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The role of knowledge in climate transition and transformation literatures

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Abstract

Rooted in different theories and focusing on different elements of the socio-ecological fabric, climate transitions and transformations are conceived to have various forms. Although these literatures recognize the significance of learning and boundary spanning, systematic reviews of the role of knowledge in climate transitions are lacking. We review how targets of transformation, functions, types, and intermediaries of knowledge are conceptualized in five types of literature. We highlight that knowledge has a role as: the \textit{motor} of transition in Transition Management literature, a \textit{consultant} supporting transition in Transformational Climate Adaptation literature, an \textit{emancipator} of transition in Transform Political and Economic Systems literature, the \textit{beacon} guiding transition in Social-Ecological Transformation literature, and an \textit{Ad Hoc Committee} motivating transition in Grassroots Transitions literature.

Introduction

As humanity struggles to reduce greenhouse gas emissions, scholars have argued that incremental change of current infrastructure, institutions and economic systems is insufficient to mitigate climate change and adapt to anticipated future impacts [1-2]. Instead, profound transformative change is necessary [3-4]. Different literatures conceptualise processes of transformation and transition [5-11] with variations influenced by theoretical origins and the element of the socio-ecological fabric in focus [8]. Both the transformation and transition literatures acknowledge cities as seedbeds for local innovation niches [5,12-15] and city
governments are increasingly viewed as purposeful actors in socio-technical transitions [16], although the degree of this purposefulness is debated [17-19].

Recent studies examine if various functions and processes in cities demand different types and roles of knowledge to address climate change [5-7]. We see climate transitions as “processes in which both the technical and social parts of the system transform in order to tackle climate change” [20:1239] and review five literatures that have frequently been used in studies of cities and climate change. The reviewed literatures are: transition management (TM) [4,9,19,21], transformational climate adaptation (TCA) [22-27], transform political and economic systems (TPE) [3,7,28-29], social-ecological transformations (SET) [6,30-33], and grassroots transitions (GT) [14,35-38]. In general, some of these studies use the transformation and transition concepts interchangeably, whereas others refer to transition as incremental changes and transformation as fundamental change [28]. As both concepts are used in the different literatures and this review addresses the role of knowledge in different literatures, we have decided to retain the terms preferred by the different scholars when conducting our analysis.

Even if the significance of learning [39] and boundary spanning [28,34] are increasingly recognised in the five literatures, only [8] elaborates on transformation and research approaches. The author Feola (2015) distinguishes between descriptive-analytical approaches where knowledge primarily informs policy-making, and solutions-oriented approaches in which research is more actively engaged in the deliberations [8]. Our review expands these findings by assessing how target of transformation, types, functions, and intermediaries of knowledge are conceptualized in the five literatures. This article is thus timely and informs debates on boundary spanning and co-design in transition governance.

In this review, we propose that four dimensions shape the role of knowledge in the five literatures (Table 1). These four dimensions are subsequently used to derive an overall characterization of the role knowledge in each of the five literatures. Firstly, target of transformation [9], concerns its teleology, i.e. the normative goal. Target knowledge has often been inadequately addressed [10], obscuring knowledge production [40] and the question of who has access to and is included in deciding the target [4,6]. Secondly, function of knowledge, concerns how knowledge engages in decision-making towards transition; stretching from a traditional “speaking truth to power”-logic where research is used hierarchically top-down to inform local government, to research and governance being co-produced by researchers and
local stakeholders from the bottom-up [41-42]. Thirdly, *types of knowledge*, distinguishes between: target knowledge, systems knowledge, experimenting knowledge, and process knowledge. Target knowledge entails how the normative goal is derived [9,10]. Systems knowledge concerns a well-grounded comprehension of the societal problem [9] including in-depth understanding of the city [17] transcending spatial, temporal and institutional scales [10,13,25] and complexity and uncertainty [10] ([15] questions whether we can “know” the city through measurements). Experimenting knowledge concerns nurturing innovations [6], experimentation [20,43] and learning from them [15,19,37]. Process knowledge involves organizing and running the transition process [10]. Fourthly, *knowledge intermediaries*, concerns knowledge brokerage including actors [44] with insights into “different social worlds” [45], arrangements [34], organizations [46], or objects [10,47] unifying knowledge production among a range of stakeholders.

[Insert table 1 about here.]

**Transition Management**

TM concerns the facilitation and acceleration of sustainability transitions based on structured, yet flexible, participatory processes involving multiple levels of government and diverse experimentation [4,6,9,21]. TM has been employed to assess the practical complexities cities face when confronting urban transitions [5,21]. Aspiring to make sustainability transitions operational and governable, TM describes how actor-based processes that trigger transitions are built [1,34,21,48-49]. Although sustainability is the agreed target in TM, there is no consensus on how it should be assessed [9] (e.g. some authors suggest different varieties of sustainability criteria [9] or comparison with implementation of Local Agenda 21 [4]). One form of approach in TM is Urban Transition Labs (UTL) signifying “the metaphor for a deliberate and identifiable process of systematic change towards sustainability” [19:113,15]. UTL is inspired by the urban living labs concept with which it shares emphasis on systems, establishing a vision, experimenting and process knowledge [50] but adds empirization through measurement-capacity [15].

In TM the function of knowledge is comprehensive and co-produced [10,15,19,50-51]. Knowledge is primarily developed by stakeholders co-creating a vision and working towards it [21,49]. This requires all types of knowledge (systems, target, experimenting and process) [19,49] some of which are external to local governments. Knowledge production in TM is
consensus-seeking [10] although not necessarily democratic [15,19,21,49] or straightforward [10,19]. TM can, though, empower groups by translating system knowledge into the transition process [9]. Experiments are designed to overcome local bottlenecks, often addressing new modes of governance; providing time for learning, reflection and development of alternative solutions is essential [1,4,15,20-21,49,51]. Process knowledge is vital since TM requires formation of a transition team, which co-designs and supplies information to the transition process [19,51]. Process knowledge can be enhanced by incorporating initiative-based learning [10]. For TM and UTL, researchers are central actors [15,19,49]. Knowledge in TM is primarily developed bottom-up, and facilitated by a cyclical process, where experiences from designing, using and evaluating the responses inform a subsequent loop of problem-structuring [15,21].

**Transformational climate adaptation**

The TCA literature presumes that dramatic climate impacts force societies to transform, not just adapt [22-23]. Accordingly, the target of TCA is to build climate-proof cities by changing the climate damage-response system [24]. TCA studies devote substantial attention to advances in climate science [23-24]. Access to climate knowledge is critical when building knowledge and thus shapes the perceptions of participating individuals [24]. Climate impacts are presented as key departures in TCA, giving climate science a prominent function in problem-framing and, subsequently, for providing local actors with adequate decision support to identify necessary measures. More detailed climate scenarios are assigned significance for target knowledge because of the weight assigned to climate change vis-à-vis other societal goals. TCA thus feeds climate science into urban planning practices through a classic top-down process in which scientific knowledge informs policy and supports urban transitions [26]. Systems knowledge in TCA is often derived from a sectoral or a systems perspective [24], e.g. agriculture [27], flood management [25], and overall economic development [26]. Experimenting knowledge concerns overcoming limits to adaptation [24,26] with transformational adaptation measures [23-25] the main means. Measures are usually technological or behavioural, emphasizing their novelty, scale and/or intensity [23]. Building “local climate expertise” for transition is key to deciding about adaptation measures. Climate scenarios, impact assessments and concrete adaptation measures act as knowledge intermediaries.

**Transform political and economic systems**

The TPE literature emphasizes the political dimension of transformation [3,7,28-29]. The literature thus sheds light on inequality and power relations shaping and maintaining
vulnerability to climate change. “Seeking to address underlying failures of development” [28:114], transformation is seen as one pathway, alongside resistance and incremental adjustments, for climate adaptation. The TPE literature points beyond current political, economic and social systems and explicitly acknowledges different transformational spheres: practical, political and personal [7] or activity spheres: behavior, environment, institutions, individuals, technology, livelihoods and discourse, recognizing that transformation can be seen from very different perspectives [28]. This widens the policy options available to respond to climate change and thus inspires human agency and creativity [7]. Knowledge on drivers of social and political change is important and may be engaged to analyze and depict features of the transformed system. Target knowledge is both social justice and sustainable development, recognizing the need to balance immediate needs and risks with long-term [28]. Experiments primarily concern root causes of climate vulnerability and may entail all activity spheres, meaning “transformation acts as a boundary object” [28:124]. Process knowledge rests on inviting and engaging a diverse range of actors [28-29]. For example, development NGOs addressing empowerment of vulnerable groups can act as an intermediary by opening up new political spaces and improving local livelihoods.

Social-ecological transformations

The SET literature addresses urban transformation to re-orient the social-ecological system [6,30]. In essence, SET regards the city as part of its wider environment, making it vital to apply ecosystem services or ecosystem-based perspectives to keep the city within ecological limits [31]. SET presumes that a shift to a new configuration of the socio-ecological system is needed, which signifies the target of SET [6,31-32] and is illustrated by the adaptive cycle framework [33]. Institutional entrepreneurs often initiate transitions by disturbing the status quo using messages of environmental shock [32]. This destabilizes stable systems and releases resources required for experimentation [32-33]. SET gives prominence to social-ecological knowledge in a similar way as for climate knowledge in TCA. Knowledge from several disciplines should be assimilated based on its contribution towards the re-oriented worldview. Systems knowledge is thus primarily built by “local social-ecological expertise” needed to strengthen resilience and nurture the new worldview. Experimenting knowledge is central and acts as a knowledge intermediary, with social-ecologically-determined experiments aiming to make the ecological context more transparent to actors [32], which is rare in urban transition projects [20]. Starting from social-ecological experiments is an explorative, bottom-up process where action-oriented research is requested. In contrast, the application of ecosystem services in order to assess local
social-ecological limits is top-down. SET includes institutionalization of the social-ecological experiments, involving exploitation, accumulation and scaling-up. Support is mobilized to build the resilience of the new ecosystem stewardship-compatible system. Process knowledge is not explicit.

**Grassroots transitions**

Grassroots transitions are often initiated and driven by civil society actors as community-based initiatives [14,35-38], such as the Transition Town [11] or Ecovillage movements [35], or by transitional entrepreneurs [38]. The target of GT is to enhance the community’s social economy [14,35,37]. Because GT is place-based and small-scale it can be described as a niche that may diffuse by replication, scaling-up, or niche-to-regime translation [35]. Knowledge is determined by local availability, as is the interpretation of sustainable development. Target knowledge does thus not explicitly consider sustainability; rather the GT establishes its own goals [35-36]. There are few systematic assessments of experiences gained from GT [35-36]. Cross-case comparisons found that already existing purposeful sustainability transition initiatives and salience to sustainable development goals are important for starting-up a GT [36-37]. This raises concerns for the applicability of GT in places lacking such initiatives. Systems knowledge is assembled by the experiences from the actors participating in the initiative, and does not necessarily involve scientific knowledge. Experimenting knowledge primarily concerns social innovation to enhance the local social economy but there are also social-ecological experiments [35]. Concrete action/activity is essential [35-38] and the ability to demonstrate success is important and works as knowledge intermediary. Process knowledge is essential, partly as GT initiatives often resulted in improved processes rather than completely new activities, and also because the process is the primary deliverer of activities [36]. Through the process, actors are enrolled and organized and proposals developed. A tendency to deliver marginal improvement raises concerns about the transformative potential of GT [36] while effectiveness in changing behaviour and larger social acceptance point in the opposite direction [11].

**Conclusions**

This paper set out to clarify the role of knowledge production in transition processes through a review of how targets of transformation, functions, types, and intermediaries of knowledge are conceptualized in the TM, TCA, TPE, SET, and GT literatures. We demonstrate that the role of knowledge varies in these literatures. Even if sustainability is generally considered to be the
target in all five literatures, we concur with previous observations that sustainability criteria are seldom applied [10,39] yet recognize recent attempts to incorporate sustainability assessments [37]. Rather, sustainability is either derived from what is considered to be locally appropriate (as in TM and GT), from a specific scientific perspective (as in TCA and SET) or a combination thereof (as in TPE). In all cases, evaluation in relation to more generally applicable criteria is required to clarify the target and the process to achieve it.

Addressing target, system, experimenting and process types of knowledge, we found very different mixtures in the five literatures. Knowledge is comprehensive in TM, involving measurement and evaluation of the system from many angles, experimenting with new forms of governance, facilitating the co-production process and its primary outcome – the common future vision. Many scientific disciplines are essential and integration becomes necessary but will require considerable effort [9-10]. We see several recent attempts of integration [5,7,9-10]. We suggest knowledge has a role as the motor in urban transition towards sustainability [see 48]. In contrast, the theoretical points of departure of TCA and SET shape the role of knowledge and, consequently, what will qualify as systems knowledge. In TPE knowledge intends to widen system boundaries to include social and political organisation and the individual and cultural sphere. Neither TCA nor SET explicitly addresses process knowledge. In TCA experimentation is applied to select adaptation measures and, consequently, it is essential to establish what exactly the city should be protected from, with knowledge depicted as a consultant offering services for urban transition. In SET experimentation is about eye-opening, providing knowledge that needs to induce higher-order learning for a transition to occur. Eye-opening enables societal actors to understand the local social-ecological limits and re-orient their worldviews and, consequently, knowledge has a role as a beacon guiding urban transition. Likewise, the role of knowledge in TPE is also to widen the options available to respond to climate change; emphasising root-causes and structural change, knowledge works as an emancipator that catalyses action. In GT, process knowledge drives the outcome of the transition process, i.e. the practical demonstration of activity. Experimentation is mostly about the local social economy. Systems knowledge is assembled by the local participants and informed by what is locally available. Knowledge in GT functions as an ad hoc committee for urban transition towards sustainability.

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References and recommended reading
Papers of particular interest, published within the period of the review, have been highlighted as:
- of special interest
- •• of outstanding interest


This article empirically analyses the synergies and tradeoffs between mitigation, adaptation and sustainability in Canadian cities. The paper suggests that pursuing an integrated sustainability strategy has higher transformative potential than a narrow focus on climate change.


This article reviews the normative orientation, interdisciplinary orientation, theories and methods applied of sustainability transition research. The paper finds four research epistemologies: transforming urban metabolisms, configuring urban innovation systems, improving adaptive capacity of communities and ecosystems, and empowering grassroots niches. It suggests more research into agency across systems and drivers of change, and conceptualizes cities as places shaped by and shaping interactions between multiple socio-technical and social-ecological systems.

This paper advocates bridging sustainability transitions and social-ecological transformation approaches in order to establish new scientific capacity that is able to support large-scale social-ecological transformations. The authors propose a Safe Space approach with five guiding principles: emancipation, ensuring reflexivity, knowledge co-creation, transformative learning, and nurturing innovation.


This article discusses Transition Management (TM) and argues for a more comprehensive conceptual basis able to produce systems, targets and transformative knowledge. Moreover, it suggests adding descriptive practice theory and a normative and individualistic capability approach to TM.


This paper proposes linking quantitative systems modeling, socio-technical transition analysis and initiative-based learning. It is argued this will enable more robust analysis of sustainable transitions pathways by overcoming five analytical challenges. The authors suggest a strategy based on alignment and iteration contending that a structured dialogue between these three approaches is needed.


17. Hodson M, Marvin S: *Can cities shape socio-technical transitions and how should we know if they were?* *Res Pol* 2010, **39**:477-483.


19. Nevens F; Roorda C: *A climate of change: A transition approach for climate neutrality in the city of Ghent (Belgium)*. *Sustain Cities Soc* 2014, **10**:112-121 http://dx.doi.org/10.1016/j.scs.2013.06.001.

This paper reports findings from an Urban Transition Lab-inspired process in the city of Ghent, Belgium. It describes stages of preparing and exploring, problem-structuring and envisioning, back casting, experimenting, and monitoring and embedding. The paper finds that the forerunners developed a necessary system thinking mind-set and a sense of co-creation. Further, time for action and reflection, willingness to re-consider actors and their roles, and creation of a comfort zone for radical experimenting were critical conditions for success.


Expanding adaptation to include transformation raises issues of power and preference. The paper modifies Harvey’s notion of activity space to derive a framework and research questions for climate change adaptation. Decision-making is situated within seven co-evolving sites: individual, technology, livelihoods, discourse, behavior, environment and institutions. The framework is reviewed by the non-governmental organization Save the Children.


This paper presents results from a cross-case analysis of grassroots transition initiatives in four UK communities. The study suggests a set of success factors including socio-demographics, community governance, community capacity, organization, resources and mobilization. The factors are intended to form a basis for successive build-up through further studies.


Table 1. Targets of transformation, and the functions, types and intermediaries of knowledge in five transition literatures. Targets of transformation concerns the normative goal of the transformation or transition. Functions of knowledge characterises how knowledge is engaged in decision-making. Types of knowledge illustrates if the literature recognises knowledge of the system under study, the target, i.e. how the normative goal is derived, if experiments uncovers kind of innovations the literature suggest, whether process knowledge concerns how the transition process is organized and run.

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<th>Literatures</th>
<th>Targets of transformation</th>
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