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Te Kōmihana Whai Hua o Aotearoa

What can complexity theory tell us about urban planning?

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Author: Ron Crawford

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[1] The Commission that pursues abundance for New Zealand.

Purpose

The purpose of this note is to generate a discussion about cities as complex, adaptive systems and possible implications for urban planning. The note raises questions about the place of different broad approaches to planning, in dealing with complexity. It also raises questions about how collective choice mechanisms to support a participative, collaborative approach would develop.

Complexity theory is only one frame that the inquiry will use. In any case, complexity theory builds on an eclectic range of other disciplines. Urban economics, the economics of innovation, behavioural economics and comparative institutional analysis are other relevant frames from which to view urban planning. Standard economic equilibrium analysis, suitably contextualised, also has its place (Colander & Kupers, 2014).

We envisage that the ideas set out in this note will inform the inquiry as it proceeds. The advantages of complexity and effective governance within complex systems are integral to well-performing cities.

Contents

Key points

- Complexity theory studies the genesis and properties of complex systems. It is a young science that draws on many disciplines and has yet to establish a unified framework.
- The primary distinction between *complex* and *complicated* systems is 'emergence'. Emergence means that a complex system exhibits aggregate properties that are not just the sum of the properties of individual system elements. Reproduction through genetic codes is an example of emergence.
- Complex systems exhibit self-organisation, non-linear dynamics, path dependence, adaptive behaviour and a multi-layered ordering of sub-systems. Each level in the system follows its own rules, which need to be consistent with those of a lower level.
- The effect of interventions on outcomes in complex systems is unpredictable, at least in detail. Infeasibility of defining precise initial conditions, adaptive behaviour by system elements and emergence explain unpredictability. Yet it is possible, on the basis of simulation models and other techniques, to predict the types of patterns that arise when certain conditions are satisfied.
- Urbanists have viewed cities as complex systems at least since the 1960s. An eclectic set of approaches has looked at how implicit economising and cultural rules shape cities; and how networks give effect to relationships among a city's agents. Complexity underlies many of the benefits that cities offer through "agglomeration economies" – particularly through better matching and learning among diverse and specialised agents.
- Complexity and unpredictability challenge the feasibility of urban planning beyond a certain point. In response, some theorists propose to limit planning to setting a few simple and universal rules to guide private development, while allowing place-based plans for publicly resourced city elements (such as roads and public spaces). Simulation games suggest that such rules, combined with private action, could generate well-ordered urban spaces, while supporting the complexity that give cities their advantages.
- The other broad response to complexity recognises that while no one actor can control urban outcomes, agents acting collectively and iteratively can identify shared goals and agree on a means to achieve them.
- Government is just one of an evolving set of collective choice mechanisms in a complex system. In a participative approach to urban planning, government can influence the evolution of other collective action mechanisms, building on and influencing existing norms and values. Emerging mechanisms need the appropriate scale and scope to match the urban development issues they are addressing.
- A rules-based approach to planning (using a few, simple universal rules) still requires place-based plans for publicly resourced city elements. In a hybrid system, policy would need to define the relative scope of rules-based and collaborative, participative approaches. Rules may also need to vary over space to better accommodate different urban morphology, such as desirable differences in density.

What is complexity theory?

Complexity theory is a developing field covering a wide range of natural, social and economic phenomena (eg, rainforests, markets, cities, languages, the internet). Complexity theory uses a variety of other theories to draw insights about the genesis of complex systems, and system characteristics and dynamics. While many approaches are eclectic, some theorists (eg, Holland, 2014) are working towards a unified theory of complexity.

What are complex systems?

The Complexity Academy, (2015) sees complexity as a function of:

- the number of elements in a system,
- the degree of connectivity within a system,
- the ability of system elements to adapt over time to become increasingly complex (often modelled as evolutionary processes that allow the emergence of organization from the bottom up), and
- the degree of diversity between elements within a system (an important input into evolving systems complexity) (cf, Allen, 2012).

Holland (2014) and others distinguish the "complex" from the "complicated". While the boundaries are fuzzy (as with "life" and "consciousness"), "emergence" distinguishes complex systems as a subset of complicated systems. Emergence means that "the [system] aggregate exhibits properties *not* attained by summation [of individual interactions within the system]" (p. 3). Examples of emergence include wetness as a property of an aggregate of water molecules, or "self-reproduction" as a property of sequences of "instructions" (for instance those instructions contained in strings of RNA and DNA).

What generates complex systems?

There are a wide variety of approaches to understanding complex adaptive systems (eg, Colander & Kupers, 2014; Complexity Academy, 2015). Holland (2014) draws threads from genetics, evolution, linguistics, computer science and information processing (among other disciplines) to work towards a more general theory. Common to all these are features and processes that generate complexity:

- the existence of boundaries between system elements,
- the transmission and selective re-transmission of signals across those boundaries (typically based on filters that recognise "tags" or small segments within those signals),
- recombination of signals into new configurations; and selection pressures that lead to adaptation and the appearance of new types of agents,
- sophisticated agents using autonomous internal sub-systems to anticipate the outcomes of a sequence of actions (ie, an ability to plan), and
- more complex substructures forming from building blocks of extant substructures.

While identifying common processes that generate complex systems, Holland (2014) concludes:

> It is clear that complex systems [theory is] … still primarily at the stage of collecting and examining examples, much as was the case in the early stages of biology, or the early stages of physics before Newton, or the study of electrical and magnetic phenomena before Maxwell. We are still a long way from an overarching theory of complexity, but there is strong evidence that such a theory is possible. (p. 90)

Features of complex systems

Colander and Kupers (2014) and Holland (2014), amongst others, identify salient characteristics of complex adaptive systems, including:

- self-organisation into patterns (such as occurs with flocks of birds or schools of fish),
- non-linearities, including "butterfly effects" (where small scale events can have large systemic effects[2]), and tipping points (where a minor shift in parameters can produce sudden changes of state (eg, liquid water turning to ice; species extinction as a result of a small change in environmental conditions),
- path dependence, so that possibilities for future evolution of the systems are shaped by how the system has evolved in the past,
- adaptive behaviour, where autonomous system elements modify their behaviour as the system evolves and experience accumulates,
- unpredictability of the effect of actions on system outcomes – arising from difficulties in identifying complete initial conditions, from the adaptation of autonomous system elements to their environment, and from emergence (Batty & Marshall, 2012, p. 35),
- hierarchical ordering within the system, with the behaviour of phenomena at each level following its own set of rules. Rules at a higher level need to be consistent with those of a lower level, but cannot be directly derived from them. Phenomena at different levels interact through "bottom-up" and "top-down" influences. (Holland (2014) gives the example of buyers and sellers in an equities market being influenced by daily market averages; while, at the same time, their transactions determine the market average).

Complex systems and prediction

Formal analytic models of complex systems are not tractable because of a combination of adaptive behaviour, non-linearities, the difficulties in fully specifying initial conditions and emergence. Moroni (2012) points out that adaptive behaviour means that system parameters are not stable. As a result, deductive approaches do not work well as a way of understanding complex systems.

In practice, researchers have used agent-based models that can generate complex patterns based on simple rules of interaction (Colander & Kupers, pp. 127, 210). The resulting patterns indicate the sorts of outcomes that are possible or likely as a result of particular changes, rather than a prediction in detail of those outcomes. Moroni (2014, p. 250) following Hayek says "when we are dealing with structures of essential complexity (such as social phenomena), it is not feasible to provide *explanations of detail*, but only an *explanation of the principle*…" By this he means explanations of typical kinds of events – such as the "types of patterns that arise when certain general conditions are satisfied."

Batty and Marshall (2012) and, more broadly, Colander and Kupers (2014, p. 154) suggest an eclectic, multidisciplinary approach to understanding complex systems, based on "educated commonsense".

[2] Portugali (2012b, p. 228) gives the example of an unknown resident of Te Aviv deciding to enlarge their apartment by closing in their balcony, somewhere around the end of the 1950s. The innovation spread, and "before long the vast majority of balconies in the whole country was closed." Portugali observes "…the planned action of a single person might have a much stronger and significant impact on the urban landscape than the plans of architects and official planners" (p. 229).

Cities as complex adaptive systems

A very broad range of theories and approaches are used to depict cities as complex systems (Portugali et al., 2012, in particular Read, 2012).

Alexander (1966) early recognised that the complexity of "natural" cities arises from an "inner nature" or "ordering principle" (p. 3). He argued that the units forming a city comprise overlapping and hierarchically ordered sets. Such an arrangement leads to a far more complex set of possibilities than a system where sets are entirely contained within or entirely discrete from other sets. For instance, a system with 20 elements allows 1 million subsets if overlapping sets are permitted; but only 19 if they are not. Alexander believed that then prevailing view of cities, particularly planned cities, ignored this source of complexity. He illustrates the potential complexity with interactions at a particular city street corner (Box 1).

Box 1 **A microcosm of urban complexity – a street corner in Berkeley, California circa 1960**

> … in Berkeley at the corner of Hearst and Euclid, there is a drugstore, and outside the drugstore a traffic light. In the entrance to the drugstore there is a newsrack where the day's papers are displayed. When the light is red, people who are waiting to cross the street stand idly by the light; and since they have nothing to do, they look at the papers displayed on the newsrack which they can see from where they stand. Some of them just read the headlines, others actually buy a paper while they wait.
>
> This effect makes the newsrack and the traffic light interactive; the newsrack, the newspapers on it, the money going from people's pockets to the dime slot, the people who stop at the light and read papers, the traffic light, the electric impulses which make the lights change, and the sidewalk which the people stand on form a system - they all work together.
>
> From the designer's point of view, the physically unchanging part of this system is of special interest. The newsrack, the traffic light and the sidewalk between them, related as they are, form the fixed part of the system. It is the unchanging receptacle in which the changing parts of the system - people, newspapers, money and electrical impulses - can work together. I define this fixed part as a unit of the city. It derives its coherence as a unit both from the forces which hold its own elements together and from the dynamic coherence of the larger living system which includes it as a fixed invariant part.

Source: Alexander (1966)

Alexander argued both that the "required" "semi-lattice" overlapping structure of the modern city was changing over time, and that it had yet to be discovered. Alexander later developed his thinking in the search for a "pattern language" whereby architectural and urban form would be generated by the application of rules which architects and designers were free to adapt to particular circumstances.[3]

Another strand of thought looks at how the complex morphologies of cities are generated by *implicit* rules for economising on transport and communication costs. Batty and Marshall (2012, p.36) talk about deep similarities of city structure and function at different spatial scales that are driven by finding a means to "deliver energy" in the most economical manner. Models based on fractal geometry can generate such patterns using "local rules relating to land development". Hillier (2012. p. 147) comments "…urban space networks seem to be shaped to some degree by a combination of spatial laws and human agency, with the human agents implementing, and so in a sense knowing, the spatial laws."

[3] Eg, Alexander, C., Ishikawa, S. & Silverstein, M. (1977). *A pattern language: Towns, buildings, construction.* Oxford, UK: Oxford University Press.

At some scales, the influence of cultural norms is also important. Hillier (2012) describes how, at the macro level, the old core of Nicosia conforms to a typical "deformed wheel" shape, across Greek and Turkish quarters. Yet, within each quarter, the arrangement of residential streets is very different, reflecting specific cultural preferences.

Researchers have used simulation games to explore further the idea that "spatial laws", understood implicitly by human agents, shape urban form through "self-organisation processes" (eg, Tan & Portugali, 2012). The game process is sequential and iterative, with each player responding to the emerging city form with new negotiated design choices (which however are constrained by what has already emerged). While the starting rules are typically extremely simple (eg, play is sequential, and earlier development has priority over later) "other rules came into being as emerging properties during the game" (p. 389).

This approach to understanding city development, sees individuals as planners, each with their own internal representations of desired future states, but each adapting iteratively to the collective realisation of those plans (Portugali, 2012 & 2013). Similarly, de Roo & Rauws (2012, p.213) talk about path dependency in a city's development which shapes "the possibilities for adaptive behaviour, self-organisation and the diversity of potential developments."

Writing at the same time as Alexander, Jacobs (eg, 1961, 1969) also recognised the complexity of cities and the advantages to residents arising from this complexity. For Jacobs, such complexity emerged spontaneously and organically from the bottom up. Like Alexander, she strongly opposed prevailing planning theory and practice – which intrinsically operated to reduce complexity.[4] For Jacobs (1961), planning was a science of "organised complexity" (cited in Batty & Marshall, 2012, p. 32).

Consistent with Jacobs' understanding, Marshall (2012, pp. 193-194) identified three benefits of urban complexity:

- perceptual richness (which "[is] more aesthetic, satisfying, or in some way makes humans psychologically feel more at home than in simpler environments"),
- functional capacity ("through properties such as hierarchy, symmetry or asymmetry, flexibility, redundancy or specialisation of different parts"), and
- synergy (which creates the possibility that the whole is greater than the parts – as in Alexander's newsrack example above).

Economists rely on similar mechanisms to explain agglomeration economies. Duranton and Puga (2003) identified benefits from sharing (for instance of inputs, or of indivisible facilities), matching (improving the frequency and quality of matches involved in transactions) and learning (improving the frequency and quality of transfer of learning). The possibilities for each of these increase with complexity. Alternatively, Webster and Wai-Chung Lai (2003) argue that cities are essentially an arrangement to reduce transport and transaction costs broadly defined. "Cities - their size and internal morphology – may … be said to be shaped by an aversion to transaction costs" (p. 215).

Another approach draws on network theory to understanding cities as complex systems. Batty and Marshall (2012, p. 36) noted:

> Massive strides have been made in examining different forms of network structure and using these to represent different kinds of dynamics ranging from the way percolation functions to the impact of epidemic processes on both spatial and temporal structures.

Researchers have also looked at the dynamics of cities as complex adaptive systems. Such systems exhibit non-linearities and discontinuities and are often or usually far from equilibrium (Batty & Marshall, 2012). Such systems, for instance, can magnify small differences in preferences to relative large differences across space.

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[4] Alexander (1966) was not persuaded, however, by Jacobs preferred solutions.

> [Emergence] means that the local interactions between urban agents often give rise to properties that exist only at the global scale of a city. For example, a high level of cultural/ethnic segregation in a city does not imply highly segregative behaviour on the part of individual urban agents … a very small proportion of segregative urban agents might give rise to a highly segregative city. (Portugali, 2012, p. 49)

What can complexity theory tell us about urban planning?

Complexity has significant implications for the practice of planning. In particular, the difficulty with predicting the effects of interventions in detail raises questions about the purpose of planning, and what approaches would best achieve that purpose.

> The idea of the planned city as a knowable utopia is a chimera. Nevertheless, we continue to try to plan in the belief that the world will be a better place if we intervene to identify and solve issues that are widely regarded as problematic. But this must be tempered with an awareness of the limitations of planning, not least through an awareness of the evolutionary nature of urban change … (Batty & Marshall, 2012, p. 44)

The difficulty of predicting in complex systems will have differing implications for each aspect of planning, and for the overall design of the planning system. The inquiry proposes to break planning down into something like the following aspects:

- Plan making (including processes of balancing and finding trade-offs among competing values and interests, including quasi-judicial and judicial processes);
- Assessment and approval of development proposals (which might occasionally lead to variations in plans);
- Resolution of disputes about development proposals (including who has standing and appeal rights); and
- The culture of planners and planning.

The complexity frame is likely to have particular implications for the design of the system as a whole, for plan making and variations to plans, and for the culture of planners and planning.

Another pertinent distinction is between planning for things entirely in the public domain such as transport infrastructure and local public goods on the one hand and planning in the sense of regulation of private property rights on the other.

Two broad approaches to planning in complex urban systems

While they agree that complexity poses a problem for planning, urban theorists split into two broad approaches in response.

City development based on a few simple, universal spatial rules

One broad response builds on the observation that a complex order can arise spontaneously from the consistent and persistent application of often implicit, spatial laws over time. In this approach, the government sets a few simple and universal rules to guide the behaviour of urban agents, who are then free to realise their own plans as they think best.

Moroni, for instance, argued that complexity theory (and inability to predict outcomes) favours a 'nomocratic' approach in which there is a

> crucial difference between seeking to direct the activities of others as separate and independent members of a complex system, and seeking to organise our own delimited and circumscribed activities... (2014, p. 261)
>
> … local governments must *regulate* the actions of the private actors (allowing landowners, developers and so on to make free use of their lands and buildings within a framework of relational rules that apply equally to everyone, and as long as such use does not create negative externalities), and *plan* their own actions (trying to coordinate the use of public resources at their disposal in a responsible and efficient manner, to guarantee infrastructures and services). (2014, p. 260)

By "relational rules" Moroni (2014) primarily means "rules of conduct" which directly and uniformly control the ways in which private citizens may or may not use or modify land and buildings (p. 258). Together a set of relational rules form an "urban code". "Urban codes are based on …relational rules that are few, simple, generic, end-states-independent, long-run oriented and prevalently 'negative'" (p. 257). Moroni provides examples: "'no land transformation and no building development or use may produce externalities of type E, F and D'; 'No building of type H may be constructed within X metres from building of type K'…"[5]

Moroni (2014, p. 26) explicitly argues against a "participative, communicative, collaborative process" as a way of solving the problem he identifies with planning in complex systems:

> … if explanations of detail and specific predictions are intrinsically impossible in the case of a complex system like a city, any participative, communicative, collaborative process – no matter how extensive, transparent and shared it may be – cannot solve the root problem.

Yet, looked at another way, an approach based on a few, simple and universal rules, provides plenty of scope for private actors to find ways to organise themselves and collaborate in developing urban spaces. At the same time, it could reduce the quantum and likelihood of private gains and losses from planning decisions, in turn reducing the political stakes and opportunities for corruption.

This note does not intend to explore in depth the strengths and weaknesses of a universal rules-based approach of the type that Moroni (2014) proposes. It is worth noting here, though, that such an approach, strictly applied, might have dampening effects on innovation. For instance, developers are rapidly changing the way they want to use space in the Brisbane CBD, while there is little demand for change in planning codes outside the CBD. It might be efficient to have different rules for high density urban areas and less dense urban areas.

A participative, collaborative approach to city development

The second broad response to the problem of planning in complex systems is to use a participative, collaborative, iterative approach to engage urban agents in the evolutionary development of a city. Planning is essentially provisional and adjusts, through collective action, to emerging city form and behaviour.

This approach recognises that no one actor (including government) can control system outcomes. As discussed above, the effects of interventions are inherently unpredictable (at least in detail and over the longer term) and, in any case, depend on actors' adaptive responses to emerging developments.

Because actors together shape outcomes, they need to develop shared understandings of planning objectives and the trade-offs in achieving those objectives, and shared commitment to achieving those objectives. The system needs feed-back loops so that, through shared understanding of what is happening, actors can adjust plans as the system evolves.

Recognising that actors within the system play an important part in shaping outcomes means that planners cannot necessarily rely just on general and broad approaches. They will often need to look at particular circumstances and engage with actors in a fine-grained way to find the best or feasible

[5] As discussed above, researchers use simulation games to explore the outcomes of a rule-based approach to urban development (eg, Portugali, 2012b; Tan & Portugali, 2012).

solutions. Colander and Kupers (2014) describe how this worked for the French post office in designing postal routes (Box 2). Analogous processes would suit a collaborative, participative approach to planning.

Box 2 **Designing new postal routes – the French experience**

The French post office engaged Icosystem (a data analytics company specialising in complex systems) to help design postal routes for its tens of thousands of mail deliverers. Designers have standard techniques to optimize the routing if the mail deliverers have no relevant information in addition to that held by the designers and the goal is solely efficiency. "Unfortunately for the standard techniques, neither assumption holds" (Colander & Kupers, 2014, p. 210).

To overcome this problem, Icosystem used a computer algorithm to design an initial set of routes, based on minimising the time that would be spent delivering mail. Each postal worker was asked to rate their preferences across an initial set, and these, in turn, were analysed by another algorithm to produce a new set of routes. The algorithm worked by recombining "successful" bits of a solution and dropping less successful bits. The new routes deviated from the efficiency optimum, but took account of workers' local knowledge and preferences. The process was repeated several times, to produce the final routes.

> The result is that this process generated an evolving set of routes that were optimized not from a classic cost efficiency perspective, but from a perspective that reflected the desires of the individual postal workers, as well as the interaction between individual and collective choice. (p. 211)

Colander and Kuper point out that:

> …optimality in a complex environment requires bottom-up feedback into the design of the system to use the local information available only to the agents on the ground. Any attempt to collect that will fail since the preferences of the individual postal workers are not fixed and are affected by the relative routings as well.

De Roo & Rauws (2012) also emphasise the importance of accounting for local circumstances in planning in complex spatial systems:

> … area-specific characteristics and local stakeholders have been increasingly integrated in planning processes …Here we see the increasing need for an open planning process in which actors work together to reach consensus on an area-oriented strategy, and share responsibility for the system. (p. 209)

Colander and Kupers (2012, p.182) look at government policy in complex systems more broadly. They argue that "complexity policy is contextual and consists of a set of tools, not a set of rules, that helps the policy maker to come to reasonable conclusions." The tools they discuss include those derived from behavioural economics ("the economics of influence"), which recognise that norms and values matter as well as incentives, and that they can be influenced. Norms and values are important mediators of collective action and collective action can shape norms and values. Complexity policy recognises the potential for path dependence and lock-ins and seeks ways to address these dynamics if they are a problem.

Yet participation and collaboration is not a simple panacea for solving urban planning problems. Collective action institutions need careful design to succeed in overcoming inherent conflicts of interest.

For instance, urban planning has many examples of diffuse costs and concentrated benefits, or concentrated benefits and diffuse costs. Parties with diffuse costs or benefits have lower incentives to be involved than those with concentrated costs and benefits. Some people with an interest in effective planning in a particular urban area – such as potential residents kept out by price barriers – are not represented in local decision making.

What should be the goal of urban planning?

Complex systems are dynamic and far from equilibrium. It is not possible to plan for an "optimal" future state (Batty & Marshall, 2012; Colander & Kupers, 2014). What should be the goal of urban planning?

At one level, the goal may simply be to "to identify and solve issues that are widely regarded as problematic" (Batty & Marshall, 2012, p. 44). This would fit with the collaborative, participative approach discussed above.

Goals at the system level, however, are more than just individual goals aggregated (Colander & Kupers, 2014, p. 196). Colander and Kupers (and others) propose that system survival or system resilience is an important system-level goal. "Resilience is the capacity of the system to absorb and adjust to change by learning from it." (Colander & Kupers, 2012, p. 199). Colander and Kupers use the financial system after the great financial crisis to illustrate their point. A search for "efficiency" among the constituent parts of the financial system does not address the risk of systemic breakdown. Yet a dysfunctional system (a system that exhibits features "that are widely regarded as problematic") may be resilient, in the sense of being capable of surviving. So resilience is not sufficient for desirable outcomes.

Other thinkers substitute "sustainability" for "resilience". Echoing Colander and Kupers definition of resilience, Allen (2012) says "…sustainability is a result of the existence of a capacity to explore and change …" (2012, p. 87). Yet Batty and Marshall (2012, p 44) argue that "sustainability is intimately bound up with maintaining some kind of desirable state … into the long term future … [in a complex, evolving system] what might seem sustainable [now] might not be 'sustainable' in future."

Within the broad goal of system resilience, Colander and Kuper (2012) repeatedly suggest modest, "commonsense" goals for complexity policy. The complexity frame "shows that any policy frame can only be an heuristic rather than a scientific truth … any model will only be a rough guide … the focus is more on creating a resilient environment than on finding an optimal solution…"(p. 273).

Consistent with this:

> In the complexity frame engaging widely is not only logical but also essential. [This involves] .. a continuous exploration of evolving goals and the means to achieve those goals (p. 254) [and]
>
> …careful and creative consensus building, with only a general specification of the goals, lest the discussions get bogged down in frozen polarization… (p. 255).

General specification of "strategic goals" for urban planning might include things like enhancing the performance of labour markets in the spatial context of a city, making a city more liveable and an attractive place for high-skilled workers to live.

Role of government in urban planning

Government is just one of the adaptive/evolving elements in a complex system (Colander & Kupers, 2014, p. 179).

> Government is simply an institution built by people to help solve collective choice problems. If current government structures are not reflecting people's will as well as they should, then they will evolve and become better able to do that.

Colander and Kupers propose that a key focus of policy should be positively influencing the evolution of institutions. Government co-evolves with the economy and society and they should not be considered separately. While normative codes and the ecostructure in which people operate are important for bottom up policy, top-down policy should be seen as an evolving process that works alongside evolving institutions. "[G]overnment is one instance of a collective choice mechanism" (p. 273). Policy should allow for others, particularly those that "enable bottom-up collective action."

According to Colander and Kupers (2012), government has a meta role in "providing a balance among various views and coming to a compromise" (p. 237); and, to facilitate this, system institutions should be shielded from direct political pressure (p. 246). Similarly, de Roo and Rauws (2012) identify a spectrum of complexity facing spatial planning. At the more complex end of the spectrum (where the outcomes of interventions are uncertain) "values and opinion play an important role and … making agreements is an important part of constructive planning action" (p. 211).

It is worth noting that this approach to "making agreements" in complex systems relies on a genuine devolution of some decision rights. It is very different to using consultation as a means to bolster planning decisions, where the decision rights rest largely or solely with a planning authority.

Finding the effective scope for collective action in urban planning

If the role of government in spatial planning is to build consensus and collective action, what is the appropriate scope for such action? The Canterbury Clincial Network is an example of clinician-led collective action at a scale and with a set of issues and goals that seems to work (Love, 2015; NZPC, 2015; Timmins & Ham, 2013). This initiative has worked because it has brought together people with the right knowledge and skills, given them the appropriate decision rights and control of resources, and set up ongoing processes for identifying local goals and building consensus on the best means to achieve them. The initiative works within the complex Canterbury health system, because different elements of the initiative are nested within and integrated with broad overarching system goals and support functions. While different disciplines are involved, to some extent they share a common culture and service ethic on which the initiative could build.

How might a collective action process work in spatial planning? It is difficult to answer this in the abstract. From the Canterbury Clinical Network example, developing a collective action approach to spatial planning might involve:

- understanding how the particular urban system is structured: Where are the joints between the different sub-systems around which collective action might be organised? What are the levels within which sub-systems are nested? How are the sub-systems connected or integrated within and across levels?
- identifying within sub-systems the relevant resources and actors with decisions rights and the knowledge needed to move things forward;
- building collective action institutions at a workable scale and ambit, and
- identifying required system-wide support functions (such as data collection, analysis and feedback on system development).

Elinor and Vincent Ostrom, in their work on "polycentric" governance of complex economic systems, looked in particular at water provision and policing in US cities (Ostrom, 2007 & 2009; McGinnis & Ostrom, 2012). They stressed that the most effective and resilient arrangements might well result from overlapping and multi-level governance arrangements that could involve public and private and non-government collective action institutions. The use of urban space could, like the use of water sources, be regarded in some respects as a "common-pool resource" – a good whose use by one person subtracts from the use available to others, but which is difficult to exclude potential beneficiaries from enjoying (Ostrom, 2010).

The Ostroms spent much of their careers documenting and analysing the conditions that help collective action institutions succeed in dealing with common-pool resource use (Ostrom, 2010; McGinnis & Ostrom, 2012). They focused particularly on the rules (implicit or explicit) at play and design principles "that characterized the long sustained regimes as contrasted to the cases of failure" (Ostrom, 2010, p. 13). Non-government collective action governance arrangements were often (but not invariably) found to be more successful in improving outcomes than top-down approaches. Top-down regulation could, at times, crowd out "voluntary behavior to cooperate" (p. 16).

Elinor Ostrom emphasised that a diverse range of institutions can work in practice, so long as they are "well matched to local settings and involve[e] the active participation of local users" (2010, p. 24).

> We need to ask how diverse polycentric institutions help or hinder the innovativeness, learning, adapting, trustworthiness, levels of cooperation of participants, and the achievement of more effective, equitable, and sustainable outcomes at multiple scales… (p. 25)

The approach of Webster and Wai-Chung Lai (2003) to "managing spontaneous cities" may also have some relevance to identifying urban sub-systems, the appropriate ambit of collective action or which actors would usefully be involved in such action. Webster and Wai-Chung Lai use an analysis of property rights to identify "five kinds of urban order" which "emerge to reduce the costs of co-operation". In particular they identify "exclusion costs (the costs of protection from third party opportunism)", "transaction costs (the costs of using markets)" and "organisation (or agency) costs (the costs of managing co-operation and planning within an organisation)" (p.213). The five kinds of urban order are:

- Institutional (patterns of rules and sanctions governing ownership, exchange and combination of property rights).
- Proprietary (patterns of property rights resulting from institutions);
- Organisational (patterns of combined property rights)
- Spatial (spatial patterns of property, resources, organisations and institutions) and
- Public domain (patterns of resources left with unclear property rights)

Spatial scale is also relevant to thinking about the scope of collective action. For instance, Brisbane has processes that allow neighbourhoods to work through and make trade-offs about how broader city-wide decisions on densification will apply. Auckland, on the other hand, has no such mechanisms. Copenhagen has institutions and processes that support planning trade-offs between competing interest groups, both city-wide and in neighbourhoods or suburbs (Guy Salmon, pers. comm. 5 April, 2016).

Understanding relevant norms and values (such as those underlying NIMBYism), and how they might shift in response to the planning environment and the co-evolution of new collective action institutions, could contribute to a more effective system of urban planning.

A hybrid approach to city planning?

This section has identified two broadly different possible responses to dealing with the uncertainty arising from the complexity of urban systems. The first, proposed in particular by Moroni (2014) would largely restrict spatial planning to a few, simple and universal rules. Residents and property owners would be free to organise themselves and collaborate in developing urban spaces, while making their own design choices within the framework of an urban code. The second response to complexity, instead, advocates a participative, collaborative approach in which urban actors develop shared goals and agree on the means to give effect to those goals. The process is iterative and evolutionary as actors' preferences and plans change in response to emerging system features. Overlapping and multi-level governance arrangements could involve public and private and non-government collective-action institutions.

The two approaches are not mutually exclusive – though the proper ambit of each would need to be agreed. Indeed Moroni (2014) envisages that more traditional spatial planning would still apply to developments that use public resources. Obvious examples include roading and other infrastructure, public buildings and public spaces and amenities. Making plans for these presumably requires some conception of possible outcomes in terms of location of urban activity, land use densities and intensity of use. A participative, communicative, collaborative process may well be the best approach to such planning.

A participative, collaborative approach might be required for things like long-lived infrastructure and developments that have large effects on other parties. Here the optimal timing of infrastructure development and the option value of waiting are important considerations. Yet much of the planning system could rely on simple, common sense rules guiding the actions of private parties.

Marshall (2012) argues for such a mixed system:

> a system of planning that involves not only design (master-planning) but coding and development control (involving increments of generation and selective feedback) … more like evolution than design. (p. 192)

Allen (2012) also, in essence, argues that suitably modest prediction continues to have a role in planning:

> … [in complex systems] it is possible to predict to some degree and for some time-scales…it is important to know what qualitative structure could emerge and discuss the merits and demerits of these, since these are the choices open to the system at present… These are the possible targets for planning interventions and other outcomes will not really occur … Without models that can explore the possible future structures and morphologies of the system, planning and interventions can have no predictable outcomes. (p. 83)

Under a rules-based approach of the type advocated by Moroni (2014) there is also a prior question of who and how the few, simple and universal rules would be determined. Simulation games suggest that such rules can arise through negotiation during planning processes – though it is likely that rules that emerge reflect culturally bound norms and values. Participative, collaborative processes might assist in identifying a minimum effective set of rules – though careful design of processes may be needed to ameliorate any tendency towards a maximal rather than a minimum set.

Questions for the inquiry

- Who should set the goals of urban planning and how? What sort of broad, strategic goals should guide planning? At least in some level in the urban system, should goals emerge collaboratively?
- What place could or should an approach using a few, simple, universal planning rules (as Moroni (2012) proposes) have in urban planning? How far could such an approach extend? In areas where it would not apply (such as planning for infrastructure funded from public resources) what approach should be used instead? Would something less than fully universal rules be more efficient or better support innovation (for instance by allowing different types of development in denser parts of a city)?
- In a collaborative, participative approach to urban plan making, how would collective action institutions with the right scale and scope to match different aspects of the urban system emerge? What is the role or potential role of government and non-government collective action institutions in urban planning?
- If "culture" is shaped by malleable norms and values, how would norms and values conducive to collective action in urban planning emerge in conjunction with co-evolving collective action institutions? What shifts in the culture of planners would be needed?

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