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Lost in translation: Translating low carbon experiments into new spatial contexts viewed through the mobile-transitions lens

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ABSTRACT

Low carbon urban transition experiments are emerging across cities globally. These experiments are socio-technical innovations with a high potential to contribute to a low carbon. Through the Global Intelligence Corps knowledge of these experiments is being disseminated across a variety of spatial contexts. Foreign cities are keen to replicate these examples of best practice; whilst technical experts, technology providers and governments are keen to export their expertise and technologies. However, the factors influencing the successful translation - movement, transformation and adaptation - of these experiments across spatial contexts requires deeper investigation. This paper explores the process using a mobile transitions conceptualisation. In this paper we develop a theoretical conceptualisation of the mobile transition process and test it using two low carbon experiments - Hammarby Sjostad (Stockholm) and BedZed (London). We identify the type of knowledge that is translatable (in the global form), and how this is modified both by the global and local assemblages throughout the process.

The implication of our findings is that greater clarity is needed throughout the translation process if outcomes are to improve. Firstly, in order to determine the potential for an urban experiment to translate into a new spatial context the practitioner must understand the context from which it emerged and the context into which it will be translated. Secondly practitioners need to clearly define the translatable global form emerging from an experiment. It must be possible to decontextualise and re-contextualise the global form if it is to translate successfully. In some cases it may be impossible to decontextualise the global form without undermining the fundamental principles underlying the experiment. Thirdly, practitioners need to be aware of how the global form can be manipulated and re-represented by the global and local assemblages during the translation process. The global form is not fixed. Finally practitioners should be aware that new socio-technical systems (adopting the fundamental principles developed in the experiment) will emerge from the translation process.

1. Introduction

Low carbon urban transition experiments are emerging across cities globally. They combine culture, structure (e.g. technologies, policy targets, decision support tools, design tools) and practices (e.g. planning processes, sustainable behaviours) into one socio-technical system. These experiments are socio-technical innovations with a high potential to contribute to a low carbon transition (Williams, 2016). Through the Global Intelligence Corps - international consultants, academics, governments and global networks (C40 cities, ICLEI, Climate Alliance and Energy Cities) - knowledge of these experiments is being disseminated across a variety of spatial contexts. Foreign cities are keen to replicate these examples of best practice; whilst technical experts, technology providers and governments are keen to export their expertise and technologies. However, the factors influencing the successful translation – movement, transformation and adaptation - of these experiments across spatial contexts requires deeper investigation. Using a mobile transitions conceptualisation can help us to do this.

The mobile transitions conceptualisation was first mentioned in the literature by Afforlderbach and Schulz (2016). They made a valuable contribution, critically reviewing the transitions and policy mobility literature, identifying the complementarities between the theories and suggesting the need to combine approaches to better understand the spatial dimensions of socio-technical transitions. However, they did not provide a conceptual model which demonstrated how these two ideas could be combined. In this

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paper we set out to build on the work of Afforlderbach and Schulz (2016) by developing a clearer conceptualisation of the mobile transition process; creating a theoretical model which can be operationalized (Fig. 2) and tested using two case studies. Thus, we make a significant contribution to the development of the theoretical approach and provide an empirical analysis of its application.

2. Theoretical conceptualisation

The transition process is conceptualised by the multi-level perspective (Fig. 1). This perspective suggests that experiments (niches) can provide the stimulus for the transformation of socio-technical regimes,[1] either by replacing or by merging with and transforming the regime (Geels and Raven, 2006; Smith, 2007; Loorbach and Rotmans, 2010). Success is more likely when the incumbent regime is destabilised, usually precipitated by a change in the landscape[2] or when robust niches (comprised of several transition experiments) are compatible with the regime (Geels, 2002). Niches must offer considerable positive feed-back if they are to be adopted by the regime (Smith, 2007). Radical niches will not diffuse widely since they demand too many structural changes (Smith, 2007). In this interpretation, intermediate transition experiments where regime actors take on the innovations developed by the niche, are more likely produce a regime transformation (Smith, 2007).

Experiments can enable social learning; build networks between actors; articulate expectations/visions; and help to align resources (practical knowledge, tacit skills, tools, money and people) needed for new technical systems and associated social practices to diffuse more widely (Geels and Raven, 2006; Loorbach and Rotmans, 2010). Studies have tended to focus on the impact of local experiments on the local or national regime in which they are embedded, rather than the movement, adoption and adaptation of the knowledge developed from the experiment to new spatial contexts.

Transition theory explains that an emerging socio-technical system is the result of co-evolution of technical and social elements. Thus, the local context and the local embeddedness of experiments are key to their development, and ultimately their ability transfer to new spatial contexts. Local, socio-technical innovation shapes local contexts, and local contexts shape local socio-technical innovations (Coenen et al., 2012; Späth and Rohracher, 2010). The literature highlights the importance of: diverse experiments in a variety of contexts (Rotmans and Loorbach, 2006; Loorbach, 2007); translating practices between contexts (Smith, 2007); conducting multiple experiments in niche-trajectories (Geels and Raven, 2006) and a parallel development pattern (Raven, 2005) in the transformation process. However, the difficulties of translating knowledge developed from low carbon experiments into new spatial settings have been highlighted and the merit of "broadening" has been questioned (Williams, 2016).

Previous empirical work which studied the scalar and spatial dynamics of the transition process, suggested that low carbon experiments (including the cases studied in this paper Hammarby and BedZed) could influence development regimes across national borders (Williams, 2016). However, it also demonstrated that structures (e.g. technical systems) and practices (e.g. integrated and collaborative planning) developed in an experiment in one spatial context often encountered barriers in another (Williams, 2016). The findings also suggested that the process of "broadening" (developing multiple models in a variety of locations) creates such a diversity of models that it could eventually destabilise the niche-regime, rather than lead to transformation (Williams, 2016).

From a transition perspective the focus is on the temporal dynamics of the transformation process, rather than the spatial dynamics. It is unclear at what scale or where spatially the niche, regime or landscape operate. Most studies seem to focus on the national context and the embedded, localised niches (Afforlderbach and Schulz, 2016: pp). There is limited discussion of how knowledge produced from experiments, travels to new contexts and how it evolves.

Conceptual perspectives in critical urban geography – policy mobility, assemblages and mutation - when used in tandem with the transition conceptualisation can help overcome these limitations. The conceptual framework offered by the policy mobility literature helps us to understand the process by which experimental policies (technologies and tools) may move from one spatial context to another (Evans, 2004; McCann, 2008; Peck and Theodore, 2001; Stone, 2004; Ward, 2006). It highlights that "policy transfer rarely results in carbon-copied policies being instituted in different places" (Prince, 2010. pp171). Local variation in political, institutional, economic and cultural parameters, results in policies changing or mutating as they move between contexts (Stone, 1999; Peck and Theodore, 2001; Phelps et al., 2007).

Policy mobility and mutation literature denies the existence of localised best practices and models of good governance by introducing a relational view on continuous transformation and adaptation processes and their underlying driving forces (Afforlderbach and Schulz, 2016: pp7). It offers a better understanding of a continuous learning process resulting from the transference of this knowledge to new spatial contexts. It highlights the importance of evolving narrative, supportive programmes, key individuals and power relations in this process.

The mobility literature explains how policies disassemble and reassemble in new contexts (McCann and Ward, 2010, 2011; Peck, 2011). Actors transferring policies view and present them differently, and thus policies evolve through the spatial translation process (Roy, 2010; Hult, 2015; Callon, 1986; Tait and Jensen, 2007). The physical manifestation of these policies in new contexts, are deeply influenced by the translation process and by the context in which they remerge (Prince, 2010). New knowledge is subject to recombination with pre-existing on site knowledge (reassemblage) that leads to further innovation (Afforlderbach and Schulz, 2016: pp9).

The importance of context (temporal and spatial) is highlighted by both literature. For the transitionists, the regime and events in the wider landscape influence the experiment which emerges. In the mobility literature, local actor constellations, ideas, attitudes, values, past experiences and power relations all inform the urban experiment which emerges. Thus the successful transfer of best practice is bound to be determined by socio-spatial conditionality (McCann and Ward, 2011). So we must study the forces that condition urban experiments, to understand whether they will successfully translate into new contexts (McCann and Ward, 2011).

The policy mobility conceptualisation suggests experiments precipitate global forms. These are objects, systems or techniques which can translate into new spatial contexts because their "validity is not dependent on the context of their production" (Collier and Ong, 2005. pp400). Global forms have "a distinctive capacity for decontextualisation and recontextualisation, abstractability and movement across diverse social and cultural situations" (Collier and Ong, 2005. pp400). However, the universality of the global form is dependent on the global assemblage.

[1] A regime comprises culture, practices and structure of the wider system.

[2] The landscape encompasses a broad range of factors such as economic pressures, cultural values, social trends, wars and environmental issues, which are exogenous to the regime.

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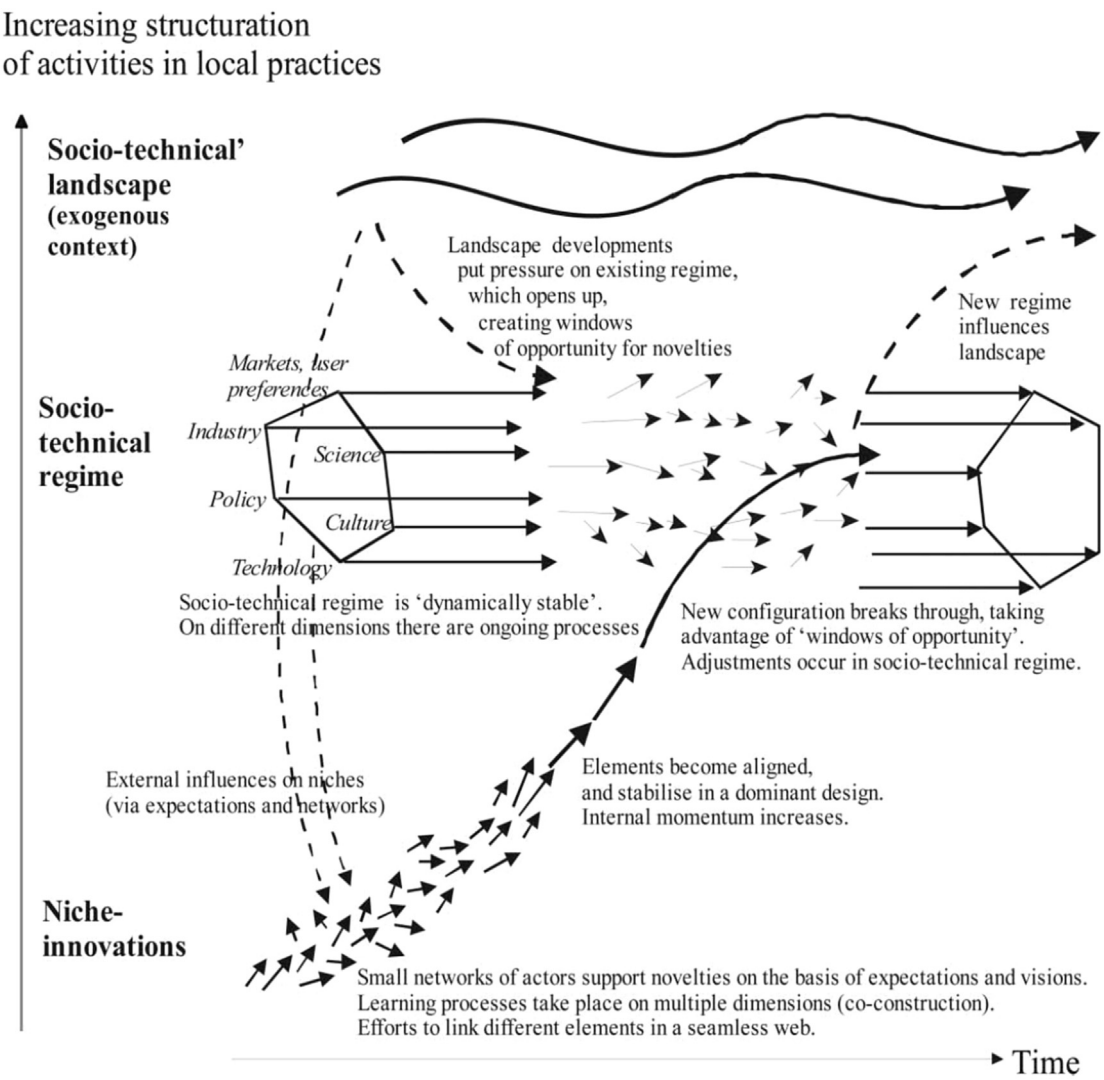

Fig. 1. The multi-level perspective.
Source: Geels, 2002.

A global assemblage is the "articulation" of a global form to new spaces and situations (Prince, 2010). In real terms the global form is "articulated" through actor networks, narratives, programmes and strategies for translation. Thus, the global assemblage articulates the global form into new contexts (Prince, 2010). Successful translation of the global form to a new spatial context will also depend on the local assemblage. The local assemblage comprises the actor constellations, events and ideas which come together to shape an experiment where it originates and where it re-emerges.

By combining the transitions and mobility conceptualisations we can build a clearer picture of the whole spatial translation process (Fig. 2). The transitions perspective focuses on the creation of knowledge from experiments and the socio-technical processes which lead to transformation over time. The mobility perspective focuses on transferring knowledge across spatial contexts (a socio-spatial process). The former is highly structured and scalar. The latter is relational and spatial.

Conceptualisations from transitions theory, particularly the multi-level perspective, provide a clear structure within which to understand how the socio-technical regime and events in the landscape influence experiments: how they develop; critical support factors; and potential to be transformative in new spatial contexts. It can also provide a temporal dimension to the global assemblage and evolution of the global form.

The mobility conceptualisation helps us to understand the spatial dimensions of the transition process. Crucially it highlights that not all knowledge generated from an experiment is translatable. Only the global form translates, evolving as it travels, influencing the socio-technical system that emerges in a new spatial context. The process is far more fluid, less structured and relational than posited by transitions theory. Thus, the knowledge created from the initial experiment (and resulting global form) will be constantly evolving throughout the translation process.

The mobile transitions conceptualisation of spatial translation brings these ideas together. The experiments are socio-technical systems which have emerged from the local context and could bring about a transition within the development regime (locally, nationally or globally). The local assemblage shapes them (local actors, ideas, events, culture, structures and practices). The experiments produce contextually embedded and translatable knowledge. The translatable knowledge (global form) moves successfully to the new spatial contexts. However, the global form will constantly evolve during the translation process.

The interaction between the global form, landscape and regime

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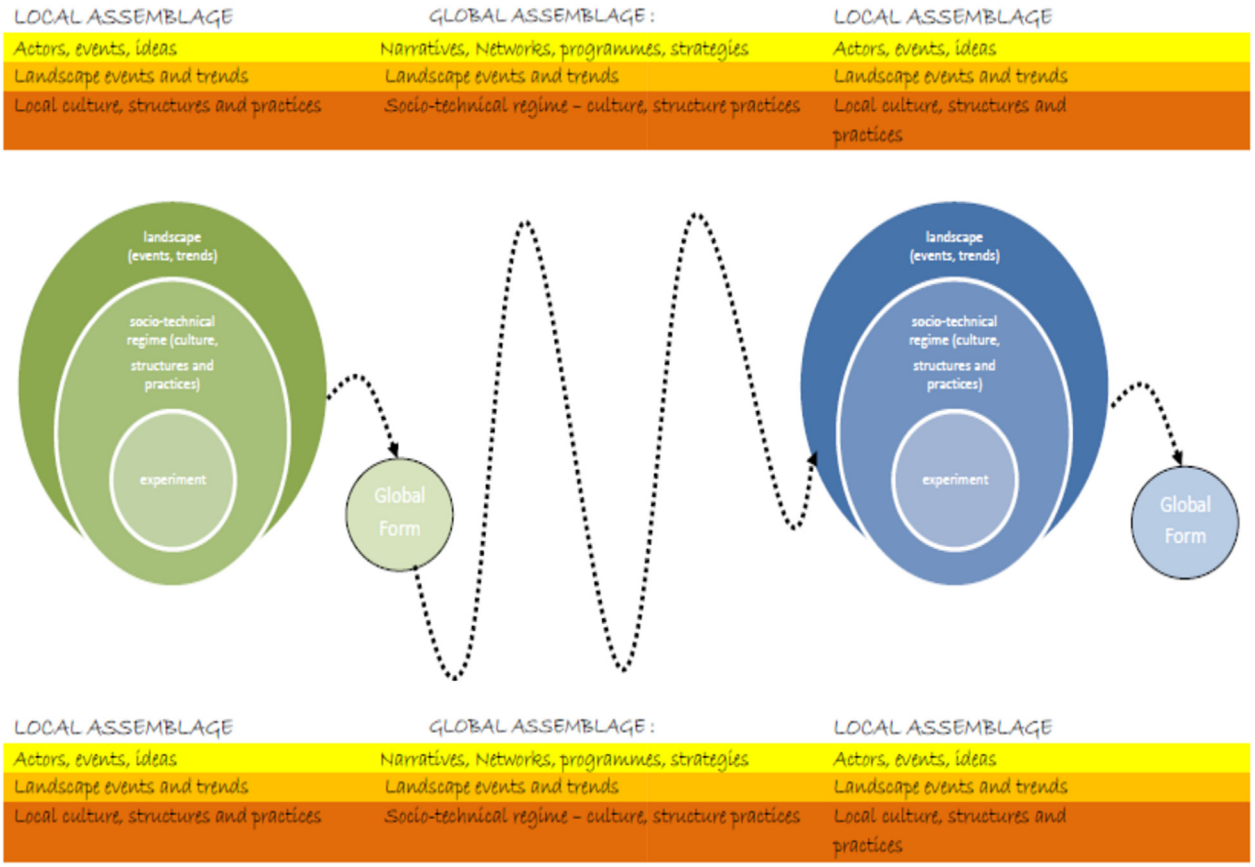

Fig. 2. Mobile transitions conceptualisation of the spatial translation process.
Source Author's own.

will in many cases alter the narrative and the knowledge which is being transmitted by the global assemblage to recipient cities. The local assemblage in the recipient cities will also filter and adapt the knowledge. The potential for the global form to transform the development regime in the recipient city could then be analysed using the transitions conceptualisation. Using this mobile transitions conceptualisation of spatial translation we will review the findings of the research to determine the value of experiments in the process.

This paper follows the process, focussing on two low carbon urban experiments and their translation across spatial contexts (from Europe to China). It explores the local assemblages producing the experiments. It examines the nature of the global forms which emerge from the experiments and the global assemblages which translates the global forms across spatial contexts. It traces how both the global forms and assemblages evolve through the process and investigates the factors influencing the success of the translation process. Finally it considers how mobile transitions conceptualisations can provide a better understanding of the spatial translation process.

3. The study

The two European low carbon urban experiments chosen for study are Hammarby Sjöstad (Sweden) and BedZed (UK). Both test a combination of novel technologies, policy frameworks, planning processes, strategic planning and design tools (Table 1). Both experiments have been actively translated by a range of actors into new spatial contexts. In this paper we focus on their translation to Chinese eco-cities.

The paper draws on data from the *Lost in Translation* project (funded by the BHP Billiton Prize). The project used a comparative methodology and drew upon low carbon urban experiments in European cities. It explored the translation of experiments to new spatial contexts attempting to understand:

- the nature of the global forms translating to spatial contexts;
- the nature of the global assemblages translating the global forms;
- how both global forms and assemblages evolve;
- the factors influencing the success of the translation process.

The studies used several data sources: interviews with actors involved in the translation processes (Table 2), plans (strategic, local, low carbon, infrastructural), technical reports, policy and legal documents, academic articles, company reports, websites and news articles.

The data was analysed using a combination of historical event analysis, mapping and content analysis techniques. The historical event analysis helped to understand the historical context from which the experiments emerged and followed the evolution of the global forms and assemblages. Mapping was used to trace the movement of global forms through networks to new spatial contexts. Content analysis was used to analyse the changing narrative and to identify the factors influencing the successful translation of global forms into recipient contexts. A synthesis of the results of all 3 analyses is presented in the following pages.

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Table 1
The case studies.

	Hammarby	BedZed
City in which low carbon experiment developed	Stockholm	London
First phase completion	2004	2002
Population	20,000 residents	244 residents
Carbon production in city (tonnes per capita/annum)[a]	4[b]	12.5[c]
Carbon production in experimental neighbourhood (tonnes/capita/annum)	2.5–3.0[d]	0.51[e]
Goals	Integrated, circular resource flows; substitution for renewables; energy efficiency.	Zero CO_2 emissions; zero waste; local resources and localised activities.
Technology and design	Eco-cycles system; waste to heat systems; v acuum waste systems, renewable energy, energy efficient building; biofuel powered transport.	Energy plus buildings; renewable energy; electric vehicles; rain and grey water recycling; green rooves, live -work units.
Planning	Integrated collaborative planning	Planning and design based on the OPF and ZDS.
Lifestyles	Use of non-car modes, recycling household waste; effective use of energy efficiency technology in homes.	Use of non-car modes, electric vehicles and car-pooling; recycling household waste; effective use of energy efficiency technology in homes; work locally; use locally sourced materials.

[a] Cross comparison of cities and experiments co2 savings should not be made since the calculations may have been made using different assumptions. However, it does provide an indication of the scale of co2 savings made by the experiment within a given city.
[b] City of Stockholm, 2009.
[c] Minx et al., 2013.
[d] Brick 2008.
[e] Bioregional 2009a.
Source Author's own.

4. Hammarby: the experiment and local assemblage

Hammarby is a mixed-use, high density district, built on a brown-field site in the centre of Stockholm. When complete it will house 20,000 residents (Fig. 3). It tackles CO_2 emissions by increasing system efficiency (low energy buildings, public transport, and district heating) and substituting fossil fuels for renewable energy or energy-from-waste (eco-cycles system). It is estimated that an average Hammarby resident produces 2.5–3.0 tonnes of CO_2/capita/annum (compared to 4 tonnes for the average Stockholm resident).

The Hammarby experiment combined a novel policy framework, planning process and technical system (eco-cycles). The policy framework supported a low carbon, resource efficient city district, based on two novel principles integrated urban sub-systems (water, waste, energy, transport) and circularity of resource flows (reuse and recycling resources, energy recovery and renewable energy). This manifests as the eco-cycles system (Fig. 4).

Eco-cycles utilises the existing, proven city-wide infrastructure (city-wide district heating system; the Högdalen combined heat and power plant and the Hammarby thermal power station) in combination with new technologies (for converting sludge into fertiliser and biogas and technologies for producing renewable energy on-site) to close resource loops, thus reducing waste and use of fossil fuels (Pandis et al., 2013). The buildings in Hammarby have been designed to be more energy efficient (consuming 60 kWh/m^2/year), with solar cells, solar collectors and fuel cells in some units (Pandis et al., 2013). Low carbon transport modes (walking, cycling, and tram) are encouraged through urban design and tram links to the rest of the city.

A pioneering integrated, collaborative planning process was used to design and deliver eco-cycles in Hammarby (Williams, 2011, 2013). It engaged stakeholders from the development regime (i.e. the municipality and construction industry) to participate in the visioning, design and development of the system within the Hammarby district. The process was highly technocratic (top-down) engaging technical experts, and not the wider community.

The co-ordination of resource flows between urban sub-systems (waste, energy, transport and water) was enabled by the degree of public control over the utilities, transport services and strategic development within Stockholm (Williams, 2011). The effective operation of the new technical systems introduced into Hammarby was also dependent on the sustainable behaviour of residents (e.g. recycling waste; using low carbon technology effectively; and opting to walk, cycle or use public transport) living in the district (Williams, 2011).

Hammarby emerged from a local assemblage in which there was political support (locally and nationally) for resource efficient, low emissions city districts. The technical capacity to deliver the eco-cycle system developed in Swedish cities over several decades (Williams, 2016). District heating systems powered by waste, decarbonised energy mix and energy efficient buildings have been integral to mainstream development models in Swedish cities for many years. Thus, the infrastructure found in most Swedish cities underpins eco-cycles developed in Stockholm.

However it is only in the more recent experiments (Hammarby, B001) that an attempt was made to integrate systems to encourage circular resource flows (interview with SCC, 2009; MCC, 2009). Significant public funds were available for infrastructure and

Table 2
Interviews.

	Hammarby	Date of interview
Government bodies	SKL International (SKL)	2015
	Malmo City Council (MCC)	2009
	Stockholm City Council (SCC)	2009
Consultants	SWECO	2015
	Tengbom	2016
	Zed Factory	2014
	Urban Earth Consulting	2015
Academics	Hult (KTH Stockholm)	2015
	Ranhagen (KTH Stockholm and SWECO)	2015

Source Author's own.

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Fig. 3. Hammarby Sjostad.
Source Author's own photograph.

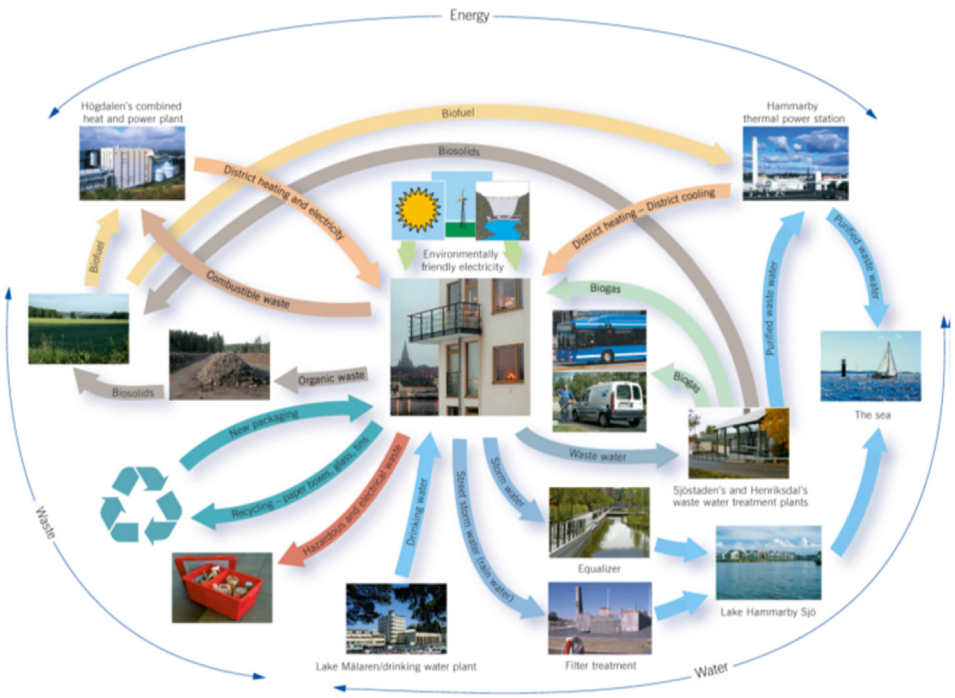

Fig. 4. Eco-cycles.
Source: Hammarby Website (2016).

pioneering urban experiments (Local Investment Programme 1998; Swedish delegation for Sustainable Cities 2008 and Climate Investment Programme 2012.). These funds enabled new technologies to be tested and integrated infrastructural solutions to be developed which may have otherwise proved too risky and or expensive for private investors (interview with SCC, 2009).

Institutional structures also enabled infrastructural integration. When Hammarby was conceived and designed, the utilities and transport infrastructure were publically owned. Thus integration of urban sub-systems, to produce the eco-cycle system, was easier to co-ordinate (interview with SCC, 2009). An integrated approach towards urban systems planning also developed in Sweden over

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several decades (since the adoption of the Natural Step by cities in 1995). Eco-cycles developed in Hammarby was a natural extension of this kind of thinking.

Thus, the local assemblage – local technical systems, political support, institutional structures and culture - shaped the district that materialised and the model for urban planning (the global form) which emerged from the Hammarby experiment, making both potentially difficult to decontextualise.

5. BedZed: the experiment and local assemblage

The policy aim underpinning the BedZed experiment was to create a zero carbon, resource efficient suburban district, operating within the carrying capacity of one planet (zero waste, zero carbon emissions and localisation of activities). BedZed is probably the best known (and certainly the oldest) low carbon experiment in London, completed in 2002. It is a mixed-use, medium density development, built on a brown-field site in a suburban London borough. It houses 244 residents (Fig. 5).

The practicality of implementing the zero carbon building standard was tested in BedZed. CO_2 emissions produced by a variety of household activities (including travel, consumption of food and production of waste) were tackled, as well as those produced by thermal demand and electricity consumption in the home. BedZed combined a range of technical solutions to addressing CO_2 emissions and resource consumption: energy-plus houses, district heating system, electric vehicle charging points, green roof gardens, rain and grey-water recycling and live-work units. It also had excellent access to public transport. The success of the experiment was dependent on the sustainable behaviour of residents living in the district both in using their homes and in their wider lifestyle choices (e.g. buying locally sourced products; working from home; car-sharing and using public transport). It is estimated that an average BedZed resident produces 0.51 tonnes of CO_2/capita/annum (compared to 12.5 tonnes for the average London resident).

BedZed emerged as a low carbon model for suburban planning. The local assemblage which produced BedZed was somewhat different to Hammarby. Although there was considerable local political support for BedZed in the London Borough of Sutton, there were no regulatory controls or funding streams which supported its development. There was also reluctance within the house-building industry to construct low carbon homes because: market demand was very limited; energy prices were low; and there was no regulatory framework which set higher mandatory ecological standards (Williams, 2008), although a voluntary code for ecohomes was introduced in 2000.

However, there was growing interest amongst house-building pioneers in ecological building (Williams, 2008). Also demand for housing in London was growing rapidly, which reduced the risk of building more innovative housing forms as additional costs of low carbon technologies and design could be borne by the London market (Williams, 2008). In addition at a national level within government, there was increasing concern about energy security and delivering carbon reduction targets (Williams, 2010). Thus house-building pioneers believed there would eventually be political support for ecological buildings.

BedZed was also influenced by its location in the suburbs; lack of public investment in urban experiments and local political support for environmental projects. This combination produced a mixed funding model for suburbia, incorporating smaller scale (building-level) systems that could be financed by a developer and maintained by a household. It also included live-work units and electric vehicle charging points aimed at reducing commuting or the impact of commuting by car in the suburbs.

Both experiments clearly reflect the local assemblages from which they have emerged. Both emerged from the development regime, driven by pioneers in the regime (Williams, 2016). However, the intended purpose of the two experiments was different. BedZed was built by Zed Architects and Bioregional (pioneers, operating commercially) to test technologies, designs and tools which could be adapted and used in a variety of spatial contexts. Hammarby was built as a solution for sustainable living in Stockholm (and to attract the Olympic games to the city), although it was eventually re-packaged as a more generic solution for cities globally. Thus, it could be argued that one experiment was “designed to travel” (i.e. BedZed), whilst the other was designed for its context and was then re-configured for translation to cities globally (i.e. Hammarby).

Fig. 5. BedZed.
Source ZedFactory.

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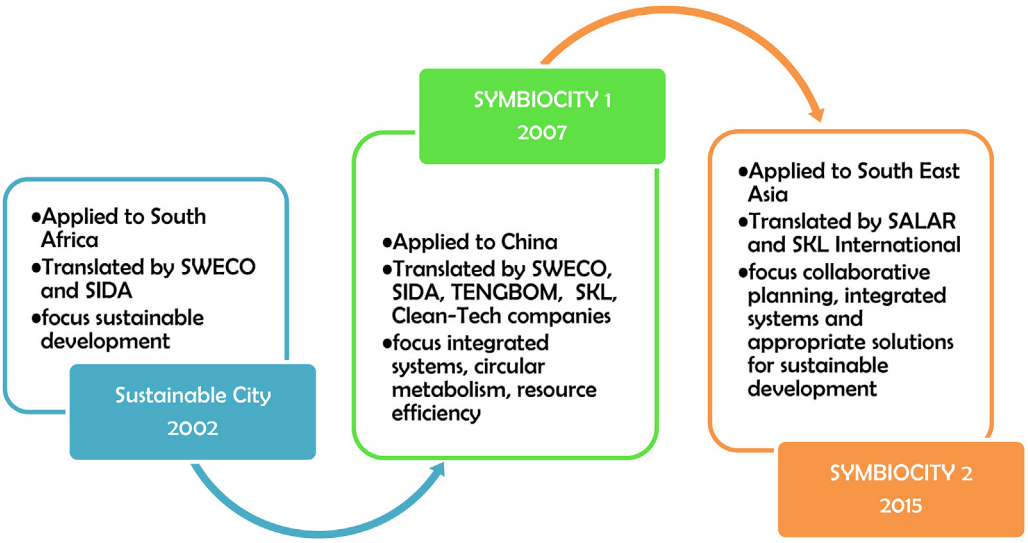

Fig. 6. Evolution of the Swedish global form.
Source Author's own.

6. Translating Hammarby: global form and global assemblages

Three global forms emerged from Hammarby (and other Swedish urban experiments, particularly B001 Western Harbour, Malmö): the *Sustainable City* (2002), *SYMBIOCITY1* (2007) and *SYMBIOCITY2* (2015). In all three cases the "form" provided an approach to urban planning based on the Swedish low carbon urban experiments. The form evolved as the global assemblage altered. The actors and narratives underpinning the translation process have shifted. The global form has become more synthesised and abstracted as it has evolved from the *Sustainable City* concept to *SYMBIOCITY2* (Fig. 6).

The global narrative surrounding the need to create sustainable cities (which developed post-Rio 1992) created interest in the *Sustainable City* form. The form was very prescriptive and complex, offering a dashboard of options for achieving sustainable urban development including: policies, processes, design options and technical systems (SIDA's manual, *Support to Environmentally Sustainable Urban Development, 2006–7*). It was translated to South Africa by the Swedish government (SIDA) and planning consultants (SWECO).

Post Kyoto (2002), the global narrative switched to one focussed on climate protection and resource depletion. *SYMBIOCITY1* tackled both through the introduction of the technical system - eco-cycles. It gradually synthesised the *Sustainable City* concept into a collaborative, integrated planning process to support the development of eco-cycles in urban districts (Ranhagen and Groth, 2012). *SYMBIOCITY1* also acted as a platform for exporting Swedish urban planning expertise and clean technologies, driven by the Swedish government's desire to build its green industrial sector (SKL International interview, 2015). The Swedish government (SIDA[3] and Business Sweden), consultants (SWECO, Tengbom), SKL International [4] and Swedish clean-tech companies (e.g. EnVac) were involved in the translation of *SYMBIOCITY1* to China.

SYMBIOCITY2 is the most recent incarnation of the global form. Again it emerged alongside a new global narrative focussed on collaborative planning, integrated urban systems and context appropriate approaches to sustainable development, climate mitigation and resource depletion. It has been developed by SKL International which represents technical experts from Swedish cities. SKL is more focussed on practitioners from Swedish cities assisting other practitioners to deliver integrated, sustainable development solutions, and less on exporting technology. Thus, *SYMBIOCITY2* focuses on developing an integrated, collaborative planning approach to creating appropriate sustainable urban environments (SKL International interview, 2015 and Backmann et al., 2015). It is being translated to South East Asia by SKL International.

The global form appears to be evolving with the knowledge gained through its application in new spatial contexts. It has moved from being a highly prescriptive planning approach (which encountered problems translating into new contexts) to a much more context appropriate, process-based approach to urban planning (SKL International interview, 2015). Application of the *Sustainable City Concept* in South Africa highlighted the need for a less prescriptive approach to urban planning (SWECO interview, 2015). It demonstrated that the direct application of Swedish sustainable urban planning models to entirely new contexts was inappropriate (SWECO interview, 2015).

This led to the creation of *SYMBIOCITY1,* which was less prescriptive. This form was also adapted to meet the demand from China, which focussed on technical solutions to decoupling resource consumption from economic growth (Hult, 2013). The Swedish actors claimed that eco-cycles could produce this decoupling. However, as will be explored in the paper, the application of *SYMBIOCITY1* to China met with some local resistance, particularly in translating the technologies and planning approach underpinning the eco-cycles system.

Thus, *SYMBIOCITY2* dropped eco-cycles and the accompanying technological platform, focussing on the context-appropriate, process-based approach to delivering integrated urban systems in South East Asia (SKL international interview, 2015). This integrated approach is embedded in thinking within Swedish institutions (especially city councils), but not so elsewhere and thus is also meeting with some local resistance.

The Swedish government's approach to translation has been

[3] SIDA - Swedish International Development Cooperation Agency.

[4] SKL International is the international company owned by the SALAR who act as consultants to cities globally. SALAR is the Swedish Association of Local Authorities and Regions.

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exceptional. Low carbon urban experiments to test and show-case Swedish expertise and technology were publicly funded. The Government has been engaged in extensive publicity campaigns and negotiations with foreign governments to encourage the adoption of Swedish technologies and expertise tested in these experiments, in return for foreign investment (SKL and Hult interviews, 2015). However, translation of the global forms described has so far proved problematic. This is largely because the validity of the object, systems and techniques which comprise the global forms appear to be dependent on the context of their production. The fundamental nature of all 3 forms cannot be de-contextualised.

7. Translating BedZed: global form and global assemblages

Two global forms emerged from BedZed: the Zed Design System (ZDS) and One Planet Framework. The Zed design system (Dunster et al., 2007) is a design tool. It calculates the carbon footprint of a range of design options for buildings and communities based on technologies and materials used; building structures and layouts; urban design and local services. Initially applied to buildings and urban districts, it is now used by the architect to master-plan villages and cities (e.g. Bickleigh Down eco-village Tongshan, Dalian, Namyangju, Itahyê). It has also produced an array of new low carbon solutions for a variety of problems including: solar bikes, zero bills homes, zed rooves, etc (ZedFactory website, 2016). The tool produces a range of technical systems and provides a framework for the accreditation of Zed projects.

The One Planet framework (OPF) provides a strategic decision-making tool – based on a set of 10 principles (Fig. 7) - which can be used to master-plan new cities and city quarters, guide policy frameworks and inform the creation of new socio-technical systems (Bioregional, 2002, 2003). In BedZed, the framework was used to guide policy goals and plan an environment which enabled these goals to be achieved. In combination with an accreditation procedure, the framework also provides eco-rating and branding for projects which have been accredited (Bioregional, 2009b). “Zed” and “One Planet Living” also became international brands (see Zed Factory and Bioregional websites).

The two main consultants – Bioregional and Zed Architects – involved in planning and designing BedZed, separated after the experiment was complete. Subsequently they marketed their brands and tools separately. The Global Intelligence Corps (global consultancies, academics, city networks) began to cite BedZed as a best practice example of zero carbon/carbon neutral development and resource efficient living. This was reinforced by trusted international and national organisations (OECD, 2013; UNEP, 2009; NHBC, Zero Carbon Hub and PRP Architects, 2015; RIBA Sustainability Award, 2003). Thus, the global assemblage developed, giving both global forms greater momentum. The initial experiment played a key role in the translation process and was part of the global assemblage which took Zed and One Planet living to China. BedZed demonstrated how to design and build a zero carbon development and what it might be like to live in a zero carbon neighbourhood (interview with ZedFactory, 2014). However, unlike the Swedish government, the British government did little to reinforce the translation process. The innovators (Zed Factory and Bioregional) translated their expertise into new contexts.

Both the OPF and ZDS offer translatable knowledge. They are flexible tools for delivering low carbon or one planet living environments. Originally the OPF was based on bioregionalism; the localisation of activities and resource flows (Desai and Riddlestone, 2002). However, the framework covered the 10 principles outlined in Fig. 7. This range has enabled the framework to adapt to a variety of spatial contexts with differing policy priorities. In BedZed the focus was on environmental priorities: zero carbon emissions, zero waste, sustainable modes of travel, use of sustainable materials in construction and localised food production. However, in subsequent projects this has shifted, as will be demonstrated by the Chinese case study. In contrast, the guiding principle for the Zed design system (the zero CO_2 emissions goal) remains constant. Only the mode of delivery alters (materials, technologies and designs) with context. Both forms produce new socio-technical systems in new spatial contexts.

From this analysis we learn that only some experiments produce translatable knowledge (global forms). Knowledge which guides policy choices (OPF) or provides tools for implementing those choices (ZDS) appears to be translatable. Knowledge which informs culture, structures and practices is less easily translated. Global forms are also constantly evolving (SYMBIOCITY), influenced by the actors involved in translation, the changing narrative, events in the landscape and the learning from the experience of implementation in new contexts.

8. Translation to China

International and national narratives on climate change, resource scarcity and energy security peeked Chinese interest in Hammarby and BedZed. Thus, the global forms (SYMBIOCITY, BedZed, Zed Design and One Planet Living) found traction in China linking with the government's dematerialisation, resource efficiency, low carbon and eco-cities agendas (Li, 2009; Ma, 2004; Zhu and Zhou, 2003; Zhu and Huang, 2005; Wu, 2003; Liu, 2012; Yang, 2006).

In addition, solar technologies had become ubiquitous in China thanks to significant Government investment and subsidies (Urban and Geall, 2014). Thus, they were affordable and accessible. BedZed was particularly interesting to the Chinese government because of its conspicuous use of solar technologies (interview with ZedFactory, 2014). Eco-districts and cities designed using ZDS would provide an opportunity for the Chinese government to show-case solar technology in state-of-the-art surroundings. It was hoped that these experiments would generate interest in Chinese solar technologies in both internal and external markets (interview with ZedFactory, 2014).

The local assemblage in China was supportive of all 3 global forms. Chinese local politicians were very interested in eco-profiled development (interviews with SWECO, 2015 and Tengbom, 2016). Eco-city branding increased Chinese investors' interest in new development projects (interviews with SWECO and Hult, 2015). The political kudos gained by local politicians who successfully delivered an eco-city project significantly helped their career progression (interviews with SWECO and Hult, 2015). The designation of an eco-city in China also allowed the appropriation of communally owned rural land by city authorities (Wu et al., 2013). It also helped to attract foreign investment from European governments, consultants and clean tech companies wishing to demonstrate their expertise and technical systems in new cities (interviews with SWECO and Hult, 2015). Thus, involvement of European actors and the *eco*-brands in Chinese eco-cities was perceived to have numerous benefits for the host city.

SYMBIOCITY1, OPF and ZDS were introduced to China via the World Urban Forum (2008) and World Expo (2010). In the case of *SYMBIOCITY1*, export to China was also facilitated through several memorandums of understanding between the Swedish and Chinese government, signed between 2008 and 2010 (Froberg et al., 2013). It was expected that Swedish clean technologies, British and Swedish urban planning and design expertise, would be used alongside foreign investment, to develop eco-cities in China (interview with SKL International, 2015; ZedFactory, 2014).

The Swedes created a very strong narrative around their ability

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Fig. 7. One planet framework.
Source Bioregional website, 2015.

to design sustainable urban environments (interview with Hult, 2015 and Hult, 2013). The success of this narrative relied heavily on their design reputation and the experiments (like Hammarby) found in Swedish cities (interviews with Hult, 2015; Ranhagen, 2015 and Hult, 2013). The BedZed experiment was also critical in the translation of the global forms (ZDS and OPF) to China (interview with Zedfactory, 2014). However, the British government did not reinforce the translation process through bilateral agreements with China or funding (interview with Zedfactory, 2014).

To date none of the Chinese developments which have adopted *SYMBIOCITY1*, OPF and ZDS at the master-planning stage are complete. This poses a problem for understanding the translation process fully. However the master-plans and interviews revealed the extent to which knowledge has been translated to new developments at the planning stage.

8.1. Assembling Hammarby in the Chinese urban context

SYMBIOCITY1 was used to master-plan Caofeidian, Taihu, Dongli Lake Project, Luodian Town (Table 3). To date these projects are only partially built. The most advanced is Caofeidian Eco-city. This project is currently failing as a result of change in the local assemblage, more specifically in local leadership and severe lack of funds (Yu, 2014; Liu et al., 2014). This lack of progress makes it difficult to determine exactly how *SYMBIOCITY1* has translated into the local Chinese context. Nevertheless, even during the master-planning process it has become evident that some facets of *SYMBIOCITY1* are incompatible with the local context. An analysis of the socio-technical regime operating in Chinese cities helps to identify why.

City-wide, integrated, publically funded infrastructure of the sort introduced in Hammarby, is unlikely to provide a suitable model for Chinese cities. A lack of municipal power and resources within Chinese cities means there is heavy reliance on private developers to invest in infrastructure (interviews with SWECO, Urban Earth Consulting and Hult, 2015). There is a lack of trust amongst citizens in large-scale, state-owned infrastructural systems, resulting from the pollution problems found in the state-owned water infrastructure (interview with Urban Earth Consulting, 2015). In combination both points suggests that small-scale, systems which can be funded, managed and maintained by residents or building owners are likely to be better suited to the Chinese socio-technical regime (interview SWECO, 2015).

The eco-cycle system was one of the key features which attracted Chinese interest in Hammarby (interview with SWECO, 2015). Thus, the eco-cycle system has been included in the Caofeidian, Taihu and Dongli Lake master-plans. However, the technology under-pinning the system tested in Stockholm is likely to encounter some problems when translated to the Chinese context. For example, the application of a vacuum waste system in Chinese cities is difficult, because of the informality of the waste management system and a lack of recycling behaviours amongst citizens

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Table 3
SYMBIOCITY1 projects in China.

City	Consultant	Project description	Progress
Caofeidian (nr Tangshan)	SWECO	Master-planning, eco-cycles and technologies	Partially built, but deserted. Lack of funds.
Dongli Lake (nr Tianjin)	SWECO	Master-planning, eco-cycles and technologies	Partially built but deserted.
Taihu (Wuxi)	SWECO, Tengbom	Master-planning, eco-cycles and technologies	On site
Luodian Town (nr Shanghai)	SWECO	Master-planning and technologies	Partially built

Source Author's own.

Table 4
ZDS and OPF projects in China.

City	Consultant	Project description	Progress
Tongshan (XuZhou)	ZedFactory	Master-planning using ZDS	None
Dalian	ZedFactory	Master-planning using ZDS	None
Jinshan (Guangzhou)	Bioregional	Master-planning using OPF	Partially completed and occupied. To be complete 2016.

Source Author's own.

(interviews with SWECO and Urban Earth Consulting, 2015).

Chinese households are not accustomed to sorting or recycling their waste, both are essential for the effective operation of the vacuum waste system. The waste-pickers who currently collect and sort waste produced from households are not managed or regulated by the cities (Duggan, 2015; Liu, 2012). The introduction of vacuum waste systems would negatively impact on this informal waste sector, creating further poverty and discontent. Thus, vacuum waste systems are likely to encounter resistance to translation in Chinese cities from citizens and waste-pickers.

The use of district heating/cooling systems integral to the eco-cycles system may also be limited by the land zoning policy in Chinese cities (interview with SWECO, 2015). A mixture of land uses supports a balanced load model throughout the day, whilst land-use zoning (adopted in Chinese cities) creates problems with managing heat loads and transmission losses across the system. Thus the clean technology (although very attractive to Chinese technocrats and politicians), which underpins *SYMBIOCITY1,* is unlikely to be suited to the Chinese urban context.

The Chinese have not adopted the integrated, collaborative planning approach central to the successful translation of the *SYMBIOCITY1* into the local context. There is a lack understanding of integrated systems planning amongst the technocrats in Chinese cities (interviews with Urban Earth Consulting and SKL International, 2015). Technocrats tend to be siloed within their professions. A lack of institutional structures which could enable cross-sectoral arrangements to develop (Yin et al., 2016), exacerbates the problem and reduces the potential for the adoption of integrated planning of urban sub-systems (interviews with Urban Earth Consulting and SWECO, 2015). Overall, a radical reform of the existing socio-technical regime would be required for the Chinese to adopt the *SYMBIOCITY*1 approach towards planning their eco-cities.

8.2. Assembling BedZed in the Chinese urban context

In contrast the One Planet Framework (OPF) and Zed Design System (ZDS) work with the socio-technical regime, to produce context appropriate socio-technical systems. The global forms were used to master-plan three cities (Table 4) in China: Jinshan (sub-urban district of south-western Shanghai), Dalian (Liaoning Province, completed 2012) and Tongshan (Jiangsu Province, 2007).

ZDS has been used to produce the Tongshan and Dalian master-plans, which use renewable energy (solar), energy efficient materials, urban and building design to create low carbon developments. Both plans have also been adapted to address local needs. In Tongshan, water quality, scarcity and the climate are important local issues. Thus, sustainable urban drainage systems were designed into the development. These systems help to control temperature in the local microclimate; conserve water and improve water quality (Tongshan master-plan, 2007).

In Dalian, green infrastructure (green rooves, terraces, urban agriculture) has been incorporated into the master-plan, to appeal to the farming community which will be displaced by the town and re-housed in the new development (Dalian master-plan, 2012). The ZDS has been conceived to adapt to local context (interview ZedFactory, 2009). It can adapt to local vernacular architecture, urban design, cultural values and physical environment (Dunster et al., 2007). Thus, the application of the ZDS is likely to result in very different socio-technical systems, as demonstrated by the Dalian and Tongshan master-plans.

Bioregional worked with China Merchants Property Development to build a mixed-use development with 8000 homes in Jinshan (in the suburbs of Guangzhou) which drew on the OPF. The focus of the development was on water and energy efficiency[5]; and promotion of greener transport modes. Thus Bioregional focused on three OPF policies in the Jinshan master-plan (Bioregional, 2013). Other policies were likely to encounter difficulties in translation to the local context. For example, the Chinese public are particularly resistant to household recycling of waste [Duggan, 2015] car sharing and car-pooling schemes [Zeng, 2014]).

The global forms OPF and ZDS were designed to adapt to local context. The transformation of local culture, structures and practices were not required for their adoption. As demonstrated by Jinshan, solutions requiring radical change (e.g. recycling, car sharing, etc) weren't included. There were no specific technologies (e.g. district heating, vacuum waste systems) institutions (e.g. strong, well funded municipal government), processes (e.g. integrated, collaborative planning process), or funding streams (e.g. significant public funding) on which these global forms relied (unlike *SYMBIOCITY1*).

The consultants also ensured that the global forms adapted to the local context, by using constructive dialogue with local actors through a co-evolutionary – two way learning - process (interview with ZedFactory, 2014 and article by Bioregional, 2013). This dialogue appears to have encouraged greater support for projects from local actors and should eventually lead to the development of context appropriate models (interview with ZedFactory, 2014 and article by Bioregional, 2013).

[5] The aim is to produce a 65% reduction in energy demand and a 50% reduction in water demand when compared to other Chinese developments.

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9. Discussion

Global form (translatable knowledge) is a useful conceptualisation for exploring spatial socio-technical transitions. The analysis shows that only some experiments produce global forms. Successful global forms appear to be tools which aid in policy choices (OPF) and design decisions (ZDS). Knowledge generated from experiments which informs culture, structures and practices appears to be less translatable (demonstrated by the Swedish case study).

The way in which knowledge (global form) is articulated appears to be constantly changing (e.g. Swedish case study), as a result of changing global narratives, translating actors, political agendas and experiential evidence. Thus, the global form is a very fluid concept. The way in which knowledge is articulated will have a significant impact on the socio-technical systems which emerge from the translation process.

The mobility literature recognises that an array of socio-technical systems will emerge from translation of knowledge (global forms) to new spatial contexts. This results from the way in which knowledge is articulated and the interplay between global form and the recipient socio-technical regime. Thus, socio-technical systems (culture, structure and practices) developed in the experiments do not translate directly to new spatial contexts (demonstrated by the Swedish case).

Also by introducing the concepts of landscape and socio-technical regime into the global assemblage, we can begin to see how knowledge might be altered not only by the actors, programmes, etc conveying them but also by the changes in the global socio-technical regime and landscape in which the assemblage is embedded (demonstrated by the Swedish case).

Using the transitions conceptualisation to understand the ability of the knowledge produced from the original experiment to transform the socio-technical regime in the new spatial context is a useful addition to mobility conceptualisation when looking at the impact of experiments. The mobility conceptualisation which considers the “local assemblage” is more limited.

Overall by joining these conceptualisations we can begin to understand more clearly the knowledge (GF) that can be distilled from experiments (socio-technical systems) and translate into new spatial contexts. The knowledge which translates is limited usually to policies or decision-making tools relating to these policies. This knowledge produces new contextually appropriate socio-technical systems. We can also understand how the knowledge evolves over time throughout the spatial translation process. It does not remain one immutable package. This degree of fluidity will ultimately influence the socio-technical outcomes.

10. Conclusions

So what do these findings mean for practitioners? Overall greater clarity is needed throughout the translation process if outcomes are to improve. Firstly, in order to determine the potential for an urban experiment to translate into a new spatial context the practitioner must understand the context (narratives, networks, programmes, socio-technical regime and landscape events/trends) from which it emerged and the context into which it will be translated. Secondly practitioners need to clearly define the translatable global form emerging from an experiment. It must be possible to decontextualise and re-contextualise the global form if it is to translate successfully (e.g. OPF and ZDS). In some cases (e.g. SYMBIOCITY) it may be impossible to decontextualise the global form without undermining the fundamental principles underlying the experiment. Thirdly, practitioners need to be aware of how the global form can be manipulated and re-represented by the global and local assemblages during the translation process. The global form is not fixed. Finally practitioners should be aware that new socio-technical systems (adopting the fundamental principles developed in the experiment) will emerge from the translation process.

Theoretically, it seems that using mobility or transition conceptualisations alone is insufficient for understanding how low carbon experiments can influence developments in new spatial contexts. This paper demonstrates that using the mobile transitions conceptualisation can provide a more accurate understanding of the translation process and its outcomes. The paper makes two significant theoretical contributions. First it provides a more detailed conceptualisation of how the two frameworks can be effectively merged, resulting in a model for understanding the mobile transition process (Fig. 2). It tests the model using two experiments, thus addressing the lack of empirical evidence mentioned by Afforlderbach and Schulz (2016). Second, it builds on our understanding of what knowledge is translatable (in the global form), and how this is modified both by the global and local assemblages. It demonstrates that the translation of socio-technical systems to new spatial contexts is a highly fluid process.

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