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RESEARCH ARTICLE

TOWARD THE THEORY OF SOCIAL-ECOLOGICAL TRANSFORMATION TO SUSTAINABILITY

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ABSTRACT

Sustainability transformation as a powerful concept has become “hot spot”. Although recent studies on sustainability transformation are mostly based on resilience theory and/or transition theory theoretically and empirically, its conceptual grounds, theoretical development and practical relevance are still in infancy. In this explorative theoretical paper, based on the premise of ensuring consistency between ontology, methodology and practice, I try to face these challenges to synthesize and integrate ecological resilience theory, transition theory, realist social theory, and social-ecological theory to develop and build theory on sustainability transformation in SES to uncover specific conditions, mechanisms and patterns underlying sustainability transformation. My first step to explore this theory is to re-develop and re-conceptualize resilience thinking theory (resilience as adaptability, as transformability, and as persistence) so as to liberate resilience thinking theory from “capacity” to “dynamic process”, from “passive and negative regime shift” to “positive and active regime shift”, from “non agents of agency” to “agents of agency”. I propose Social-Ecological Transitional Resilience Thinking Framework, that is, resilience as adaptation, as transformation and as transition. The second attempt is to integrate this framework with the morphogenetic approach to construct Morphogenetic Social-Ecological System Framework (MSES) with the purpose of furnishing a theoretical framework for transformative change and process onto SES.

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INTRODUCTION

No surprisingly, the concept, sustainability transformation, as a powerful approach has attracted great attention. Not only does this concept provide a new significant channel toward sustainability, reconnecting nature, and radical systematic change in social-ecological system (SES), but also a passage toward hope. More and more scientists, scholars, policy makers, individuals and organizations have recognized that “business as usual” is not an effective and sufficient approach to today’s persistent problems (Rotmans, 2005; Loorbach, 2007; Loorbach *et al.*, 2009), and that radical systematic shifts are imperative in order to achieve “real sustainability” (Gell-Mann, 2010). However, Olsson *et al.* (2014) indicate that: 1) a clear-cut understanding of the underlying mechanisms and patterns, as well as conditions, of transformation, which might greatly promote our opportunities for challenging “persistent problems” and successfully steering prominent transformation to sustainability, is still in infancy; 2) as resilience theory and transition management are two major

conceptual and theoretical frameworks for studying sustainability transformation so far, combining, and integrating with the two different research fields could provide a promising road towards sustainability transformation theoretical building and empirical study, though there is still a long way ahead. I concur with the above two propositions except that I prefer to call these two research fields as resilience thinking and transition approach, which are subtly different from resilience theory and transition management and I will return to this conceptual clarification later. And I assert that before building the theory on sustainability transformation there still exists a bunch of issues to be tackled and clarified: how to free resilience thinking from the conflated view between engineering resilience-based resilience thinking and ecological resilience-based resilience thinking; how to conceptualize SES so as to study transformative process and change onto it.

In this paper, I try to meet these challenges. My first step is to dismantle the conflated view rooted in resilience thinking between engineering resilience and ecological resilience after reconfirming the ontology of ecosystem resilience. A new conceptual dimension of resilience thinking is proposed, I call, *social-ecological positive resilience thinking*; the second move is to synthesize resilience thinking based on social-ecological

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positive resilience thinking dimension with transition approach into a new theoretical framework, I call, *social-ecological transitional resilience theoretical framework* so as to provide theoretical foundation for sustainability transformative process, centered on resilience; the third attempt is to integrate this framework with the morphogenetic approach (Archer, 1995) to construct *Morphogenetic Social-Ecological System Framework* with the purpose of offering a theoretical framework for transformative change and process onto social-ecological system.

What Ecosystem Resilience Is

In Holling's seminal paper *Resilience and Stability of Ecological Systems*, resilience is defined as *measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables* (Holling, 1973) or *magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behavior* (Holling and Gunderson, 2002), which puts emphasis on the existence of alternative stable regimes in ecological systems (including alternative irreversible stable regimes and alternative reversible stable regimes) and is different from global stability viewpoint that there is only one stable equilibrium in ecological system, which is also called engineering resilience. Engineering resilience is referred to the time a system takes to recover from a disturbance (Pimm's, 1984) or as rate and speed of return to pre-existing and original conditions after disturbance (Holling and Gunderson, 2002). But, there is an unfortunate phenomenon on conceptual and practical development of resilience concept: ecosystem resilience is equal to engineering resilience ontologically and epistemologically and is mistakenly regarded as returning to original state and maintaining "status quo". Therefore, it is imperative to reconfirm the ontological aspect of ecosystem resilience concept. It is obvious that there are two essential attributes about ecosystem resilience: persistence and collapse. In Oxford Dictionaries (2015), persistence is defined as: 1) continuing firmly or obstinately in an opinion or course of action in spite of difficulty or opposition; 2) continuing to exist or occur over a prolonged period; 3) remaining within the environment for a long time after introduction; 4) remaining attached instead of falling off in the normal manner. By definition, "to continue when facing difficulties while still within critical threshold in long-time dimension" is the core meaning of persistence, which also signifies existence and even sustainability of SES. Thus, I assume that the ontology of ecosystem resilience concept is *the capacity and process of positive changes and changing the changes positively between persistence and collapse or between 0 and 1* (Strunz, 2012) *with or without external disturbances*. There is no doubt that change is the core philosophy and research object in resilience research and that the stage for change is system where change have been changed or is being changed. In next section, I will discuss resilience thinking that matches partially to the ontology of ecosystem resilience. To say, "partially match", there is still a need of distinguishing "ecosystem resilience-based resilience thinking" from "engineering resilience-based resilience thinking".

Resilience Thinking on "Bounce Forth"

Resilience thinking is based on a series of papers and books (Walker, *et al.*, 2004; Walker and Salt, 2006; Folke, 2006; Walker *et al.*, 2009; Folke *et al.*, 2010), especially the paper *Resilience Thinking: Integrating Resilience, Adaptability and Transformability*. The critical contributions of this paper are that: 1) ecosystem resilience is extended from ecological system into SES; 2) another new two concepts, adaptation and transformation are added as essential prerequisites for social-ecological resilience; 3) confusion between resilience and transformation is tactfully resolved by "multi-scalar and temporal resilience" perspective; 4) three aspects of SES is addressed: resilience as persistence, adaptability, transformability (Folke *et al.*, 2010). However, resilience and adaptations, implicitly or explicitly, understood as "maintenance", "recovering to the original state" or "business as usual" when applied.

Rather than doing a state of art literature review, I will identify two basic exemplary conceptual dimensions of resilience thinking, I call, social-ecological conservative resilience thinking and social-ecological positive resilience thinking (Table 1). As shown in Table 1, social-ecological conservative resilience thinking (*SE-CRT*) is featured as: *to buffer capacity for preserving what we have and recovering to where we have; all about absorbing shocks; survival and bounce-back ability and process; avoiding negative regime shift and keeping staying the "original" regime; adaptive resilience*, while social-ecological positive resilience thinking (*SE-PRT*) is as: *the ability to change, adapt, and importantly transform with or without external disturbance; the process to continually reinvent and innovate for doing new things and new possibilities with hope; not necessarily about absorbing shocks; bounce forward, to-forth and bounce beyond ability and process; to change and not to continue doing the same thing and to be stronger and better than before; positive and active regime shift with intentionality of human actions; transformative resilience*. Apparently, social-ecological positive resilience thinking takes root in ecosystem resilience; social-ecological conservative resilience thinking is rooted in engineering resilience. The reason why this conceptualization, social-ecological positive resilience thinking is employed, is that radical change process is accentuated in complex adaptive SES, not ecological system or social system. It emphasizes that SES as a unique system differs from ecological system and social system. Social-ecological positive resilience thinking as a weathervane can direct the development of interdisciplinary research when translating resilience thinking into, or integrating resilience thinking with other research fields. As Mcevory and Fünfgeld (2011) indicate, there are two prominent inconsistencies and alienations: to mostly concern with "staying the status quo", while to ignore transformation potential and process; to bound itself within "engineering resilience" which underlines "bouncing back to the previous stable state as soon as possible". Sustainability transformation is usually defined as "shifts that fundamentally alter human and environmental interactions and feedbacks (Olsson *et al.*, 2014)" or as "physical and/or qualitative changes in form, structure, or meaning-making (O'Brien and Sygna, 2013)" or as "the capacity to create untried beginnings from which to evolve a

fundamentally new way of living when existing ecological, economic, and social conditions make the current system untenable” (Westley *et al.*, 2011). Apparently, these above definitions of sustainability transformation match with social-ecological positive resilience thinking perfectly. But it is worth noting that social-ecological conservative resilience thinking and social-ecological positive resilience thinking is not completely opposite to each other. To some degree, social-ecological conservative resilience thinking only expresses naïve appeal and comfort. In other words, humans can chose to return and recover, but can not to the original one.

Table 1. Social-Ecological Conservative Resilience Thinking vs. Social-Ecological Positive Resilience Thinking

Social-Ecological Conservative Resilience Thinking	Social-Ecological Positive Resilience Thinking
<ul style="list-style-type: none"> • As buffer capacity for preserving what we have and recovering to where we have (Folke, <i>et al</i> 2010) • All about absorbing shocks • Survival and Bounce-Back ability and process (Shaw, 2012; Valikangas, 2010) • Resilience 1.0 (Hodgson, 2011) • Avoiding negative regime shift and keeping staying the “original” regime (Disturbances and shocks move SES into alternative undesirable regime within the same system or into another undesirable regime within different system.) • Conservative connotation • Adaptive resilience (Wilson, <i>et al.</i>, 2013; Robinson, 2010; Anthony, <i>et al</i> 2015; Nilakant, <i>et al.</i>, 2014; Cutter, <i>et al.</i>, 2008) 	<ul style="list-style-type: none"> • As the ability to change, adapt, and importantly transform with or without external disturbance and as the process to continually reinvent and innovate for doing new things and new possibilities with hope (Scheffer, 2009; Simmie and Martin, 2010; Folke, <i>et al</i> 2010) • Not necessarily about absorbing shocks • Bounce forward, to-forth and bounce beyond ability and process (Shaw, 2012; Leach, 2008) • Resilience 2.0 (Hodgson, 2011) • To change and not to continue doing the same thing and to be stronger and better than before (Seville, 2009) • Positive and active regime shift with intentionality of human actions (Hodgson, 2011) • Radical connotation • Transformative resilience (Hodgson, 2011; Gotham and Campanella, 2010) • Evolutionary resilience (Simmie and Martin, 2010)

Two Theoretical Pillars for Sustainability Transformation

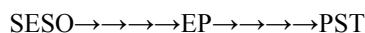
The two theoretical frameworks resolve two questions about sustainability transformation in SES: what transformative process is in SES and how transformative process happens in SES. I support Archer’s notion that before any methodology and explanation the ontology part should be addressed, and the consistence between ontology, epistemology and practice should be pursued.

Thus, I strive to develop the theory of sustainability transformation with the consistence of the tripartite connections and consistence between ontology, epistemology and practice. Archer (1995) delineates the structure of social theory as consistent three parts as follows (Fig.1). Based on this the theoretical structure of sustainability transformation in SES can be developed (Fig.2).



Social Ontology Explanatory Programme Practical Social Theory

Fig.1. Structure of social theory (Archer 1995, 20-6)



Social-Ecological System Ontology Explanatory Programme Practical Sustainability Transformation (complex realism) (What is sustainability transformation?)

How does sustainability transformation happen?)

Fig.2. Structure of the theory of sustainability transformation in Social-Ecological System (SES)

In the process of building the theory of sustainability transformation in SES, I advocate an overarching ontology, namely, complex realism that synthesizes critical realism as philosophical ontology with complexity theory as a scientific ontology (Reed and Harvey, 1992). I argue that SES as a critical concept in resilience framework, together with social system and ecological system are all complex adaptive system and they are all unique and different from each other. In other words, SES has independent ontology distinguishing from the ontology of social system and ecological system. Thus, SES can be as an object of scientific research. Social-Ecological System, SES, is first coined by (Berkes and Folke, 1998) because they did not want to treat the social or ecological dimension as a prefix, but rather give the two same weights during their analysis. Thus, transformative process doesn’t happen in the social or the ecological, but in SES. The three approaches: resilience thinking, transition approach and Archer’s realist theory of morphogenesis, resonate in harmony with each other which parallel complex realism, and their synthesis nature have an explanatory power to uncover generative mechanism for sustainability transformation in SES. Olsson, *et al.* (2014) argue that resilience theory and transition management, among others, as two promising conceptual frameworks provide basis for researching sustainability transformation. Before introducing Social-Ecological Transitional Resilience theoretical framework, I firstly will make some differences between resilience theory and resilience thinking, and between transition management and transition approach. I assume that resilience theory is positioned between descriptive resilience (including two conceptual dimension: ecological resilience and engineering resilience) and resilience thinking (including two conceptual dimension: social-ecological conservative resilience thinking and social-ecological positive resilience thinking) (Fig.3) and that theoretical foundation of sustainability transformation is nearer the end-point of resilience thinking, more specifically, is based on social-ecological positive resilience thinking dimension of resilience thinking. Thus, I call one of conceptual framework, resilience thinking, instead of resilience theory.

Regarding transition management, I use transition approach (Rotmans, 2005; Martens and Rotmans, 2005) instead of transition management. Transition approach focusing on persistent problems in societal system draw attention to a

gradual, continuous and fundamental process of structural change within a society or culture, instead of treating symptoms of those problems with marginal changes and adjustments (Frantzeskaki, 2011; Rotmans *et al.*, 2001); it is also featured as “transformative change, meaning irreversible racial change that takes a long-term to materialize (Frantzeskaki, 2011)”, which coincides with the ontology of ecosystem resilience and social-ecological positive resilience thinking.

transformability. It means that a new concept is needed and this new concept can locate itself in the same conceptual level as transformability and adaptability; 3) it remains in vague about agency itself, interaction between agency and structure as this is a critical topic in social science. Drawing on this, I propose theoretical framework for studying what transformative process is in SES, centered on resilience: resilience as adaptation, as transformation and as transition (Fig.4).

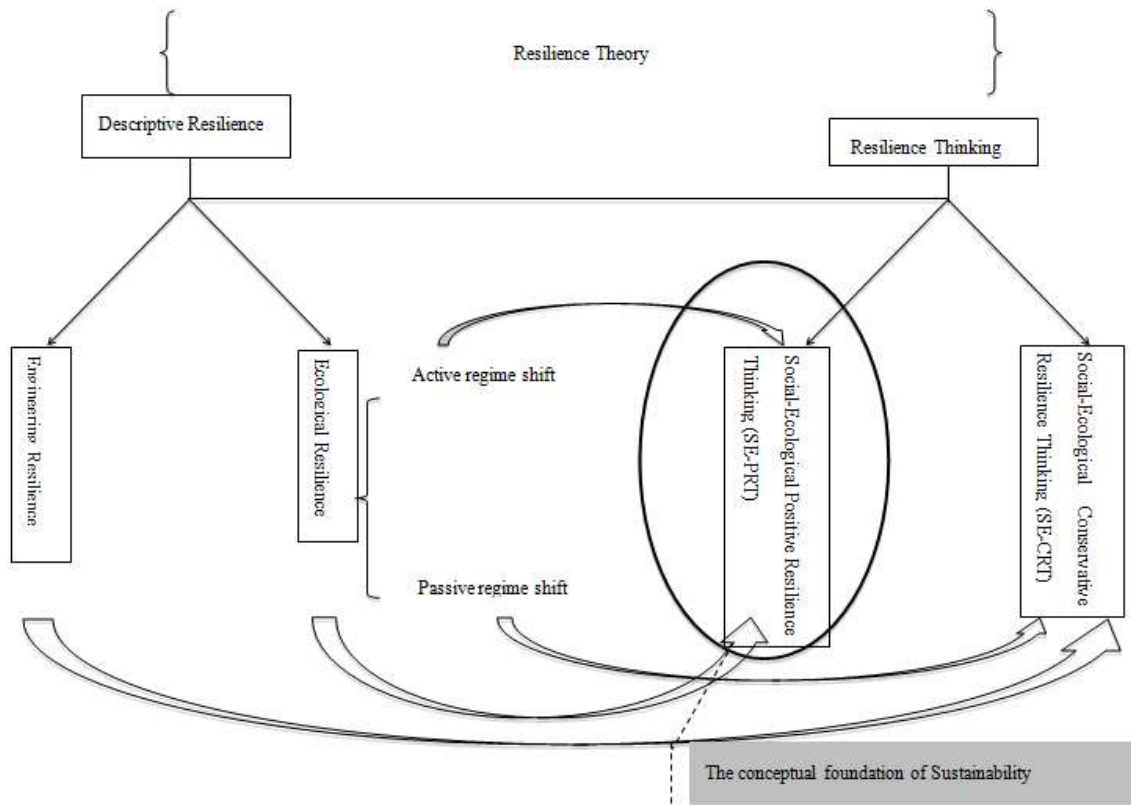


Fig.3. Conceptualization of resilience theory

Synthesis

Hatt (2013) argues that there are two uncomfortable mistakes when applying resilience thinking in SES: when translating resilience thinking into social system, resilience thinking is ironically based itself on structural functionalism theory that is determined by the assumption of social system committing itself to equilibrium and “status quo”, which is strikingly in conflict with the ontology of resilience thinking positioning itself as adaptive equilibrium rather than mechanical equilibrium; given that resilience thinking is obsessed with systematical level, there is no room for human agency. Hence, a new picture comes when integrating resilience thinking with transition research: transition approach offers human agency for resilience thinking and removes the ontological contraction indicated by Hatt (2013). But, there are still three problematical issues in resilience thinking theoretical framework (Folke *et al.*, 2010): 1) to large degree, resilience thinking, that is, resilience as adaptability, as transformability and as persistence is too much concerned with capacity, and process is implicitly ignored; 2) the concept, persistence, is not as the same conceptual level as the other concepts, adaptability and

The reason why this framework centered on resilience is that what resilience thinking counts is SES dynamics and interactions, and “reconnecting to the biosphere” (Folke *et al.*, 2011; Berkes and Folke 1998). Thus, the significance of sustainability transformation in SES is that it not only transforms the social but also the ecological through positive changes, or “transformative process generates further transformative process.” As a new conceptual level, transition, is not simply added along with adaptation and transformation, its true connotation consists in, on the one hand, producing new emergent relation between and among adaptation and transformation, on the other hand, making SES not continue developing within current stability domain or basin of attraction, that is, adaptation (Berkes *et al.*, 2003), but shift to an alternative regime in the same SES, I call this transformative process, *adaptive transition*, or “jump” to a new kind of basin in a new SES (Walker *et al.*, 2004), I call it as transformative process as *transformative transition*. Here, these two transformative processes, *adaptive transition* and *transformative transition*, are emergent systematic process

initiated by “change agents”. How do these two transformative processes perform in SES? I will synthesize this framework with Archer's realist theory of morphogenesis into a new theoretical framework (Fig.6), so as to study these two processes onto SES.

Why is Archer's realist theory of morphogenesis? Archer's realist theory of morphogenesis is consistent with the ontology of resilience thinking and transition approach; Archer's realist theory of morphogenesis (Fig.5) maintains an analytical distinction between structure and agency, but separated ontologically (Porpora, 2013).

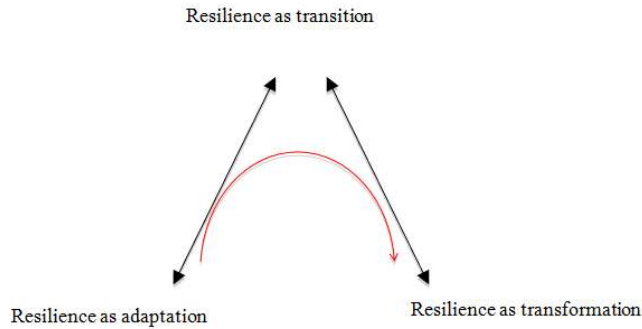


Fig.4. Social-Ecological Transitional Resilience

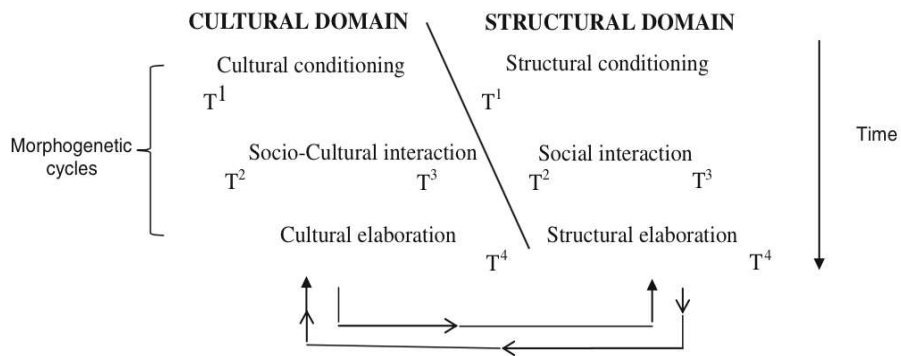


Fig. 5. Morphogenesis with structure and culture together, From Archer (1995)

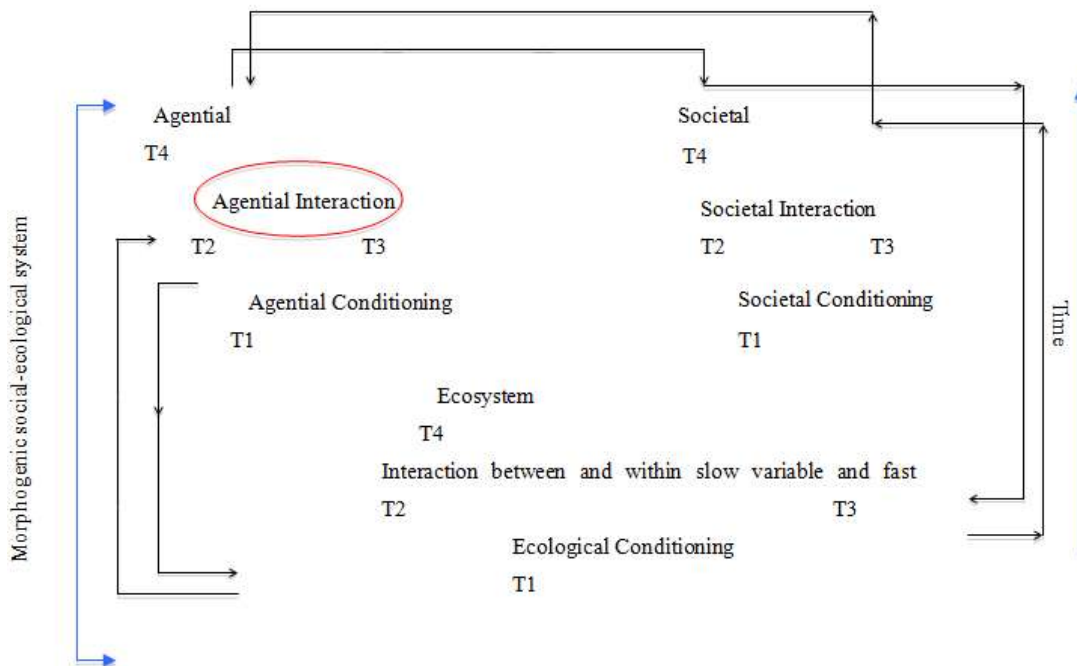


Fig. 6. Morphogenetic Social-Ecological System Framework

This analytical distinction liberates “change agent” from structure, which resonates with my proposition that every transformative change starts from “change agent”(Fig.6); in recent book, *Social Morphogenesis*, edited by Archer (2013), morphogenetic society as a theory is proposed, and it intends to re-explore the morphogenetic approach as a meta-theory to a theoretical conception. The theoretical framework, Morphogenetic Social-Ecological System Framework (MSES), is inspired by both of social morphogenesis and the morphogenetic approach. MSES comprises three conceptual entities that are interconnected causally, but separated ontologically: the agential, the societal and the ecological. Three emergent levels: conditioning, interaction and elaboration, constitute each of these three entities, respectively. Here, I synthesize the cultural domain and structural domain (Archer, 1995) as the societal domain.

The societal domain is the emergent outcome between/among the cultural domain and the structural domain, which means that the cultural domain and the structural domain still maintain analytical distinction. Moreover, time dimension plays an important part in MSES as the mismatches between the social dynamic and ecosystem dynamics that intimidate to push life-supporting ecosystems over critical thresholds into more degraded, less productive regimes to which resilience scholars also pay great attention (Olsson *et al.*, 2014). Thus the temporal dimension in MSES accentuates consistency of the social and the ecological when transformative process happen. In MSES, the ecological domain explicitly highlights interaction between and within slow variable and fast variable, these concepts of which originate from ecosystem resilience theory. As argued by Walker *et al.* (2012), it is critical to take into account the interaction between and within “slow variables”, “fast variables” and external drivers in order to successfully steer SES in a desired direction. In MSES, every transformative change starts from agential interaction. More importantly, every transformative change must involve ecological elaboration, to this point, which is different from resilience thinking, and transition approach, both of which exclusively focus on the social or the ecological. A whole morphogenesis process in SES means the realization of agential elaboration, societal elaboration and ecosystem elaboration simultaneously, three of which are as emergent entities respectively. As shown in this framework, I can deduce many morphogenetic cycles, among which there are two prototypic cycles. One is *the agential—the ecological cycle*.

In this cycle, every agential interaction is constrained by agential conditioning, societal conditioning and ecological conditioning. The outcome of this cycle is the realization of both of agential elaboration and ecological elaboration by transformative transition process or either of them by adaptive transition process; another cycle is *the agential elaboration—the societal elaboration—the ecological elaboration*. This process finishes a complete cycle. In this cycle, three of them achieve elaboration through transformative transition process or two of them realize elaboration through adaptive transition process. MSES provides a good theoretical start for further discovering underlining generative mechanisms of transformative process towards sustainability.

Conclusion

In this paper, I aim to go beyond disciplinary limits with the ambition to develop a theory on social-ecological transformation to sustainability. Theory is always in work-in-progress. At least, I have already taken the first step on the journey towards that wonderful future.

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