Up to six such hypothetical, possible scenarios, or ‘pathways’ of the dynamics of socio-technical transition have been outlined (Geels and Schot 2007; 2011; Geels et al. 2016)²:

- *reproduction process*; the system stays rather stable and change takes place according to regime-internal logic
- *transformation pathway*; there are pressures from the landscape level, but there are no niche-innovations mature enough to take over the regime. This provides incumbent regime actors time and opportunity to gradually adjust the regime to correspond with new operational environment,
- *de-alignment and re-alignment pathway*; significant pressure from the landscape level changes the rules of the game in the regime level. There are no immediate substitutes available in niche, instead a competition of several potential niche-solutions follows. Eventually a new steady state is achieved around one such solution,
- *technological substitution pathway*; unlike the three cases above, there are mature niche technologies that can become dominant following changes on landscape level,
- *reconfiguration pathway*; agile regime actors are willing to change by consciously nurturing and benefiting from development of niche level technologies,
- *mixing pathways*; development might follow several sequences. There is increasing landscape pressure, but the nature of development path depends on the ways the regime actors react to perceived changes. In the case of mixing pathways it is difficult to present general model on how development might follow. The essential point is that development is non-deterministic and might proceed from one configuration of actors, actions and rules to another following varying development phases.

One of the basic discussions within futures studies is about and against deterministic forecasting (Slaughter 1982; Bell 1997; Robinson 1990; Inayatullah 1990; Höjer & Mattson 2000; Tapio & Hietanen 2002; Börjeson et al. 2006). The point is clear and often repeated – humans as individuals, communities, organizations and species can actively influence the future. Therefore alternative possible scenarios and images of the future should be created rather than predictions of the most likely future. The thinking in emancipatory, critical futures studies takes a step further. Not only alternative ‘utilitarian’ scenarios to assist decision-makers are made but deeper, more radical, decolonizing, more inclusive and more empowering futures studies processes should be outlined (Inayatullah 1990; Slaughter 1996; Sardar 1998; Ahlqvist & Rhisiart 2015). Recent discussion on anticipation for emergence (Miller et al. 2018) embraces spontaneity, improvisation and novelty when encountering the future.

The purpose of futures studies is related to the MLP as well. MLP can be used for creating and understanding both utilitarian and radical socio-technical change. The active role of the regime level actors is essential in the transformation and reconfiguration pathways (Lyytimäki et al.

² Due to their somewhat non-original nature development paths *reproduction process* and *mixing pathways* are not considered in most articles

2018). Radical, emancipatory solutions typically arise from the niche level ‘grassroots’, and the critical question can be raised whether the established regime level actors are willing or able to see beyond their immediate needs. Another question is, whether the transitions described by the MLP rather describe unsustainable than sustainable pathways, and in what regards. An example is the analysis of the United States transportation system from horse powered system towards a private car based system despite the fact that there was a competing more sustainable public transport alternative (Geels & Schot 2011). This leads to the question whether unsustainable and sustainable transitions evolve in the same way, or if they differ and why.

Further shared elaboration of these fields can provide new insights and support for understanding and promoting holistic, sustainable global development. Studies on potential future development carried out using methods familiar to futures studies by familiar methods might benefit from understanding of dynamics of development that is of central interest also in MLP. As MLP describes an open development in the interactions between the multiple levels, with transitions taking place over time, and also acknowledges exogenous shocks and other dynamic variables, it suits well to be applied alongside with futures studies theories and methods.

5. Searching for commonalities in conceptual frameworks

It is worth investigating if MLP can be applied in futures studies as a provider of a broader theoretical framework of societal change. Additionally, when evolved further, and accompanied by other transition theories, MLP could thus even be developed into a systemic futures studies tool to support transition process analysis and planning.

Futures studies categorize phenomena relative to their scope, as does MLP, with a different but complementary interpretation of scope. In futures studies, new innovations and trend changes are described as processes that start off as *weak signals* or *emerging issues*, growing into new *trends* and potentially conglomerating into *megatrends* (Hiltunen 2008). In MLP, the same continuum grows from *niche innovations* to *regime* to *landscape* level, respectively (Geels 2002). Regarding dynamics and the temporal dimension, stages are differentiated by scope or level. This multi-level interaction between systems and their subsystems is a key characteristic for both research approaches. The similarity of the concepts of megatrends and landscape changes is striking as they consist of a bunch of trends on a general, typically supranational level, being relatively difficult to influence with normal time horizon of decision-making. The nature of changes of megatrends and socio-technical landscapes span from gradual long-term evolution to abrupt non-linear shifts. The changes are often characterized by a hysteresis and inertia. Anticipating or even identifying the exact point of no return of rapid change is highly challenging (Milkoreit et al. 2018).

The meso-level concepts show some difference in the two approaches. The regime is a composition of dominant technologies and the norms, rules, and functions of the society that are often stabilized and predictable. They include institutionalized networks, rules, norms, markets, and infrastructure. On the other hand, trends are clearly observable dynamic changes

in these attributes of the regime, not the attributes themselves. In other words, a trend is not a variable that changes but the change in the variable (Merriam-Webster 2018).

Significant interruptions or disturbances affecting the trend are called *wild cards* or *black swans* in futures studies, whereas in MLP disruptions of regimes can be labelled as *specific shocks* or *avalanche changes* (see Geels & Schot 2011, 55; Suarez & Oliva 2005; Mendonça et al. 2004). The essence of both trend changes and regime disruptions is the unfolding of path-dependencies and lock-ins of human action. They can be understood as extreme events, such as the Fukushima nuclear power plant accident in 2011 causing radical trend changes due to vulnerable and disruptive technologies, or larger disruptive transformations (Heinonen 2013; Cagnin et al. 2013). What is considered sudden and disruptive depends on the context and evaluation criteria, as the lines between sudden events and prolonged processes are blurry. The similarity of concepts proposes that there could be potential for cross-disciplinary applications.

Scenarios, or *scenario pathways*, represent a key concept in futures studies and can be applied in MLP studies. Scenarios are typically alternative hypothetical paths to a set of possible futures. Many definitions emphasize the role of decision making leading to the alternatives (Kahn & Wiener 1967). Scenarios can be built in a forward-looking or backward-looking manner. Forward-looking scenarios start from the present to the future whereas backward-looking scenarios begin with certain future states towards the present (Vergragt & Quist 2011; Author et al. 2014). Backcasting is a special case of backward-looking scenarios and shares a similar analogy with the MLP. It describes alternative scenario paths to a preferred future. This is exactly what MLP studies are trying to map down (Geels & Schot 2007).

The key concepts and approaches in futures studies and in the MLP framework can thus be compared by examining their similarities and differences according to their levels of organization (Table 1).

Table 1: Conceptual interlinkages of futures studies and the MLP framework

Futures studies	Multi-level perspective on sociotechnical transitions (MLP)
<i>Megatrends</i> Long-term processes with a profound impact on societies over decades or even centuries.	<i>Landscape level changes</i> Broad context against which development of phenomena is viewed. Changes in the landscape are fundamental and beyond the influence of individual actors
<i>Trends</i> Pervasive features of the present that are believed to be continuous or strengthened in the future, have either gradual or fast change in the society.	<i>Regime level changes</i> The dominant technologies and their norms, rules, and functions of the society. Functions in the regime are often stabilized and predictable. Networks, rules, norms, markets, and infrastructure institutionalized.
<i>Weak signals/emerging trends</i>	<i>Niche level changes</i>

Some hints of upcoming trends are present, but the phenomenon or innovation is not mainstreamed. Might seem unimportant now but trigger major change in the future.	Experimentation and radical innovations can develop outside the immediate pressure from the markets. Can be borne from R&D projects or activities in a non-competitive sector. Networks in the niche level are usually rather small and instable.
<i>Wild cards/black swans</i> Surprising events that might have fundamental impact to the society as a whole or a field of business, up to the megatrends. Seem unlikely but are possible.	<i>Avalanche changes/specific shocks</i> Rapid, intense change. For companies and other communities this might serve as a suitable time for structural re-creation. Triggers even bigger societal, broad changes.

Despite recent theoretical developments, a major strength of the MLP remains to be an improved understanding of the dynamics of historical change within and between the main systemic levels. As for futures studies, the strength is in collecting and refining information about alternative futures and emergence. Particularly understanding and identifying change is in the very core of futures studies. Simultaneous use of these approaches might help to examine long-term development and potential futures of sectors within a society by using a single coherent framework that bridges the past and the future into a seamless whole for informed decision making for sustainable societal change. Understanding the historical evolution of a certain phenomenon and tying it with ways to look into plausible futures as a continuum will aid better understanding of societal changes and transition patterns. Integrating and embracing novelty through alternative futures would be a further advantage to sustainability transitions framings, too.

One practical way to bridge futures studies and MLP is to view how combining ideas from these two strands might work in scenario building, an essential part of the methodological selection in futures studies. There are some examples of linking MLP and quantitative scenario models (Sluisveld et al. 2020), but from a futures studies perspective there is a need for further elaboration. Out of different scenario types, backcasting scenarios might be the most suitable starting point. They may be used to view various ways of describing alternative paths to sustainability goals such as achieving set emission targets, thus corresponding with the core idea behind the MLP (see e.g. Heinonen & Luttamäki 2012). As for alternative scenarios, MLP can provide a checklist of potential key drivers of the scenarios, whereas scenario methods are more equipped to identify decision points hindering or progressing certain futures. Figure 2 showcases a setting where alternative (more or less sustainable) scenarios are developed as an opponent to the current hegemony and challenging status quo regimes.

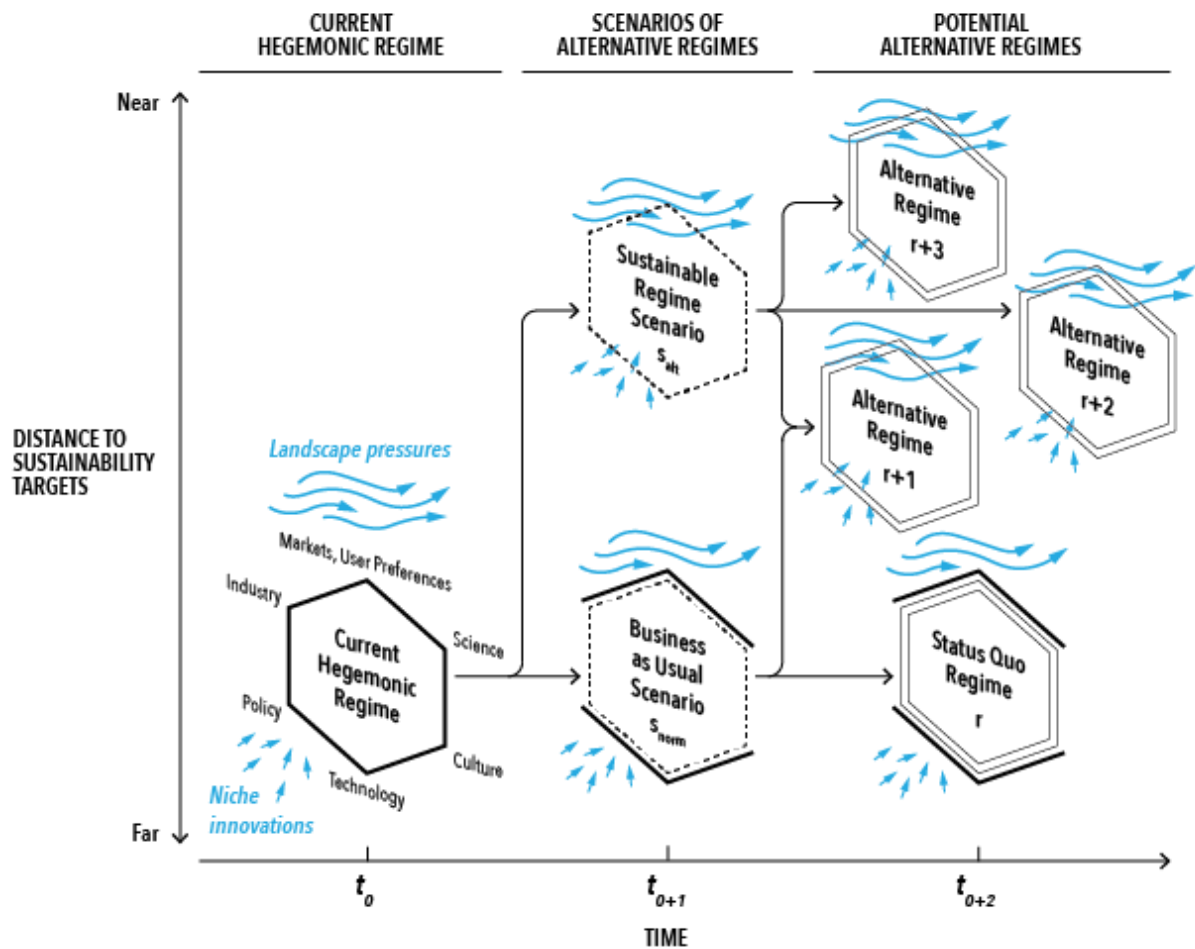


Figure 2: Constructing a potential framework on how to link elements from both futures studies (scenarios) and MLP (regime) in a development pattern of alternative sustainable futures. Scenarios on sustainable regime options are made, that influence on how potential alternative regimes could be, and eventually also transform the current hegemony.

MLP studies have produced a typology of several development paths that may be seen as archetypes of how transition processes unfold (Smith et al. 2005; Geels & Schot 2007; Geels & Schot 2011; & Geels et. al 2016). From the perspective of futures studies these development paths are interesting since they produce a starting point and a frame of reference to map potential future developments. Scenario building from there onwards provides an opportunity to describe potential development patterns of a phenomenon. Such empirical understanding might be useful especially in fields where change is rather slow and path dependent, and associated phenomena complex and ambiguous, such as in viewing the future of energy systems. Development paths may be used as frames in e.g. scenario building, while keeping in mind the necessity to consider also other possible paths.

Besides scenario paths, also further attempts to link futures studies and MLP on a methodological level can be proposed. For instance, the interlinkage of scenarios and MLP (Fig. 2) may be built or further refined, enriched, supplemented or assessed by using a futures

table, taking into account all three levels of MLP. Futures table also allows constructing entirely new development paths (see Fig. 2). In considering potential future development paths deviating from ones identified in MLP, methods such as wild card analysis and risk analysis (cf. Table 1) may be useful. Information about the future development of the phenomenon in question may be gathered in a variety of ways. For instance, when using the Delphi method the development paths of MLP may be used as propositions regarding potential future developments. Development paths may also be used as a guiding tool when building scenarios in a theory-driven fashion. In this instance, obviously, only such development paths that are supported by the collected material, are considered plausible. Extending the potential of gathering critical information and evaluations to support the scenario building is where participatory futures studies methods might be particularly useful. Thus, one might be able to shed light on goals, motivations and responses of key actor groups under changing landscape conditions.

Futures studies methods are characterized by abundance and adaptability. The methods and tools suggested here are initial opportunities in tying the first links of futures studies and MLP together. As described, the options are multiple and the theoretical and conceptual similarities suggest that cross-disciplinary applications can and should be applied further. However, more elaboration is needed on how this is best done.

6. Discussion

Although futures studies and sustainability transition studies share some essential concepts and interests in viewing alternative future development paths (STRN 2010; Vergragt & Quist 2011), formal links between these two fields remain poorly developed. Especially regarding how to understand and steer sustainable change, futures studies could benefit from concepts and methods developed and experience cumulated within sustainability transitions studies. Improved establishment of the links between the two could benefit both fields of research and open opportunities for improved frameworks to elaborate change patterns from the past to present and all the way to alternative futures.

MLP focuses on transition pathways, but it cannot provide answers on how a certain trend, innovation or phenomenon develops further, and that has never been its initial purpose anyway. Theorization of complex societal chains of events is prone to receive critique, and the arguments reflect the background of each criticizer (Lauttamäki 2018). This emphasizes the problems in capturing the essence of the dynamics of complex systems.

Normative studies always contain epistemological and ethical questions, and futures studies even more so. Due to radical uncertainty when facing complex phenomena, predictive (as well as explanatory) abilities are reduced. When the phenomena (such as sustainability) also involve strong value-laden elements and ambiguity, definition of preferences is hard, requiring a heuristic approach (Putnam 2002). Adding the fact that the future does not exist multiplies these problems. Precisely therefore, the goal of understanding sustainability transitions, including their limits and caveats, is a key addition to the goal of steering them (involving preconceptions of where and how), and provides essential benefits from a fusion of approaches.

Despite opposite views (see above), MLP is clearly a suitable theoretical structure in demonstrating, explaining and assessing transition and the multiple actors and factors present there, and remains as the most popular framework within transition studies. Both MLP and futures studies provide tools to understand the complexity of processes and leave predetermined or fixed models out. Narratives dominate quantitative data analysis as in process theory cases are uniquely elaborated (Geels 2011).

As shown above (e.g. Section 5), key concepts related to the scope of phenomena in futures studies and MLP share many similar characteristics. However, the nature of change and fluctuation is more strongly present in futures studies assessing weak signals, trends and megatrends. In MLP then, regime, for example, is usually represented with a more fixed status, or one-way direction, and the conditions for each level as rather stable. In principle however, there is no obstacle to increase the dynamic view or challenge the fixed positions even when scrutinizing these structures and conditions in the MLP. The actual change between the different actors forming, reproducing and altering the regime require more attention in further studies. Regarding the dynamics, it is especially interesting to ponder the relationship between trends and fluctuations.

This paper acknowledges other prominent frameworks in sustainability transition research that could provide further avenues for our analysis, but chose to focus on MLP only to more clearly illustrate needs for interdisciplinary explorations of future-oriented and transition-oriented thinking. Out of established sustainability transition frameworks, MLP was considered most appropriate due to its adaptability and consideration towards long time horizons. Its ability to describe multiple development paths through empirical evidence is most developed within sustainability transition studies, and further continuum could be found in synergy with futures studies. Enriching the MLP with ways of thinking and methods from futures studies, one can go deeper into issues shaping the future and at the same time tackle some of the issues found lacking in traditional ways of applying the MLP. Simultaneously, it would provide a way to more thoroughly analyse past developments that are not always sufficiently considered in futures studies. Specifically, the relationships with transition theories (in various fields of social and even ecological, economic, organizational, behavioural and multi-disciplinary and trans-disciplinary science) require additional study and offer key new insights and approaches. Their uses and potential are multiple (Köhler et al. 2019), and thus not possible to elaborate further in this effort. Thus, this paper claims that the use of the future as a critical element in sustainability transitions research, as well as learning from the approaches and methods essential in futures studies, should be understood and applied better. Simultaneously, futures studies should discuss further how to learn and gain from the work within sustainability transitions research and also frameworks beyond the MLP.

7. Conclusions

Supplementing the MLP framework with ideas and methods developed among the field of futures studies would widen the applicability of MLP by capturing the characteristics of

possible future events, thus extending the use of this framework also towards assessing and influencing not only historical, but also future developments. Bringing forth several alternative futures with correspondingly different niche, regime and landscape configurations will enrich the futures perspective applied in MLP and render options for change on these analytical levels more visible. Futures studies provides an established and interdisciplinary variety of approaches to analyse change patterns beyond the present.

In addition to similarities of the MLP and futures studies providing a solid base for further convergence between the approaches some fundamental questions requiring further theoretical discussion and empirical case studies can be identified. A fundamental question is when and how (to what extent) the MLP is in fact an appropriate framework to be applied in futures studies, specifically with regard to systemic transitions, or vice versa. Can it be best used to assess weak signals, or in pioneer thinking or detecting black swans, or all of these, and in what combinations? Can it be used to assist backcasting studies where a preferred future different from business-as-usual is defined and scenario paths to the future outlined? How well do discrepancies or sudden events manifest themselves in the MLP, and what is the role of alternative paths or emergence there? Secondly, and related to these questions, in both MLP and futures studies, balancing the reflective orientation and the goal of understanding change with that of steering it, e.g. toward sustainability, requires attention. The answers to these questions largely depend on the context and purpose of analysis, as shown above. This paper thus provides general and open-ended but not specific and definite answers and guidance. There is plenty of room for additional work in combining, enriching and applying the approaches we have addressed.

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