24. How useful is complexity theory to policy studies? Lessons from the climate change adaptation literature

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INTRODUCTION: WHAT CAN COMPLEXITY THEORY LEARN FROM THE CLIMATE CHANGE ADAPTATION LITERATURE?

The use of metaphors is widespread in policy studies (Morgan, 1980; Dowding, 1995). These root metaphors provide a central theme to a policy framework and allow analysts a starting point in advancing their understanding of policy phenomena (Mio, 1997). But not all metaphors are as useful as others in informing research, knowledge and action. As Zashin and Chapman (1974) pointed out, a long-standing problem in political studies, for example, is the constant issue whereby much relevant experience and accumulated knowledge of political processes and phenomena is 'excluded from the mainstream of the discipline by its commitment to the use of a vocabulary modeled on that of the natural sciences'.

This is true of complexity theory, viewed as the application of a metaphor from system thinking applied to the study of public policy. When metaphors such as complexity are used in social science research, the 'empirical referents, more explicitly their connections with the experience of real people, seems even more tenuous than those of the traditional theoretical concepts' such as arguments, interests and positions (Zashin and Chapman, 1974: x). In place of these older concepts – and traditional political theory constructs such as rights, power, authority or legitimacy – the use of cybernetic metaphors such as equilibrium, feedback, input, transactions, games, and the structural-functional models they often entail, have limitations when it comes to analysing policy-related activity and behaviour.

This chapter critically assesses the use of complexity metaphors in the policy literature in this light and recommends future research directions. In doing so we highlight significant problems recently uncovered in the climate change adaptation scholarship which serves as the example, *par excellence*, of the application of complexity maxims and concepts to policy-making. We argue that much of this adaptation theory's failure to have much impact upon policy-making (Wellstead et al., 2013a and 2013b; Howlett, 2014) can be attributed to its overlooking the lessons of conventional policy literature which emphasizes meso- and micro-level policy and governance relationships, relying too heavily on macro-level eco-system-based concepts and constructs. We note a similar issue with complexity theory in general and suggest it requires complementing by existing insights from the policy sciences into the actual processes of policy-making in order to better explain and inform policy studies.

THE COMPLEXITY APPROACH TO PUBLIC POLICY

What is the complexity approach to policy study? Geyer's research on issues affecting European integration in the early 2000s argued, 'the traditional linear view of science has been giving way to a growing non-linear or complexity framework and since the 1980s has been spilling over into the social sciences' (Geyer, 2003: 16). Such a framework, based on complex interactions between policy-making elements, non-linearity and emergent properties, he argued, 'does not eliminate or solve the problem of complexity. However, it provides a new and intriguing ontological and epistemological foundation for addressing the problem of complexity' (Geyer, 2003). Similarly, Sanderson (2009) found that complexity theory provided insights into a policy environment that is dynamic and non-linear, and an unstable system where disequilibrium is the norm.

Complexity theory has its own vocabulary and metaphors, however, which bring potential new insights and directions to policy research, but which can also mislead (Lissack, 1999). First, complex systems are characterized as those containing a large number of elements with non-linear interactions. These interactions usually having a fairly short range. The environment in which they occur is open, and the whole of the system is said to be greater than its parts (Geyer, 2003; Cairney, 2012a). Complex systems are also argued to be often in a state of disequilibrium and to have a history of interactions and states which matter in understanding how the system and its parts (co) evolve. Each element in the system is unaware of the behaviour of the system as a whole (Geyer, 2003) and 'self-organization' is a central complexity principle whereby agents change their actions endogenously, without external pressures to do so (Teisman and Klijn, 2008). Teisman and Klijn (2008) argue that such 'actions systems can consist of one single actor, but can also be a group, an organization or a set of organizations. In fact only single actors can act but they do so as members of a larger system, which also affects this system' (p. 344). Cairney (2012a) also highlights the role of emergence and 'strange attractors' as complex systems shift between states of activity. These complexity theory metaphors provide policy research with a distinct vocabulary and grammar and a number of helpful avenues for inquiry. There have also been a number of applications of complexity theory in the public policy field. They include Geyer and Rihani's (2010) discussion of health, international relations, development, and terrorism issues using tools of complexity such as 'cascades of complexity', 'complexity mapping', 'fitness landscapes', and the use of Stacey diagrams. Geyer (2012) also applied the notion of such a 'complexity cascade' to an evaluation of UK education and health policy.

Cairney (2012a; 2012b) has noted how the concepts and ideas behind complexity theory resonate with some of those already developed within the policy sciences, such as punctuated equilibrium, historical institutionalism, implementation concerns, and approaches to policy focusing on instruments and tools. However, complexity theory is currently pitched at a very high macro and abstract level which make it somewhat problematic when applied to a down-to-earth subject of day-to-day political activity such as policy-making. Missing from most contemporary applications of complexity theory to policy-making are the key political variables – 'interests', conflicts, bargaining, trade-offs, deal-making and others – which animate more traditional policy studies and it is argued below that scholars who use the complexity metaphor should not abandon these traditional policy frameworks in developing and applying complexity concepts

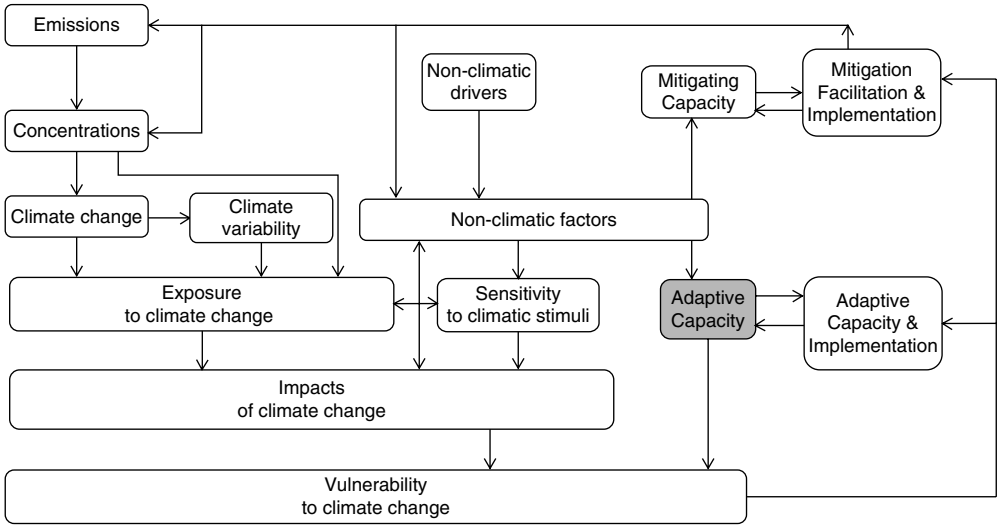
to policy-making. Rather they should give them new life within complexity theory as 'they continue to play an important role but within the wider context of complexity' (Wellstead, 2007: 147). This means that more sophisticated accounts of policy than those currently used by complexity theorists are required; these must include factors such as 'the impact of policy makers' ideologies, about the nature of decision making, [and] upon the conduct and outcomes of the various stages of the policy process' which shape policy outcomes (Smith and May, 1980: 156). How this can be done is illustrated below using the example of the use of complexity constructs in policy analysis of climate change. This is probably the single area in which complexity constructs have been most used, and the strengths and weaknesses of these applications are revealing of those of complexity theory as a whole when applied to policy studies.

ADAPTATION TO CLIMATE CHANGE: TAKING THE ECOSYSTEM METAPHOR TOO FAR

Adaptation to climate change has become a particularly pressing issue for all levels of government. This is true in both developed and developing countries faced with an onslaught of high-profile climate-related impacts and disasters. In response, governments and NGOs have invested considerable levels of resources developing voluminous vulnerability assessments and ambitious adaptation frameworks. A flourishing adaptation to the climate change research industry has also emerged, led by a new generation of climate change-oriented social scientists resulting in an impressive output of articles diagnosing policy problems and recommending management solutions found in multidisciplinary journals such as *Climate Change*, *Ecology and Society*, *Global Environmental Change* and *Mitigation and Adaptation Strategies for Global Change*. For both on-the-ground efforts and scholarly endeavours, climate change impacts and their associated vulnerabilities in ecosystems and socio-economic systems have been well chronicled and attention has turned to determining the contours, and recommending the content, of climate change adaptation policy.

Many of these studies have consciously or unconsciously applied a complexity theory framework to their analyses. Emison (2008), for example, examines changes to the US Clean Air Act within the context of complexity theory, linking this to adaptive systems theory, and many other studies have similarly been heavily influenced by complexity concepts and precepts. A growing number of national and sub-national exercises in particular draw heavily upon the Intergovernmental Panel on Climate Change (IPCC) in its Third and Fourth Assessment reports (Preston et al., 2010). The Third Assessment report, in turn, draws upon Smit et al.'s (1999) climate change assessment framework, which was heavily influenced by complexity theory concepts and arguments. As a result, this general approach has been emulated at a number of sectoral and governmental levels. This trend continues in the Fifth Assessment, with complexity highlighted as a major theme (IPCC, 2014).

Figure 24.1 from Fűssel and Klein's (2006) well-known and oft-cited assessment of climate change adaptation policy processes typifies the main components of these approaches to adaptation studies (see Figure 24.1). The authors draw their analysis from earlier contributions, namely Smit and Wandel (2006), as well as resilience studies such



Source: Füssel and Klein (2006).

Figure 24.1 Füssel and Klein's model of adaptation policy processes

as Folke (2006), Gallopin (2006), Adger (2006) and Nelson et al. (2007). As Figure 24.1 shows, this framework is pitched at a very high level of generality and attempts to model policy relationships based on the metaphor of ecosystem dynamics. Complexity concepts such as exposure, sensitivity, impact, adaptive capacity, vulnerability and adaptation are all featured in this work. The systems-level thinking behind such analyses is clear even in the definition of 'adaptation' used in these models, referring to 'the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities'. Similarly adaptive capacity is concerned with 'the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences' (Fűssel and Klein, 2006: 18).

Misplaced Functionalism in Complexity-inspired Policy Analysis

In their work, Fűssel and Klein (2006) identify two important adaptation-related functions that they argue governments usually perform: facilitation and implementation. Facilitation refers to activities that enhance adaptive capacity, such as scientific research data collection, awareness raising, capacity building, and the establishment of institutions, information networks and legal frameworks for action. Implementation refers to activities that actually avoid adverse climate impacts on a system by reducing exposure or sensitivity to climatic hazards, or by moderating relevant non-climatic factors.

Other leading scholars in the climate change adaptation field echo this approach to explaining government actions but only where government appears as a 'dependent variable' influenced by larger system-level concerns. For example Nilsson et al. (2011) note that the role of institutions and governance processes 'needs to be considered' along

with the physical production and social variables that compose the system in applying this model to policy-making and outcomes. Brooks et al. (2005) similarly develop a suite of governance proxies for national-level vulnerability to climate change (for example, political stability and rule of law) but the specification of exactly how these variables affect policy dynamics 'on-the-ground' is missing. Plummer and Armitage (2007) also identify capacity and capacity building, institutions, social capital and networks, learning, and vulnerability and livelihoods as critical in their assessment framework, and argue that these influence environmental governance, but without any details on how such processes actually work in either theory or practice. Climate change scholarship postulating governments as independent variables are exceedingly rare. Adger et al. (2007), for example, note that adaptive capacity is influenced by 'the nature of governance structures' while Smit and Wandel (2006) state only that 'improvements in institutions' may lead to increased adaptive capacity. Neither clarifies the conditions under which this is likely to occur.

A good example of the limitations these models have for understanding actual policy-making processes on the ground can be found in the work of Engle and Lemos (2010). They note the importance of 'governance and institutional mechanisms' as determinants in characterizing adaptive capacity and rank a suite of governance and institutional indicators they think are important in affecting policy-making. The key political and governance considerations that would explain, for example, how the indicators will be used to coordinate activities towards adaptation goals in the absence of political commitment from government and how that commitment emerges, are missing.

In such cases, the analysis jumps quickly and uneasily between high-level abstraction and micro-level policy recommendations, skipping over the 'missing middle' of the meso-level governance variables that are critical to joining the macro and micro levels together in practice (Voss and Borneman, 2011; Nilsson et al., 2011). Activities like public policy-making, law-making and legislative and administrative behaviour require causal and intentional modes of scientific explanation which take seriously the activities of policy-makers and the political and social forces which drive them.

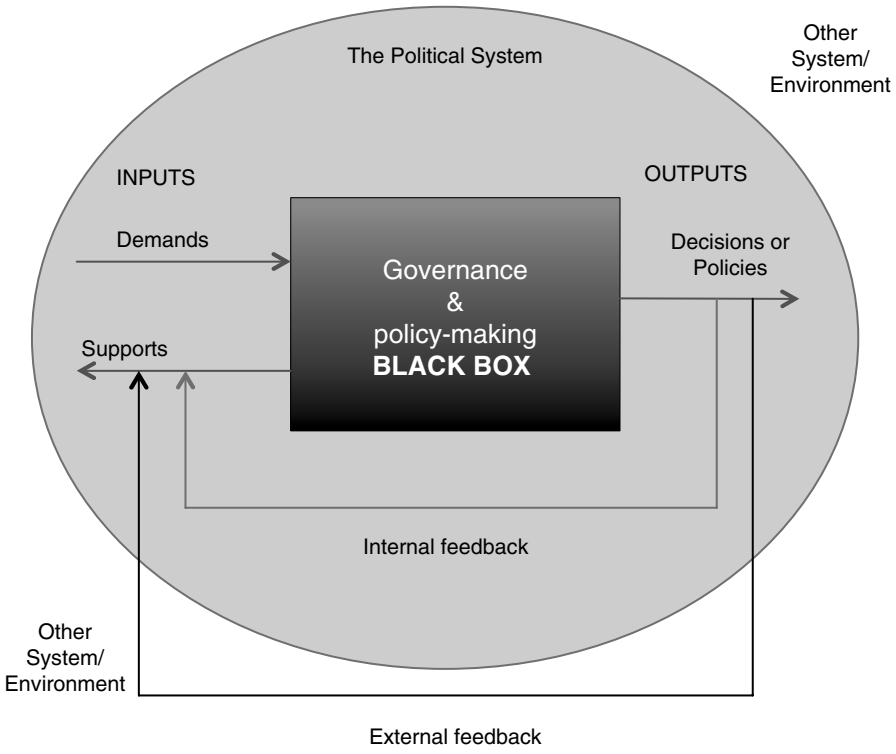
This literature thus typically notes the importance of political institutions in addressing adaptation and adaptive capacity, but models these variables only in very general terms, with a lack of specifics with regard to the precise mechanisms and relationships involved in deriving policy recommendations and instrument choices (Daedlow et al., 2011). In these complexity theory-inspired studies 'politics', 'governance' and 'policy-making' are understood in a 'functional' way: as a kind of input variable promoting 'necessary' adaptation 'functions' in response to system-level changes and needs (Holling, 1973; 2001; Folke et al., 2002). The logic is one which simply assumes that governance activities will be performed in specific ways due to system-level prerequisites (Cummins, 1975), but ignoring the policy process itself and the possible non-performance of 'mission critical' tasks (Howlett et al., 2009a; Wu et al., 2010; Weible et al., 2012).[1]

The 'Black-box' Problem

Even when some socio-political variables are incorporated into a climate change vulnerability assessment framework, a second problem arises in these studies due to the lack of specificity about the mechanisms and internal workings of institutional and other

components of political systems and policy sub-systems. This is the so-called 'black-box' problem of unspecified process variables and mechanisms, which also plagued early work in the policy and political sciences that attempted to describe and model decision-making and other policy processes. Concerns with the limitations of high-level systems-theoretic models when applied to policy-making surfaced more than forty years ago when these models first emerged in the social sciences, and these same concerns are features of today's climate change assessment frameworks and other complexity-theory-inspired studies (Black, 1961; Gregor, 1968; Landau, 1968; Stephens, 1969).

Like their contemporary climate change counterparts, 1960s-era political scientists such as Gabriel Almond (1965) and David Easton (1965) and many others suggested that high-level systems-based metaphors could describe much political behaviour and help explain outcomes. Following general systems theory scholars such as von Bertalanffy (1969), they argued that the political system exists in an environment that inputs resources and demands into that system which then produces outputs (decisions and supports) operating with feedback loops back to the environment and into the system as new inputs. As Figure 24.2 shows, this model described government or a political system as a simple feedback system in which a 'black box' (government) converted inputs into outputs which, in turn, fed back into the environment to generate



Source: Adapted from Easton (1965).

Figure 24.2 The 'black box' model of a political system following Easton (1965)

new inputs and so on. This logic is identical to that contained in Fűssell and Klein's framework (Figure 24.1).

Like earlier generations of social-cybernetic or system-theories, much systems-inspired modelling in the climate change adaptation area continues to rely too heavily upon a flawed natural sciences metaphor. As early as the 1970s this overly abstract and general conception of a political system as a resource conversion mechanism had already been largely discredited in political science and policy studies as providing an insufficient and misleading view of government and its activities. For example, Lilienfeld (1978) labelled systems theory an 'ideological movement' because of its tendency to assume that systems maintain themselves in a state of equilibrium and concluded that it contained little relevance to the real world where actors actively sought and produced change, and even less practical application. Similarly, Chilcote (1994) found 'black-box' systems-level frameworks did little to explain political or policy change, yielded few testable hypotheses, and presented a strong ideological underpinning that sought to downplay political conflict and promote a technocratic understanding and approach to political life. Thorson (1970) lamented the whole enterprise was futile so long as the 'black-box' of real political processes remained unopened and unexamined. In general, Groth (1970) found that 'structural-functionalism black-box models have run aground trying to specify its model of the social system untangled by monumental ambiguities and values in the guise of survival considerations'. These models also failed convincingly to establish at least some underlying social and political relationships as 'behavioural universals for these allegedly goals of survival and adaptation' (Groth, 1970: 499). As Elster argued, opening up the black box and showing the cogs and wheels of the internal machinery was necessary to reveal a continuous and contiguous chain of causal or intentional links between the explanans and the explanandum (in Hedström and Ylikoski, 2010).

The ultimate purpose of most climate change assessments/frameworks is to accurately inform policy-makers of the feasible directions and procedures through which climate change adaptation can be accomplished. It is here in the provision of practical advice to policy-makers that the failure to attend to governance arrangements and institutions within complexity theory is most detrimental (Koliba et al., 2010). The meso dimensions of policy and governance missing from complexity theory are the most critical in affecting on-the-ground policy change and implementation. Ascher (2001), for example, noted that implementation of a number of resource management doctrines informed by complexity-inspired adaptation studies would lead, at best, to a range of poor results due to unintended consequences, the promotion of perverse incentives and other kinds of policy failures linked to the adoption of infeasible policy alternatives (Marsh and McConnell, 2010; McConnell, 2010).

While complexity theory-inspired studies such as the kinds of climate change vulnerability assessment frameworks cited above can provide a useful heuristic for understanding system-level impacts on policy-making and policy outputs, the assumptions inherent in these approaches leave much to be desired in terms of understanding or accurately characterizing policy processes, and are of little use to actual policy-makers. Further development of key concepts, such as governance and policy, is required in order for complexity-inspired analyses to accurately model meso-level political variables and escape this misplaced structural-functionalism. Complexity theory-influenced climate

change adaptation frameworks await incorporation of the results of other studies which specifically focus on the meso-level of analysis (Peters, 1999; Hall and Taylor, 1996).

THE NEED TO INCORPORATE POLICY AND GOVERNANCE VARIABLES INTO ADAPTATION STUDIES AND COMPLEXITY THEORY

The neglect of meso-level variables in complexity-inspired climate change studies is not unique. Nilsson et al. (2011) found similar shortcoming in high-level energy systems studies, which share many similar characteristics based on complexity theory precepts. As they put it:

> The hitherto superficial treatment of institutions and politics in energy future studies is somewhat surprising. Many literatures concerned with systems-technical change recognize the importance of institutions in shaping (and interacting with) technological systems. These insights have emerged not only in economic history, sociology and political science, but also prominently in innovation systems studies, evolutionary and institutional economics, socio-technical systems, and even more recently in transitions management and elsewhere. These perspectives share several insights about institutions, what they are, why they are relatively stable and how they change. (pp. 1117–18)

In order to enter the realm of 'feasibility' and achieve practical relevance, adding meso-level variables to climate change adaptation studies, and more generally to complexity theory itself, is a prerequisite. This involves moving beyond the abstractions inherent in contemporary system-level complexity theory and instead seeking to incorporate knowledge of formulation and implementation into complexity-inspired models of political and policy interaction (Treib et al., 2007). This involves the need for a better dialogue between complexity theory and governance studies.[2]

As Frechette and Lewis (2011) have argued:

> in order to develop a comprehensive understanding of the dynamics of change, analysts require a meta-theoretical approach that not only provides complementary insights into how rules change over time, but also pushes the boundaries of conventional analysis to consider the constitutional arrangements that structure collective action and the subsequent performance of forest governance structures. (p. 582)

More sophisticated analyses are required, for example, that capture governance-related impacts of even such basic policy-making structures as federalism or the territorial division of powers between governments, the so-called basic multi-level or 'polycentric' nature of contemporary governance (Ostrom, 2008; 2009; Enderlein et al., 2011; Aligica and Tarko, 2011; McGinnis, 1999). Governance studies have shown, for example, that governments, lacking the knowledge or the mandate to govern alone, have increasingly chosen to try to construct policy consensus through more engaged and interactive forms of policy-making and to allow non-state actors to implement those policies within a broad framework of incentives, benchmarking and private governance (Sprinz and Vaahtoranta, 1994; Zito, 2007), a phenomenon which originates at the meso-level and affects micro- and macro-level behaviour and systemic conditions.

Three specific aspects of policy-making need to be explicitly modelled in new complexity frameworks. The first is to examine the structure and pervasiveness of policy networks (Howlett, 2002; 2011). In this network dimension, the number and diversity of actors (state and non-state) that exert some degree of power or influence over the outputs of the governance arrangements is a key facet of policy-making (Knoke and Kuklinski, 1982; Knoke, 1987). The concern of the analyst is to identify where political power lies in relation to society and the state (Lukes, 1974; Lindblom, 1977; Katzenstein, 1978; Offe, 1984) and the analytical challenge is to determine whether, and to what extent, in specific sectors and issue areas, the state or its agents are directly dictating the outcomes that emerge from the governance arrangement, more loosely 'steering' the arrangement, or alternatively whether ultimate power to determine outcomes rests with non-state actors (for example corporations, unions, environmental civil society organizations and so forth) (McCool, 1998).

This echoes findings in other sectors which have also pointed out the advantages to practitioners of incorporating governance into macro-level systems thinking. For health care, for example, Gómez (2011) has argued that:

> the practitioner community stands to gain from applying these theoretical approaches to their analysis of the institutional aspects of health governance and health system governance. Instead of merely measuring the presence of elite stewardship, strategic vision, responsiveness, and the like, this alternative approach suggests that practitioners begin their analysis by specifying the following issues: political and bureaucratic elite beliefs, interests, and the supportive coalitions that motivate elites to become stewards, visionaries, and to pursue institutional change. In contrast to the existing literature, this approach therefore sees elite interests and coalitions as key independent variables while the aforementioned health governance and health system governance indictors are treated as outcomes to be explained. (p. 210)

The second dimension has to do with modelling the rigidity of institutional policy-related arrangements – namely their formal or informal nature. The institutional aspects of governance arrangement can be assessed in terms of factors such as precision (how closely government constrains private action); obligation (the 'bindingness' of government commands); and delegation (the extent to which the power to adjudicate and enforce these obligations is retained by a regulator or delegated to an independent third party) (Tollefson et al., 2012). This also involves taking seriously the complex multi-level or 'polycentric' nature of contemporary policy-making and governance. Recently, Doelle et al. (2012) usefully explored these dimensions in a study of climate change-based forest governance arrangements in Canada, New Zealand and the US.

Finally, incorporating the third dimension, the policy process, is needed to understand the dynamic features of governance arrangements. The policy cycle, (Hill, 2007; Howlett et al., 2009b; Pal, 2010; Wu et al., 2010) and policy change frameworks developed in the policy sciences, such as the advocacy coalition framework, institutional rational choice and structural choice (Moe, 1984; Ostrom, 1991; Schlager and Bloomquist, 1996; Sabatier and Jenkins-Smith, 1999), are all well-developed approaches that draw upon the network and institutional dimensions of policy-making provide a fine-grained, more empirical lens on understanding the complexity and challenges of governance.

Complexity theorizing which incorporates these elements is hard to find but such an analysis would help to overcome the unrealistic functionalism of applied complexity theory as it stands, which in practice often assumes that governance will simply 'get

done' as a kind of system maintenance activity. Recent advances in the natural resource governance literature, in particular, have sought to capture these governance dynamics and their effects on policy-making (Howlett et al., 2009b, Tollefson et al., 2008).[3] Incorporating such logics and findings would help move complexity approaches forward. As Voss concluded in his study of adaptive management which takes meso-level variables seriously (Voss, 2011):

> Politics cannot be escaped or bypassed, nor eliminated or completely controlled by governance designs, but they can be analyzed and reflected on in order to devise more robust design strategies for new reflexive forms of governance. This is what we hope to encourage and support with the provision of this framework and sketching of avenues for further research.

CONCLUSION: COMPLEXITY THEORY AND THE POLICY PROCESS

Informed by complexity theory, existing climate change adaptation frameworks and vulnerability assessments suffer from conceptual weaknesses which limit their accuracy and policy relevance. But policy scientists who choose to apply complexity theory using only its systems-based focus on feedbacks, attractors and emergence risk the same problems found in the climate change adaptation field. These studies follow an implicit 'structural-functionalist' logic, which treats governments as a 'black-box' and policy-making as an undifferentiated and unproblematic output of system-level dynamics and requisites.

The absence of considerations of meso-level governance or societal steering activities and capacities in the framework literature partly explains the lack of impact on the ground that existing climate change adaptation studies and strategies, for example, have had among and upon policy-makers. The complexity models on which they draw were developed for other reasons, such as ecosystem impact modelling and studies of community resilience (Walker and Cooper, 2011), and they are not suited to policy analysis without significant modification. Although currently in vogue in many geography and natural resource management programmes, such frameworks are not well suited to the development of *feasible* policy prescriptions since they ignore or downplay the actual practices of policy-making, where the issues of political power, unequal resource distribution and institutional legacies noted in many case studies are very central concerns (Skodvin, 2010; D'Alessandro et al., 2010).

The arguments presented here are intended to further the efforts to improve complexity theory in its application to policy-making by highlighting the need to adequately model and account for governance arrangements and policy-making processes rather than relying upon outmoded and inaccurate models redolent of political and sociological theory of the 1950s and 1960s. A focus on 'macro' ecological and social systems-level variables has ignored or minimized the key role played in public policy decision-making by 'meso' or middle range variables such as constitutional structures, electoral and administrative considerations, as well as more accurate modelling of micro-level variables related to the nature of public policy decision-making processes in democratic states is required for complexity theory to move into the mainstream of policy analysis (Voss and Bornemann, 2011; Nilsson et al., 2011).

NOTES

1. Jon Elster (1986) has noted that this kind of functionalism, in the social sciences, is a 'puzzling and controversial' mode of explanation in general because, unlike other scientific modes such as causal or intentional explanations (where the intended consequences occur earlier in time), early events are explained by another event later in time (p. 31). Thus, in a functional explanation, 'we cite the actual consequences of the phenomenon in order to account for it' (p. 31). Feedbacks loops are the essential mechanism in functional reasoning because they provide 'a causal connection from the consequences of one event of the kind we are trying to explain to another, later event of the same kind' (p. 32). However, in social and political situations, as Elster further argued, such explanations are 'only applicable when a pattern of behaviour maintains itself through the consequences that benefit some group, which may or may not be the same group of people displaying the behaviour' (p. 32). That is, an institution or a behavioural pattern X is explained by its function Y for group Z if and only if: (1) Y is an effect of X; (2) Y is beneficial for Z; (3) Y is unintended by the actors producing X; (4) Y (or at least the causal relationship between X and Y) is unrecognized by the actors in Z; (5) Y maintains X by a causal feedback loop passing through Z (p. 28). Most attempts to use functionalism in social and political explanations fail because they are missing one or more of these five features (Elster, 1985). And, as Elster further noted, in political life there are many examples of singular, non-recurring events that produce unintended policy consequences (such as wars, riots and rebellions), while feedback loops are often postulated or tacitly assumed when they do not in fact exist (Elster, 1986). Hence, explanatory theories must move beyond simple functional modes of identifying and linking variables together to predict or model outputs and their impacts and effects. Elster (1985) argues instead for causal or intentional forms of explanation in the social sciences because functionalism is only applicable in biology and ecosystems.
2. 'Governance' is a term used to describe the different possible *modes* of government coordination of non-governmental actors (Rosenau, 1992; Rhodes, 1996; de Bruijn and ten Heuvelhof, 1995; Kooiman, 1993; 2000; Klijn and Koppenjan, 2000). That is, governments control the allocation of resources between social actors, providing a set of rules and operating a set of institutions setting out 'who gets what, where, when, and how' in society and managing the symbolic resources of state legitimacy which are crucial for the attainment of any policy goal, including but not limited to climate change adaptation.
3. This is true, for example, in many areas where efforts have been made to develop 'integrated strategies' such as forestry and coastal marine eco-system management (Howlett and Rayner, 2006a; 2006b), and similar efforts are typical in both climate change mitigation and adaptation efforts (Voss et al., 2006). In these new governance modes, the lines between public and private have become blurred (Gatto, 2006): from a mode of coordination based on hierarchical top-down, command and control by government actors or their agents, governments have increasingly experimented with new modes of governance that rely on the incentives provided by markets and by the sharing of information in governance networks.

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