Resilience of Urban-Rural Systems

Subjects: Management
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The urban-rural systems were defined as a complex dynamic social-ecological system based on resilience thinking and transition theory. The notions of adaptation and transformation were applied to compose a framework to coordinate “resilience” with “sustainability”.

Resilience thinking may contribute a system approach to the study by acknowledging URSs as complex dynamic social-ecological systems (SESs) with human-nature dynamics evolving cross multiple scales over time. Resilience depicts the capacity of complex URSs to absorb disturbance, adapt to changing conditions and withstand within the current regime, and cross the threshold into new development trajectories and fundamentally improved state in response to unforeseeable crises and enforced interventions. Linking it to transition theory (pp. 111–114) may help understand how the URSs evolution of technical, economic, social-cultural, and ecological dynamics bring about change towards sustainable development.

Keywords: social-ecological systems ; transformation ; adaption and mitigation

1. Abstract

Urban regeneration and rural revitalization are becoming major policy initiatives in China, which requires new approaches for sustainability transitions. The urban-rural systems can be defined as a complex dynamic social-ecological system based on resilience thinking and transition theory. The notions of adaptation and transformation can be applied to compose a framework to coordinate “resilience” with “sustainability”. The sustainability transitions have been challenged by controversial institutional arrangements, concerning population mobility control, unequal social welfare, and incomplete property rights. A series of policy interventions should be designed and implemented accordingly with joint efforts of multiple stakeholders and based on the combined technocratic and bottom-up knowledge derived from proactive and conscious individuals and collectives through context-dependent social networks.

2. History

Urbanization depicts the movement of rural population to urban areas, the increase of urban population, and the adaptation of rural population toward an urban lifestyle. The resultant socio-economic and bio-physical changes provide opportunities and challenges to sustainability. In China, urbanization has its characteristics and unique pathway with the rapid growth of the national economy, rural to urban migration, city numbers and urban areas [6][7]. For the last four decades, urbanization level and the number of cities in China have increased by 42% and 479, respectively. Starting from less than 20% in 1978, the urbanisation level exceeded the 50% threshold in 2012 (See Appendix A) and will reach more than 75% in 2050 [8][9][10]. Such rapid urbanization has involved a set of state actions on policy reforms and institutional changes about development strategies and factor markets such as land, labour, and capital [7][11]. Reform and change occur when the benefits exceed the costs of changing government rules and processes [12][13]. Thus, revisiting the policy reforms and institutional changes over time is vital to understand China’s urbanization and explore sustainable solutions.

By reviewing previous studies, this paper attempts to investigate the change in state policies and institutions about urban-rural development, environmental conservation, land management, labour use, science and technology, and economic activities and financial strategies along with the process of urbanization since 1949. It is hypothesized that the implemented policy reforms and institutional changes generated both desirable and undesirable outcomes. The failure of establishing institutions and markets (e.g., uncertain property rights) derive undesirable outcomes (e.g., increased transaction costs and negative externalities of public goods) which may challenge China’s urbanization. Efforts are hence required to define urban-rural systems (URSs) as a complex coupled system, to clarify the system components and dynamics of China’s urbanization, and to provide instrumental approaches and implications for sustainability transitions.

3. Data, Model, Applications and Influences

3.1. Resilience of Urban-Rural Systems

3.1.1. Rationale of Resilience Thinking

Resilience is the capacity of a system to retain its usual function, structure, identity, and feedbacks after undergoing change, absorbing disturbance, and reorganising behaviour [1][2]. Urban and rural systems (URSs) are hence treated as coupled SESs with human-nature dynamics evolving cross multiple scales over time. As shown in Figure 1, absorption leads to persistence of the status quo through the capacity to take intentional protective action and strategies to cope with unknown shocks and stress instead of reducing future shocks and stress; adaptation refers to incremental adjustments and better management within the current regime in response to changing conditions, increasing system stability while reducing future shocks and stress, and; transformation instigates fundamental changes in the nature of a system to address the underlying failures of development or imbalances, which is about the capacity to cross the threshold into new development trajectories [2][14][15][16][17]. Within this conceptualization, system feedbacks are emphasized as they determine and underpin the changing conditions, trajectories, and interactions across scales while feedbacking to and refining the intervention for desired effects and outcomes in the future [17][18].

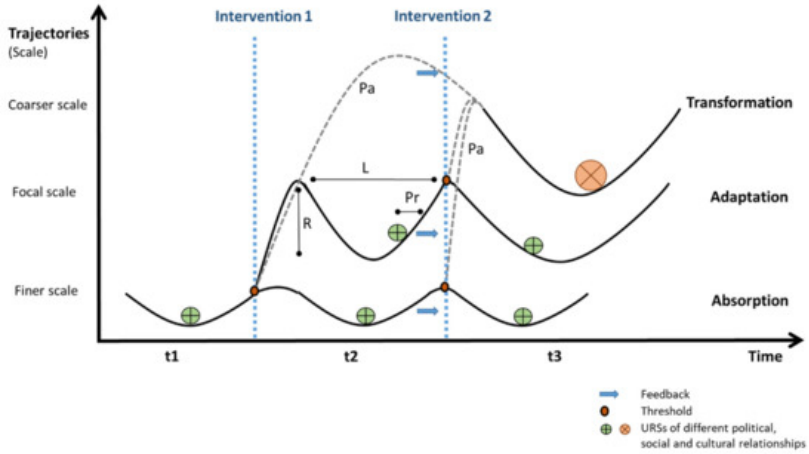

Figure 1. Resilience building of urban-rural systems (URSs) during the transition (adapted from [2][19][20]). Note: the dashed line in grey means alternative trajectories. Latitude (L) is the maximum change of a system before evolving or collapse; resistance (R) refers to the difficulty of a system to be changed; precariousness (Pr) means the distance of the current state of a system to an evolving or collapsing threshold, and; panarchy (Pa) depicts the cross-scale interaction among URSs [2].

Divergent URSs evolve in different development trajectories (i.e., absorption, adaptation, and transformation), with each having unique functions, structures, identities, and feedbacks over time (from t1 to t3). This can link resilience thinking to transition theory [4] (pp. 111–114). By looking at URSs transition from a multi-level perspective, notions of absorption, adaptation and transformation help investigate the human-nature interactions across scales [21]. The focal scale refers to understanding the current state, actions, strategies and functions of URSs at a meso level; the finer scale means a deep understanding of URSs patterns, components and dynamics at a micro level, and; the coarser scale represents the dynamics and interactions operating at URSs or cultural, economic and political subsystems at a macro level [22]. The understanding of the URSs transition processes with relevant concepts (e.g., livelihood resource, path dependency, and social memory) can define system function, structure, identity, and feedbacks while linking past pathways with current challenges and presaging future transitional processes. In any given transition, thresholds indicate the key stages and the starting point for the next transition [23]. When disruptive change and system transformation get involved, it is also vital to identify leverage points [24] which are places in URSs' structure where a solution element and innovations can be applied to strengthen or reset identity, navigate feedbacks, and improve functions. By applying system thinking and focusing on the dynamics and drivers of change, the URS framework and concepts may support the building of urban-rural resilience and the formation of innovation, policies, and management towards sustainable transitions.

3.1.2. Adaptation and Transformation as the Key to Sustainability Transitions

Based on the resilience thinking, coupled URSs are defined for a comprehensive understanding and planning. The Dual Sector Model theory [25] indicates that a developing economy like China has been undertaking the labour transition between the traditional agricultural sector and the modern industrial sector during its urbanization process. Thus, the system needs to build resilience towards sustainability transitions (Figure 2) through its ***adaptive capacities*** such as

learning to live with change and uncertainty (e.g., alteration), nurturing diversity for self-reorganization and self-renewal (e.g., diversification), combining knowledge for learning and experimenting (e.g., intensification), and creating outside opportunities for problem-solving (e.g., non-farm labouring and upscaling) [19][26]. On one hand, it may absorb the surplus-labour and other kinds of resources, promote industrialization, and stimulate sustained urban-rural development. On the other hand, the failure of the adaptation may 'trap' the vulnerable or poor people, increase domestic-public dichotomy, and generate socio-economic inequality. When the system got locked in a trap, adaptive management could be helpless [14][27][28]. For instance, rapid population growth, industrialization, and shifts to urban lifestyles and consumer demands have led to an ever-increasing demand for water resources in Beijing who relies on nonlocal ecosystem services and non-ecosystem-based production [29]. In such a case, external and internal stresses and disturbance would offset the desired effects and outcomes of intervention approaches, such as spatial upscaling of resource use. It would then need to build system resilience through ***transformative capacity*** that alters societal functioning and avoid system collapse and crisis [2][3][16][30]. Transformation may react slowly as an accumulation of incremental adaptations [31], or take place rapidly with substantial innovations in technology and fundamental changes [32][33]. In the process of transformation, leverage points are vital to apply innovations and fundamental changes to transform the system, navigate feedbacks, and correct loops [24].

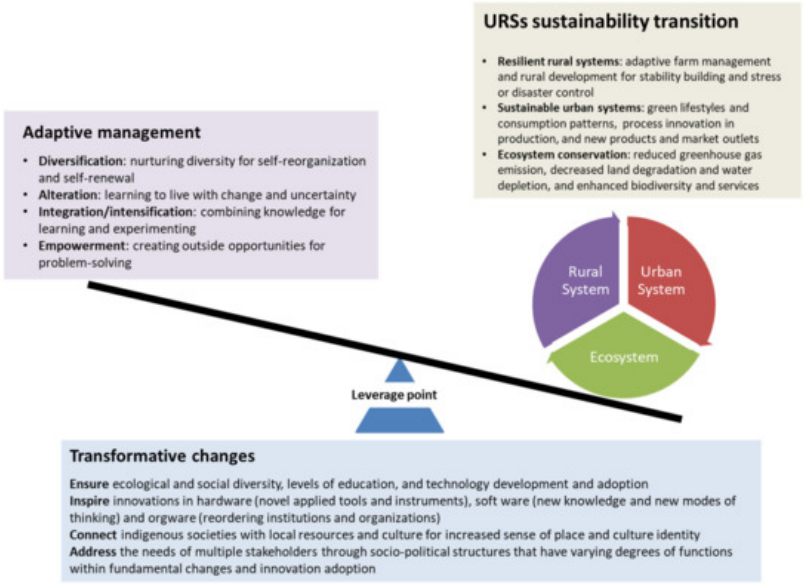

Figure 2. URSs' adaptation to changes and their transformation towards sustainability.

From an evolutionary perspective, innovations are successful novelties of hardware (applied tools and instruments) with software (knowledge and thinking) and orgware (institutions and organizations) which compete in a dynamic selection environment [34][35]. As defined by Freeman and Perez [36], incremental innovations occur continuously as 'learning by doing' outcomes of users' inventions and improvements; radical or disruptive innovations are discontinuous inventions that replace the existing design, process or system with something entirely new; technological innovations are far-reaching changes and improvements in technology creating a new range of products and services affecting more than one branches of the system, and; technological revolutions are a combination of technological innovations which can affect the behaviour and structure of the entire system [22]. Technology development and adoption are the sources of innovations which is the subset of the system that generate novelties and create new social relationships [37]. Definitions and identifications of various novelties and their associated innovations within URSs may help understand social technological motivations and develop pathways towards sustainability.

Referring to transition theory [4] (pp. 111–114)fundamental changes for transformation appear in system identify, structure, functions, and feedback within a given period. System identity is defined by key components (e.g., objects, agents, entities) that make up the system, the relationships or networks between components that describe how system components interact or fit together, and their continuity to maintain stable through space and time [37][38][39]. Hence, *system identity* is the essential element to understand URSs resilience and their drivers and barriers, dynamics of innovation and interactions, and potential alternative sustainability pathways. Identity can be quantitatively defined to the boundaries (or thresholds) of a stability domain of attraction [1], which may involve qualitative changes based on human interests and values. In URSs, human identity and cultural identity need particular attention to how people understand who they are, their role in society, their relation to the environment, and their feeling of belonging to a group [40][41]. Sense of place that is represented by place attachment [42] and place identity [43] and place meanings [44], convey connections between people, place and nature [45][46][47]. It helps understand identity in adaptation and transformation, in addition to

innovation, memory (e.g., elderly people and socio-biological legacies), self-organization (i.e., the formation of patterns due to social-ecological interactions) [37][48]. Moreover, the indigenous societies in URSs are embedded into local ecosystems and their relationships with local resources have shaped the system identity, agent, culture, governance institutions, and interactions [49]. Thus, an analysis of *system structure* through actors (e.g., civil society and NGOs), institutions (e.g., rules, laws, customs and routines), interactions (e.g., networks) and infrastructure (e.g., machines, subsidies and knowledge) [50], may provide insight into the drivers and barriers for URSs' innovations and fundamental changes. This can be further promoted by analysing *system functions* that contribute to systemic development and innovation adoption through entrepreneurial activities (e.g., commercial projects), knowledge development (e.g., studies and laboratory trials), knowledge diffusion and exchange (e.g., conferences and workshops), policy guidance, market formation and selection (e.g., tax and subsidy), resource mobilisation (e.g., investments), support from advocacy coalitions (e.g., lobbies) [22][51]. The URSs functions may be qualitative and/or quantitative depending on the nature and quantity of identity components and system structure that contribute to the function. Changes in the function may reinforce (positive feedback) or modify (negative feedback) subsequent interventions and behaviour. Therefore, a systematic understanding and clarification of the fundamental changes in system identity, structure, functions, and feedback may facilitate transition management towards sustainability.

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