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Complexity and challenges of long-term environmental governance

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ABSTRACT

Some important processes of environmental change – including those of climate change and loss of biodiversity – share three characteristics that make them extremely demanding challenges of governance. First, time-lags between human action and environmental effect are very long, often extending beyond one human generation. Second, problems are embedded in highly complex systems that are not well understood. Third, these problems involve global collective goods of a type that links them to a wide range of human activities and leaves them beyond the scope of unilateral solutions. Social science research offers two essentially different models of collective response to severe challenges. One portrays effective response as collective action through central leadership and contraction of power. The other conceives of societal response as involving a variety of local activities undertaken by subunits of a complex and decentralised system. I argue that both models have considerable merit, but also that they respond to different types of challenges. Therefore, useful insights can be gained by specifying more precisely the circumstances under which each model applies.

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1. Introduction

Some of the most important processes of social-ecological change – including those known as climate change and loss of biodiversity – share three characteristics that interact to make them extremely demanding challenges of governance. First, these challenges are long-term policy problems in which time-lags between policy measures (or ‘non-action’) and effects often extend beyond one human generation. Second, they are embedded in very complex systems of which our understanding is still incomplete and in part clouded by profound uncertainties. Third, they involve global collective goods of a nature that links them to a wide range of human activities and at the same time leaves them beyond the scope of ‘single best effort’ solutions.¹

Social science research offers two essentially different models of collective response to severe challenges. One – prevalent in, inter alia, the study of international crisis management – portrays effective response as involving contraction of power, and centrally directed action guided by some synoptic master plan. The other – found in, inter alia, the study of adaptive management – conceives

of collective response as involving a variety of ‘local’ activities undertaken by (sub)units of a diverse and complex system. The main argument of this paper is that both models have considerable merit, but also that they respond to different types of challenges. Therefore, useful insights can be gained by specifying the circumstances under which each of these strategies can be expected to work.

The next section explores how each of the three problem characteristics introduced above can render governance more difficult, and how they can interact to produce an extremely demanding challenge. Section 3 presents the two collective response models and begins to specify their respective domains of validity. The fourth and final section offers some suggestions as to how problem characteristics and governance approaches may be ‘matched’ to enhance the ability of governance systems to cope constructively with challenges such as global climate change and loss of biodiversity. My suggestions, I hope, will contribute to answering the first two questions formulated by the editors for this special issue.

2. The challenge

As indicated above, this paper deals with environmental change problems that share three main characteristics: very long time-lags between human action and environmental effect, embeddedness in highly complex systems that are not well understood, and provision of global collective goods. Each of these characteristics has important implications for governance.

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¹ The term is borrowed from Barrett (2007). It refers to collective action problems where one single actor is *capable* of providing the collective good in question through unilateral efforts, and has a strong *interest* in having the good provided. See also Sandler (1998).

2.1. Long-term policy problems

Long time-lags between action and effect will likely have important consequences regarding uncertainty, incentive structures, and the distribution of (political) power.²

2.1.1. Uncertainty

Consider first the effect upon uncertainty. Other things being equal, uncertainty tends to increase the farther into the future we look. We are in a better position to predict what will happen next week or next month than we are to predict developments decades, let alone centuries, ahead. For problems such as global climate change this difference is likely to generate a profound asymmetry between our ability to determine short-term and long-term policy consequences. This *asymmetry*, rather than the overall level of uncertainty, aggravates the challenge. A cursory reading of government programmes and public debate indicates that short-term consequences of mitigation tend to be framed largely in terms of *costs* involved in undertaking such measures while damage that can be avoided in the future is conceived of as *benefits*.³ If consequences are framed in these terms, uncertainty will weigh more heavily in the assessment of benefits to be harvested from mitigation than in the assessment of costs incurred in undertaking those measures. The greater this asymmetry, the more it will affect the cost/benefit ratio—by reducing the expected net benefit of mitigation.

To make things worse, experimental research has produced substantial evidence indicating that most people tend to react more strongly to the prospects of a certain *loss* than to the prospects of an equally large *gain* (Kahneman and Tversky, 1979). Consequently, the influence of prospective losers on the fate of a particular policy option is likely to be disproportionately large. Applied to long-term environmental policy problems, prospect theory thus seems to suggest that ambitious mitigation policies face even higher hurdles than predicted by conventional rational choice models.

In brief, then, asymmetrical uncertainty and asymmetrical sensitivity both tend to work *against* ambitious mitigation policies. Moreover, in certain circumstances the two are likely to interact synergistically, raising hurdles even further.

2.1.2. Incentives

Long time-lags may affect incentive structures in other ways as well. Two potentially important effects are known as discounting and time inconsistency.

Discounting is a procedure for estimating the present value of future benefits or costs. Discounting normally attributes higher value to current benefits than to those occurring in the future, for at least two reasons (Fisher, 1930). One is a preference of immediate over postponed consumption ('human impatience'). The other builds on assumptions of economic growth, implying expectations of rising incomes and/or cheaper goods in the future. With higher incomes the utility of a certain increment in consumption, and the marginal welfare loss from paying a certain price, tend to decline. As emphasised by Broome (1994, p. 128), economists use discounting mainly for the sort of goods that are sold and bought in markets (i.e. 'commodities'), not for human well-being.

Applying the notion of discounting to policy problems with very long time-lags between action and effect is not a straightforward

operation. Schelling (1995) dismisses the assumption of human impatience as relevant only with respect to a person's *own* consumption, not for intergenerational trade-offs. Stern (2007) argues that global climate change calls for an approach for assessing and comparing options that have very different trajectories and large intergenerational impacts. While '[S]tandard treatments of discounting are valuable for analysing marginal projects [...] they are inappropriate for non-marginal comparisons of paths' (Stern, 2007, p. 23). More fundamentally, Schelling (1995) argues that abatement of greenhouse gas emissions is essentially a matter of *redistribution* (in time and space) rather than a question about postponing consumption, and therefore largely outside the domain of the theory of discounting. These are important arguments, pointing to severe limits to the applicability of discount theory to global climate change and other long-term policy challenges.

The main question here, however, is not whether discounting is appropriate for this category of problems but whether it *in fact* plays a role. To my knowledge, we have no solid empirical basis for answering that question conclusively. We can, however, identify several mechanisms that are likely to produce discounting effects. For example, a government depending on electoral or other forms of domestic support to achieve its policy goals – and also to stay in power – can hardly afford not being preoccupied with short-term political consequences. The value of support at the polls is – at least up to the critical threshold of 'victory' – likely to be much higher than the value of the same level of support a week after the election. Moreover, even a person fully convinced that the notion of discounting is inappropriate for dealing about problems involving intergenerational trade-offs is likely to find that proximity in time tends to increase saliency, and therefore allocate scarce time and energy accordingly. He may not be performing the intellectual operation known as discounting, but the effect is likely to be similar.

Time inconsistency may be defined as a situation in which an actor's best plan for some future period of time will no longer be optimal when that time actually arrives (Kydland and Prescott, 1977). It may, of course, be perfectly sensible to revise a plan in response to new information or developments that render the original plan inadequate or inefficient. New information is, however, not what is driving behavioural change here. Rather, time inconsistency is caused by incentives to abandon or defect from a plan that is believed to be optimal over the long-term, in order to achieve short-term gains at specific points along the way. The core of the problem is incongruity between the cost/benefit considerations for the plan as a whole and those pertaining to individual micro-decisions required to implement that plan. Such incongruity may occur even when a single individual makes *all* decisions.

An everyday example may help us see how this mechanism works. Assume that you have embarked upon an extended programme of regular physical exercise to improve your health. Even if you firmly believe that the overall programme will yield substantial net benefits, you need not come to a positive conclusion for each training session in that programme. One single defection would hardly reduce long-term health benefits but may well increase short-term well-being—e.g. by avoiding exposure to heavy rain or chilling winds, or free up time to attend a concert. In technical terms, the cost/benefit calculus for this particular training session may show a negative balance despite expectations of substantial gains from the overall programme. Even someone strongly committed to the overall programme is likely to encounter instances where perfectly sound reasons can be given for skipping – or, more gently, 'postponing' – a single training session. The more such instances there are, however, the greater the risk of multiple defections. Moreover, the more defections, the

² Parts of this section build on Hovi et al. (2009).

³ Analytically, it would make equally good sense to conceive of both in terms of costs—the (short-term) costs involved in undertaking mitigation measures versus the (future) costs stemming from damage that could have been prevented by those measures. Moreover, some mitigation measures – for example those that create or boost markets for environment-friendly products – are likely to produce significant short-term gains as well.

greater the accumulated loss in goal achievement. Even a person fully aware of these pitfalls would probably on some occasions find the temptation to defect very hard to resist, and the solution prescribed by Schelling (1960/1971), known as that of *irrevocable* commitment, may be hard to implement.

Any long-term policy programme for mitigating the impact of human activities on the global climate system or on biodiversity will face this kind of incongruity problems. Any government will be constantly aware that its own efficacy – and, ultimately, its survival – will depend upon how well it succeeds in meeting the demands and expectations of influential stakeholders and its broader constituency. The logic of politics implies that even a government strongly committed to its own long-term goals and programmes must be preoccupied with short-term political consequences. The fact that most governments serve for a relatively short period of time also contributes to focusing their attention on what can be done during their terms in office. Moreover, all governments have multiple goals and programmes to attend to, and with limited economic resources and political capital to spend they will sometimes have to modify or even sacrifice one goal to secure sufficient support for another. Combining these two observations, we can easily see that governments will sometimes find themselves in a situation in which they cannot afford to do (now) what their own high priority goals or programmes would require.

2.1.3. Power

Finally, long time-lags may affect the distribution of power – more precisely, *the distribution of power over the configuration of interests*. Where important consequences of current policies materialise several decades – in some cases even centuries – later, important future stakeholders will not be present to voice their concerns and weigh in when preferences are aggregated into policy decisions. For current decisions we are, in other words, faced with an extreme temporal asymmetry in participation and political power. To the extent that the interests of ‘upstream’ generations coincide with those ‘downstream’, the former may well turn out to be good custodians of the interests of the latter. But the well-being of future generations will ‘...only [be] taken into account to the extent that it is valued by the present generation’ (Broome, 1994, p. 137, italics added). As we have seen above, very long time-lags between measures and effects mean that those who are in a position to embark upon effective mitigation programmes must pay most of the costs but will reap only a small fraction of the benefits derived from the damage averted. The material self-interest of the present generation will therefore diverge significantly from those of future generations. No doubt, many people care a lot about the well-being of their children and grandchildren. However, if Schelling (1995) is right, those who will benefit the most will be much more ‘distant’, not merely in terms of kinship but also with regard to space, culture, and other dimensions important for collective identities. Other things being equal, the willingness to pay for benefits that will be reaped mostly by others is likely to decline the greater the perceived overall distance to the latter. This particular combination of extreme asymmetry with regard to *both* power *and* incentives generates a real risk that outcomes will fail to meet frequently invoked standards of intertemporal fairness and efficiency.

2.2. Complex systems

The global climate is a very complex system, and so is definitely the overall Earth System, with multiple mechanisms linking social and biophysical processes. High complexity has several implications, two of which seem particularly important for governance.

First, our understanding of these complex systems is still rudimentary and uncertain. These limitations become particularly

significant when we are – in the words of the International Geosphere-Biosphere Programme (IGBP) Synthesis Report – dealing with systems that operate in a ‘no-analogue state’ (Steffen et al., 2004). In studying a system operating in a hitherto unknown state, empirical analysis of past records provides uncertain guidance to future developments. This observation does not imply that scientific research cannot contribute important knowledge and insight. Rather, the most important lesson to be learned may well be that some profound uncertainty will persist and that we must therefore find ways of navigating uncharted waters. This challenge involves, among other things, developing modes of governance as well as policy programmes that provide guidance and direction and simultaneously have the flexibility required to cope with abrupt change. In a no-analogue state, capacity for adaptive and innovative governance becomes a critical asset.

Second, climate change and loss of biodiversity are examples of environmental change that is linked to a wide range of human activities and to the belief systems, values, and institutions that guide and sustain these activities. Therefore – as far as we presently know – there can be no quick fix. Surely, measures exist that can make a truly significant difference. For example, major advances in new technologies for clean and renewable energy (windmills, solar panels, etc.) can – at least if supported by adequate incentives for adoption – bring about a substantial reduction in the emissions of CO₂ and other greenhouse gases. However, environmental change is driven by a very wide range of human activities, including – in the case of biodiversity – all those that significantly affect land cover and land use, interfere with water flows, and use nature as a sink for waste materials. Such activities are found in all populated areas. Therefore, no single cure can deal with more than a small fraction of these activities.

Fortunately, the complex structure of these problems provides interesting opportunities as well. With multiple drivers and hotspots there will be multiple targets for mitigation efforts and many opportunities to make at least a *small* difference. We are not dealing with problems where the outcome is determined by the weakest link of human response. Nor do we need to come up with a synoptic master plan or a well-integrated policy. Non-governmental schemes for eco-labelling or certification can provide incentives for change without much coordination with governmental taxation of fossil fuels. Local initiatives can supplement international regimes. Neighbouring cities may well rely on different types of measures; one city’s investment in infrastructure for public transport need not interfere with another’s plan for enhancing its supply of thermal heating. As these and other examples suggest, global climate change is a setting in which we can expect hybrid modes of governance to evolve—including co-management and public-private partnerships (Lemos and Agrawal, 2006). And it is a setting in which ‘clumsy solutions’ – response strategies combining different perspectives on the nature of the problem and different ideas about solutions – may well prove effective (Verweij et al., 2006).

2.3. Global collective goods

Most of the environmental damage averted through mitigation measures will to some degree be collective goods, meaning that – once provided – they can be enjoyed also by parties who did not contribute to mitigation.⁴ In some instances, climate change and loss of biodiversity being well-known examples, we are dealing with *global* collective goods. A global collective good can, in principle, be enjoyed by everyone on this planet, free-riders as well

⁴ The classical definition includes also another defining characteristic, known as *non-rivalness* of consumption. For the purposes of this analysis, however, *non-excludability* is the more important aspect (see Olson, 1968).

as providers. This phenomenon presents two problems. First, an individual actor contemplating whether to contribute will most likely find that no unilateral effort will pay off unless it happens to produce significant side-effects in the form of *private* goods. Second, for the collective good itself, the ‘smaller’ the actor the more its own cost/benefit ratio for unilateral efforts will deviate – negatively – from that of the world (Olson, 1968, p. 28f). In the cases of climate change and biodiversity even the largest countries are likely to find unilateral measures attractive only if they also yield significant private (~national) benefits. To make things worse, no country would be *capable* of solving these problems through unilateral action.

Fortunately, a fairly wide range of selective incentives can be identified. The history of international environmental governance provides many instructive examples of firms and industries expanding market shares and boosting their incomes by being frontrunners in the development of new and cleaner technologies. Moreover, a number of communities have adopted local measures to curb emissions of greenhouse gases that are more ambitious than those adopted by their national governments. For example, a group of the world’s largest cities – now known as C40 – have partnered with the Clinton Climate Initiative to develop new measures for reducing energy use and cutting greenhouse gas emissions. In 2007, the State of California legislature passed a law establishing more ambitious and binding commitments to greenhouse gas reductions than those of the federal US government. For these and other frontrunners, norms and values seem to be important motivational drivers. However, some also explicitly point to material incentives, ranging from improved local air quality, via savings from increased energy efficiency, to increased attractiveness of one’s own community as a good place for ‘green’ companies and organisations to base their activities.

Some studies point to coercive tools as the most effective means of securing adequate provision of collective goods (Hardin, 1968). Hardin overstated the case for coercion (Ostrom, 1977); today we know that various forms of social capital can be an important asset for collective action (Adger, 2003). Yet, most of the studies highlighting the role of social capital deal with local or national communities, and caution is required in generalising conclusions from these studies to the global level. Moreover, at the global level the capacity for collective action is severely limited by the anarchical structure of the international political system. In essence, this structure leaves the burden of proof with those who favour collective action and gives a veto to any pivotal party who is opposed (Underdal, 2002). In such a system, blocking is far easier than organising (new) collective action. Yet, significant achievements *can* be made through voluntary cooperation (Axelrod, 1984; Barrett, 2003; Breitmeier et al., 2006). Although often time-consuming and frustrating, international negotiations often lead to agreements, and a voluntary agreement *can* significantly strengthen incentives to contribute. The mechanism by which it does so is an exchange of conditional promises, establishing a link between the contribution of each actor and those of clearly identified partners. The more precise, firm, and enduring this link, and the more favourable the ‘exchange rate’, the more an actor can gain from signing the contract and complying with its provisions.

Furthermore, even in the absence of a negotiated agreement, a unilateral contribution can – under favourable conditions – strengthen the incentives of others to reciprocate. The world economy and the world polity may both be described as complex webs of interdependence, making actors sensitive – and sometimes also vulnerable – to the behaviour of important others. Information about the nature and strength of such relationships can help policy-makers detect integrative policy options and find pathways that can lead to their adoption and implementation.

Mapping global contingency webs can be a very complex and time-consuming task. Fortunately, only a small subset of relationships will be strong enough to make a significant difference. Within this small but fuzzy subset we should start searching for important clues.

2.4. Mitigation or adaptation?

The main argument developed in this section of the paper may now be summarised as follows. Problems that (1) involve very long time-lags between effort and effect, (2) are embedded in highly complex systems that are not well understood, and (3) deal with global collective goods of a nature that leaves them beyond the reach of ‘single best effort’ solutions, are very demanding challenges of governance. Each of these characteristics constitutes a major hurdle. What makes challenges such as climate change and loss of biodiversity extremely demanding is the fact that the three characteristics *coincide* and *interact* to stack the cards against effective mitigation policies.

Faced with what may seem an overwhelming combination of obstacles it may be tempting to conclude that mitigation is not a response strategy that the world will be able to adopt and effectively pursue. In an overall comparison, adaptation seems a politically more feasible option, with a significantly lower score on all of the three hurdles listed above. Once we dig deeper and examine specific measures, however, important nuances emerge. As importantly, once we look at historical records we will find instances in which societies and states have succeeded very well in coping with major long-term challenges. For example, the Netherlands – with 2/3 of its territory below sea level – has built, at high costs, an effective flood prevention system. Concerted world-wide action succeeded in eradicating small-pox. Some local communities have developed and maintained, over generations, complex and effective irrigation systems. A closer examination of these and other examples may well indicate that many of them involve one or more fortunate conditions that are not present in the cases of climate change or biodiversity loss. It took a major disaster, killing about 1800 people, to spur the overhaul and strengthening of the Dutch flood prevention system in the 1950s. Moreover, in the case of flood prevention, time-lags between measure and effect are unknown to decision-makers; another and equally severe test may come in the near future. Similarly, for at least some of the small communities that have built effective infrastructure or institutions for solving long-term problems related to the use of scarce common-pool resources, high internal stability – including little movement of people across community boundaries – seems to have been one key to success (Ostrom, 2003). These observations suggest caution with regard to generalising these conclusions to other challenges such as global climate change. Nevertheless, impressive achievements have been made in the past, and we have no basis for concluding that equally impressive achievements cannot be made also in the future.

The hard question is *how*. The higher the stakes, the more important it will be to make good use of the best response strategies and problem-solving tools available. In that spirit, I move on to explore, very briefly, two different models of effective collective response that have been studied extensively in social science research.

3. Models of collective response

One of these models is concerned with the capacity for collective action. This capacity is seen as relying heavily on centralised leadership, guided by some synoptic master plan premised on the best knowledge and understanding available. The other model is concerned with adaptive and pluralistic modes of

governance, highlighting the ability to monitor developments, learn from experience, and adjust flexibly to unforeseen change. This latter line of reasoning leads scholars to study, *inter alia*, the merits of diversity and pluralism, and the capacity of decentralised and balanced systems to withstand shocks and reconfigure themselves so that they can successfully continue functioning.⁵

At least on a first assessment, these models offer profoundly different recipes for governance. This difference does not necessarily imply that one model is right and the other wrong; in fact, my main argument in this section is that *both* have considerable merit. The question of which is right should therefore be tempered by an interest in identifying the conditions under which each model applies. The latter type of analysis will show that they have different domains of validity and therefore can, albeit only to some extent, be combined. In coping with the kind of governance challenges explored here a carefully differentiated strategy seems to offer better prospects than one relying entirely on just one of these models.

3.1. The collective action model

An extreme, and therefore instructive, version of this model can be found in research on international crisis management. As usual in social science research, somewhat different definitions of key concepts are offered. I will focus on one that is well-known, precise, and integrated into a more comprehensive taxonomy of situations that can help us identify the conditions under which the propositions derived are supposed to apply (Hermann, 1969, 1972). According to this definition, a 'crisis' is characterised by a high score on three dimensions:

- *Stakes*: the actor is faced with a severe threat to vital interests or basic values.
- *Uncertainty*: the actor has no reliable basis for predicting the further development of the challenge and developing a response strategy in advance.
- *Urgency*: decision time is very short—measured, at most, in days.

Under these circumstances, Hermann predicts (a) contraction of power and reliance on centralised leadership, and (b) a tendency to modify formal procedures by introducing various types of informal shortcuts. These propositions are offered as empirical observations rather than foolproof prescriptions. In fact, students of international crises have paid considerable attention to the risk of 'perversions' that may lead to suboptimal outcomes. One recurring finding has been that, under severe pressure, rational search for and evaluation of policy options tend to give way to more primitive approaches relying on crude cognitive heuristics, or generate excessive self-reinforcing feedback known as 'group-think' (Janis, 1982). Another concern is that decision-makers may overestimate their ability to steer complex organisations, particularly when steering involves precise and synchronised action deviating from standard operating procedures (Allison, 1971). These and other problems can by no means be dismissed as minor imperfections. That said, it is easy to see that the combination of high stakes, substantial uncertainty, and great urgency puts a premium on speed, coordination, and clarity. In such circumstances, centralised leadership and contraction of power may come close to being necessary, although by no means sufficient, ingredients of an effective response strategy. A military combat unit has sound reasons for adopting a more hierarchical structure than a university.

As pointed out above, this is an extreme version of the collective action model. The essence of the argument can, however, be found

in more muted form in many contributions to the study of environmental governance—from Hardin's (1968) sombre account of 'the tragedy of the commons' to recent studies on reform of the organisational framework for global environmental governance (e.g. Biermann and Bauer, 2005).

Now, the kind of environmental governance challenges that I am concerned with here meets only two of the defining characteristics of 'crises'. In fact, by Hermann's standards, decision time is very long. Since the propositions developed for crisis management explicitly require a high score on *all* three dimensions, we may conclude that they do not apply to the kind of long-term governance challenges that I have described above. Fortunately, Hermann's taxonomy includes also another category combining high stakes and high uncertainty with long decision time. This combination generates, he suggests, an *innovative* situation, characterised by major investment of time and energy in search for new solutions, with less centralised leadership and more open and exploratory procedures. None of the illustrations he provides does, however, involve the type of long-term policy challenges that concern us here. To be sure, global climate change and loss of biodiversity do provide multiple opportunities for innovation, also with regard to policies and institutions. As we have seen above, however, an equally important aspect is very long time-lags between action (involving costs) and effect (bringing benefits). Under such circumstances, the main challenge is not merely one of generating new ideas and developing long-term policy visions; a more critical challenge is to *transform* such ideas and visions into a *sustained programme of activities* that can deliver the goods. The premium is not on speed but rather on perseverance. This is a politically more demanding version of innovative situations, for which the propositions offered by Hermann need to be supplemented and probably also revised.

For one particular type of goods – notably collective goods requiring contributions by *all* or nearly all parties – contraction of power and centralised leadership may come close to being necessary conditions for consistency and perseverance. In dealing with this type of goods, a highly decentralised system will have a large number of 'veto players' and be very vulnerable to even a small number of defections. Some studies indicate that a weaker version of the argument may be extended also to other types of collective goods. For example, Stone (2009, p. 46) finds that '...democratic decision-mechanisms generally under-provide insurance when risks are distributed unevenly'. More generally, Downs (1972) and others argue that the attention of the average citizen tends to shift rapidly from one issue to another, providing shaky ground for consistent long-term policies. Yet, it is abundantly clear that contraction of power and centralised leadership is no panacea, and involves significant risks of its own. Other strategies seem more promising for some types of challenges.

3.2. The adaptive governance model⁶

I use this label for a less distinct family of approaches. One common denominator is that they seek to improve our understanding of how complex and decentralised systems can – given certain conditions – respond flexibly and effectively to abrupt as well as incremental change. Ability to monitor developments and learn from experiments as well as historical experience is considered important assets. Particularly when coupled to the concept of resilience – the capacity of a system to withstand perturbations and then rebuild and renew – it leads scholars to appreciate the merits of diversity and pluralism, also with regard

⁶ As will become clear from the brief outline below, I use this term broadly, covering more than the model of *adaptive management* as developed by Holling (1978/2005) and others.

⁵ A similar distinction is made by Bronzizio et al. (2009).

Table 1
Summary of scoping conditions for the two models.

Critical variable (scoping condition) ↓	Adaptive governance/pluralistic response strategy	Collective action/unitary response strategy
Task environment Type of good to be provided	Heterogeneous, in flux Private	Homogeneous, stable Collective Incongruity between cost/benefit calculus of individual actors and that of the group as a whole
Critical number of contributors required	One (few) 'Single best effort solution' available	All (most) Weakest link determines outcome
Type of activity	Loosely connected No master plan required, and no integrated end product envisaged	Tightly connected Master plan desirable, and end product to be well-integrated
Decision time	For each unit: short–intermed. For system: intermediate–long	(Very) short
Policy horizon/time lag between measure and effect	Short–intermediate	Very long? For collective goods requiring contributions from (nearly) all

to governance. Diversity can enhance adaptive capacity by increasing the range of response options. Decentralisation can provide, for each unit, the freedom required to act quickly. For the system at large, it can provide the flexibility required to adapt responses to local circumstances, and to test alternative options, thereby increasing the probability that at least some measure(s) will work. Instead of contraction of power and centralised leadership, open processes with broad and active participation of stakeholders are seen as important components of a resilient social system (Folke, 2006; Rammel et al., 2007).

Since we are dealing with a less distinct family of approaches, the conditions under which these approaches are supposed to prove effective are not identified as precisely as for Hermann's crisis management model. A comparative reading of studies of social organisation may nevertheless offer useful guidance (see, e.g. Scott, 2003). One important conclusion to be drawn from this field of research is that organisational structures and processes tend to vary systematically with, inter alia, certain features of the task environment in which an organisation operates and the type(s) of activities at the core of its mission. Two general propositions seem particularly relevant in this context.

First, other things being equal, we would expect the operational autonomy of subunits to increase with the heterogeneity and instability of the task environment. Where task environments differ significantly along geographical or functional lines, a premium will exist on differentiation. One important requirement for successful differentiation is a good understanding of local circumstances and information channels that can provide early warning. The more local circumstances differ, and the less stable they are, the more likely that local subunits will have a significant information advantage relative to the central leadership. Moreover, leaders of these subunits are also likely to have better access to local networks, some of which may provide effective channels for influencing important local actors and communities.

Organisation structures are, of course, designed also with a view to the functions to be performed and the type(s) of activities to be undertaken. Other things being equal, we would expect an organisation to adopt a more centralised mode of governance if its activities constitute a tightly coupled system than if they are loosely connected. A manufacturing company relying on 'Fordian' production lines is characterised by a tight serial coupling of work operations that all feed into a highly integrated end product (e.g. a car). By contrast, in a university setting, research projects and education programmes in chemistry or mathematics can be developed and run with little or no coordination with research and teaching activities in linguistics or anthropology. No common and well-integrated product is to be delivered. Thus, for obvious functional reasons, we would expect the university to be a less

centralised type of organisation than the industrial company, at least as far as their respective core activities are concerned.

What are we to make out of all these distinctions and propositions? Table 1 offers a crude summary. The columns distinguish between the two ideal-type response strategies and corresponding modes of governance described above. The rows indicate conditions under which each of these response strategies and modes of governance will likely be the more effective. Each of the six variables listed can be considered a critical scoping condition, specifying the domain of each strategy. The list of scoping conditions could easily be extended, and the propositions all call for further refinement. Even such a crude cut may, however, suffice to suggest one important conclusion: both of these response strategies and modes of governance have considerable merit, but for different types of challenges. Therefore, specifying as precisely as we can the types of challenges that each strategy can effectively respond to may provide important clues for making good use of both.

4. Concluding remarks

The analysis in this paper may now be summarized in two main propositions. First, to be effective, a response strategy must match the challenge. We need to think about challenge–response relationships in terms of *fit* (Young, 2002; Galaz et al., 2008). Arguably, the collective action model responds better to the challenge of climate change than to that of biodiversity loss. Moreover, for global climate change, policies of *adaptation* will by and large have higher aggregate scores on conditions favouring pluralistic strategies and decentralised governance than policies of *mitigation*. Most importantly, adaptation measures tend to have a more favourable ratio of private to collective goods, can be provided by smaller groups, and have shorter time-lags between action and effect. A closer look will, however, reveal important differences also within each of these broad categories. Some mitigation measures, for example investments to enhance energy efficiency in homes or production plants, may yield significant private returns in only a few years. Moreover, some types of adaptation measures – flood prevention systems for large geographical areas being a good example – respond to potential disasters and aim at providing collective goods of a type where the weakest link determines the outcome for all. A decentralised mode of governance will be too risky for the latter type of adaptation. These observations suggest caution with regard to sweeping generalisations; challenge–response relationships will have to be analysed in terms of more narrow categories of problems and policies.

Second, in thinking about challenge–response relationships considerable scope exists for intellectual framing and political

engineering. Surely, important features of the challenges themselves are determined exogenously. For example, the biophysical mechanisms driving the climate system are themselves beyond the transformative reach of human imagination or governmental policy. The description and diagnosis of the problem before us is, however, an intellectual construct and as such open to alternative interpretations and deliberate framing.⁷ So is the menu of choice regarding response options. Solutions can be invented and deliberately designed and presented so as to enhance their chances of being adopted and implemented. Important pieces of advice for policy design may be extracted from different strands of research literature.

From Mancur Olson's seminal study of collective action we have learned that a necessary (though not sufficient) condition for the optimal provision of a collective good in the absence of coercion is that marginal costs of additional units be shared in exactly the same proportion as additional benefits (Olson, 1968, p. 30). Ostrom (1990) offers a longer list of 'design principles' for governing the use of common-pool resources. One of these principles is very similar to Olson's proposition, others point to the importance of, inter alia, clearly defined boundaries, accountable monitoring, and graduated sanctioning systems. Sandler (1998, p. 221) concludes that collective action at the international level is facilitated by factors such as removal of uncertainty, a high share of nation-specific benefits, a small number of essential participants, and the presence of an influential leader nation. More generally, political scientists tell us that the chances of a particular option's being adopted are determined by the extent to which powerful actors see that option as meeting their interests and/or values better than other options. The political feasibility of a policy programme can be enhanced by *combining* measures that (a) offer tangible (short-term) benefits to specific sectors of the economy or segments of society, and (b) conform to core values or ethical principles subscribed to by the attentive public. This particular configuration of private profit and public virtue can be remarkably effective in generating support for effective environmental governance (DeSombre, 2000).

These and several other propositions provide useful guidance for dealing also with long-term policy challenges such as global climate change and biodiversity loss. Most of the examples referred to above pertain, though, to specific policies and programmes. Can similar propositions be formulated for the design of *systems* for long-term environmental governance?

The short answer seems to be that we can at least identify certain critical functions that such a system must perform to be effective. These functions range from promoting the development and sharing of frontier knowledge about the challenge itself and the effects of adaptation and mitigation measures, to transforming conflicting interests into effective and sustained collective action. To cover this wide range, a system of governance must provide a carefully *differentiated* framework that combines elements of the adaptive governance model – to enhance flexibility, diversity, and learning capacity – with components of the collective action model—to ensure focus, energy, and sustained commitment. It would be a system of multi-level governance—sufficiently decentralised to provide scope and incentives for local initiatives but also capable of building arenas and networks to facilitate the diffusion of best practices and international regimes and organisations to enhance the capacity for collective action. The latter is not merely a matter of centralised leadership; equally important seems to be what Schelling (1960/1971, p. 22) calls 'the power to bind oneself'. For the latter purpose (constitutional) rules 'binding' policy-makers to long-term goals or principles may be a more reliable strategy than contraction of power (Kydland and Prescott,

1977; see also Stein, 1998). Also other and very different options – for example Steinberg's (2009) notion of 'resilient institutions', relying on the mobilisation of multiple constituencies – deserve to be explored.

Building a system for long-term environmental governance based on these and similar propositions would create what Lemos and Agrawal (2006) call 'hybrid' forms of governance, in which non-governmental actors are actively involved not merely in articulating demand or support for governmental policies but also in establishing and implementing regulatory schemes.⁸ Such a system would not be particularly well suited for developing and implementing a synoptic master plan for mitigating climate change or preserving biodiversity. That need not be a major drawback. For challenges as complex as these, a strategy relying on 'clumsy solutions' may well mobilise more energy and yield better results in the long run (Verweij et al., 2006).

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⁸ Research on deliberative democracy offers other suggestions, more or less plausible. One innovative construct is a 'Chamber of Discourses' (see Dryzek and Niemeyer, 2008).

⁷ For instructive illustrations, see the article by Leach et al. (in this issue).

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