Environment International xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Understanding the systemic nature of cities to improve health and climate change mitigation

Ralph Chapman [a,b,*], Philippa Howden-Chapman [c], Anthony Capon [d]

[a] School of Geography, Environment and Earth Sciences, Victoria University of Wellington, Kelburn Parade, Wellington 6140, New Zealand
[b] New Zealand Centre for Sustainable Cities, Victoria University of Wellington, Kelburn Parade, Wellington 6140, New Zealand
[c] Department of Public Health and New Zealand Centre for Sustainable Cities, University of Otago, 23a Mein St, Wellington 6242, New Zealand
[d] International Institute for Global Health, United Nations University, UKM Medical Centre, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Federal Territory of Kuala Lumpur, Malaysia

ARTICLE INFO

Article history:
Received 4 December 2015
Accepted 11 April 2016
Available online xxxx

Keywords:
Urban system
Coevolution
Cobenefits
Transport
Health
Mitigation

ABSTRACT

Understanding cities comprehensively as systems is a costly challenge and is typically not feasible for policy makers. Nevertheless, focusing on some key systemic characteristics of cities can give useful insights for policy to advance health and well-being outcomes. Moreover, if we take a coevolutionary systems view of cities, some conventional assumptions about the nature of urban development (e.g. the growth in private vehicle use with income) may not stand up. We illustrate this by examining the coevolution of urban transport and land use systems, and institutional change, giving examples of policy implications. At a high level, our concern derives from the need to better understand the dynamics of urban change, and its implications for health and well-being. At a practical level, we see opportunities to use stylised findings about urban systems to underpin policy experiments.

While it is now not uncommon to view cities as systems, policy makers appear to have made little use so far of a systems approach to inform choice of policies with consequences for health and well-being. System insights can be applied to intelligently anticipate change – for example, as cities are subjected to increasing natural system reactions to climate change, they must find ways to mitigate and adapt to it. Secondly, systems insights around policy cobenefits are vital for better informing horizontal policy integration. Lastly, an implication of system complexity is that rather than seeking detailed, 'full' knowledge about urban issues and policies, cities would be well advised to engage in policy experimentation to address increasingly urgent health and climate change issues.

1. Introduction

Urban policy makers face major challenges as they grapple with immediate problems such as improving mobility, providing land for new housing and maintaining population health, against a complex background of macro issues including climate destabilisation, growing income inequality, and fiscal constraint. Because of issue interconnection and system complexity, issue-by-issue policies to address such challenges often have little effect or even perverse effects, especially when policies are diluted by forces of conventional urban politics and corporate decisions. Many local governments also have limited policy autonomy, embedded as they are in a hierarchy of policy-making which is dominated by higher levels of government.

Urban system complexity requires simultaneous consideration of multiple issues, processes and outcomes. In such a setting, problems such as improving urban mobility or accessibility cannot be 'solved' as such, and policies struggle to produce net benefits. For example, a policy to restrain urban house price inflation by peripheral land development may encourage car dependence and over time reduce citizens' health (Rydin et al., 2012; Satterthwaite, 2011) while locking in higher carbon emissions. Such a policy will likely contribute incrementally to climate change, worsening health globally, albeit slowly (Costello et al., 2011). Meanwhile, price restraint in the housing market could be achieved better by other policies such as housing intensification. The policy challenge, then, is to understand urban dynamics and wider implications sufficiently to make a net positive contribution to health and well-being.

The current political context in most countries emphasises economic growth and cities are under pressure to be seen to contribute to a national development and innovation process (Bettencourt et al., 2007; Hodson and Marvin, 2011; LSE Cities, 2012; Shearmur, 2012). Moreover, the dominant economic paradigm in most countries privileges the market. This paradigm assumes that higher incomes contribute directly to social well-being, not recognising the reality of a more complex long-term relationship between economic activity (measured by GDP) and well-being (Kubiszewski et al., 2013). Simplistic assumed relationships divert attention from the complex determinants (such as health) of the well-being of citizens, the prudent use of resources (including ecosystem services) and avoidance of irreversible environmental risk

* Corresponding author at: School of Geography, Environment and Earth Sciences, Victoria University of Wellington, Kelburn Parade, Wellington 6140, New Zealand.
E-mail addresses: ralph.chapman@vuw.ac.nz (R. Chapman), philippa.howden-chapman@otago.ac.nz (P. Howden-Chapman), tony.capon@unu.edu (A. Capon).

http://dx.doi.org/10.1016/j.envint.2016.04.014
0160-4120/

(Newman and Matan, 2012; Quental et al., 2011; Williams, 2010). There are clear opportunities for policies to contribute to both economic development and population health and well-being (Howden-Chapman and Chapman, 2012; WHO, 2011), but these opportunities need to recognise the complexity of urban life.

Increased economic opportunities generated through urban agglomeration have lifted health and well-being enormously over time, driving global urbanisation. But urban development can adversely affect health: for example, the increasing dispersion of modern cities is associated with a trend to major unintended health impacts, through reduced levels of physical activity, and reduced air quality, typically due largely to motor vehicle emissions. The results include epidemics of obesity, diabetes, respiratory and cardiovascular disease, and depression (Burnett et al., 2014; Frank et al., 2004; Lindsay et al., 2011; MacDonald et al., 2010; WHO, 2011; Witten et al., 2011). Alongside these health trends, there is increasing recognition among the public health community of the significance of climate change as a key driver of long-term health outcomes (Costello et al., 2009; McMichael et al., 2009; Rydin et al., 2012).

Because of these multiple linkages, a framework is needed for understanding the connections between city characteristics on the one hand, and on the other, two critical twenty-first century preoccupations – health and climate change mitigation. We bracket these together, not only because climate change increasingly affects health, but because there is a strong affinity between the health of humans and the health of planetary systems: climate change is a sentinel indicator of planetary health (Whitmee et al., 2015). We argue that (a) cities need to be seen as complex systems, with a variety of characteristics affecting urban behaviour; and (b) urban systems need to be seen within a coevolutionary framework, in which urban systems coevolve with natural systems, infrastructure, technologies and institutions. These interact to determine in a dynamic way the outcomes of interest, in particular the health and well-being of citizens.

Seeing urban challenges through these two lenses can provide rich insights for policy analysis. It offers policy makers a better understanding of the problems they confront and why solutions which appeal in the short term subsequently fail. The two lenses also crystallise important urban system interconnections, and better illuminate urban transition paths.

While it is intuitively evident that cities are complex, interconnected systems, much policy is made without considering broader ramifications and dynamics (Banister, 2005), nor how a range of drivers such as institutional evolution affect urban outcomes. This is partly because of the reductionist reaction to considering complexity, and partly because there is too little empirical evidence about policy interactions and consequences. Accordingly, this paper seeks to be practical – it focuses on tangible illustrations, useful for policy, from the urban transport and land use sector, highlighting instances where, even with limited empirical evidence, characteristic urban system behaviour can be better understood and projected.

This paper is structured as follows. Section 2 briefly summarises characteristics of urban systems, and discusses how key sectors are interconnected. It also introduces a framework identifying how key elements of dynamic urban systems coevolve. Turning to policy, Section 3 considers how policies can better recognise system characteristics of cities (especially transport and land use) and coevolutionary forces. Examples from various countries are given. Section 4 discusses how systems thinking on policy matters increases the potential of cities to be 'transformed' to yield better outcomes for health and climate change. Section 5 draws conclusions.

2. Cities as systems

2.1. Insights from the systems and coevolution literature

The general systems literature (Allen, 1997; Capra, 1996; Chapman, 2004; Dollfus and Durand Dastes, 1975; Elzen et al., 2004; Loorbach and Rotmans, 2006; Lovelock, 2006) typically characterises natural systems or human activity systems, whether communities or parts of organisms, as follows. First, systems are integrated wholes, where the whole, with its emergent properties, is more than the sum of its parts. Second, systems comprise nested (sub-)systems, at a range of scales. Third, systems have feedback processes among network elements, allowing self-regulation, self-organisation and learning in response to changing external conditions. Fourth, systems behave in a complex fashion, with non-linear behaviour, seldom stable or in equilibrium, and with interventions generating unintended consequences. Lastly, systems are able to be resilient, if adaptively managed.

Let us briefly consider the way in which cities exhibit these characteristics. First, a city is a 'socio-ecological-technical' whole, comprising strongly interconnected parts, driven by and contributing to social, ecological and technological forces (Monstadt, 2009). Within the city, nested integrated wholes exist, e.g. a city public transport network. Such wholes have important emergent properties, such as economic productivity and city identity.

The second system characteristic, nesting, is also evident. Cities exhibit interacting activity and governance at multiple *scales* – from the state to the household, and increasingly extending to international networks of cities as sites of influence on the life of a city. From a geographic perspective, the immediate region is vital, but wider systems that provide resources, from food to communications, are also important (Tyler and Moench, 2012). Urban innovation niches nest within wider sociotechnical regimes and a wider institutional and economic landscape (Geels, 2011; Monstadt, 2009). In terms of governance, we see a wide variety of nested institutions (Bulkeley and Betsill, 2005; OECD, 2009), down to local home owners' associations in the US (Seto et al., 2010). Nested systems are richly interconnected and evolving; for example, internet linkages facilitate interactions between individuals both vertically, up and down levels, and horizontally, across networks, making social and cultural linkages fluid and complex. At the same time, evolving technologies such as broadband networks can make new urban services possible, while making traditional governance more challenging (Wedel, 2009, p.39).

Complexity tends to increase with greater scale; indeed, easier communication and increasing returns to scale in knowledge appear to drive urban innovation (Glaeser, 2011b; Shearmur, 2012). Size, agglomeration and innovation are often connected (Kamal-Chaoui and Robert, 2009), which may help account for the often higher incomes and associated consumption levels of many in big cities.

Third, much urban activity is *self-organising.* For example, in a well-functioning city, largely self-regulating markets, employing myriad feedback mechanisms, respond to changing conditions such as socio-demographic shifts. City political systems are self-organising and often autonomous from national politics, frequently contesting the demands of the state (Magnusson, 2011).

However, urban analysts' ability to predict sustainability outcomes arising out of socioeconomic trends and city policies is limited, because of the non-linearity of city systems and the complexity of the interrelationships.

Complexity, a fourth characteristic, means that city development is driven by a range of interacting processes, partly described by the co-evolutionary framework presented below. Non-linear effects and chance events are important, and development paths are affected by feedback, inertia, and innovation (Arthur, 1989; Martin and Simmie, 2008; Scheffer and Westley, 2007). Developments at one scale are contingent on linked developments at other scales (Chapman, 2004). For example, cities are linked economically not only to their regional hinterlands, but into the global economic 'ecosystem' (Brown et al., 2008).

Lastly, cities can be *resilient*, although history demonstrates that this is not necessarily the case (Chelleri, 2012). Resilience in an urban context implies social-ecological adaptive capacity and the ability to reflect on and evaluate policies for long-term sustainability (Allan and Bryant, 2011; Nelson, 2010, p.115). Many cities suffer from fragmented or under-resourced institutions, but others with more strategic governance

Please cite this article as: Chapman, R., et al., Understanding the systemic nature of cities to improve health and climate change mitigation, Environ Int (2016), http://dx.doi.org/10.1016/j.envint.2016.04.014