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Beyond Regulation: Innovative Strategies for Governing Large Complex Systems

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Abstract: We have entered an era characterized by levels of complexity that are unprecedented in human experience. The hallmarks of complex systems are the growth of connectivity, the prominence of nonlinear patterns of change, the occurrence of bifurcations in contrast to oscillations, and frequent surprises associated with emergent properties. There are good reasons to question the adequacy of the standard repertory of practices associated with regulatory strategies in efforts to fulfill needs for governance in complex systems. Whereas regulatory strategies feature the articulation of rules expected to remain in place indefinitely and emphasize efforts to maximize compliance with the rules, governing complex systems calls for a willingness to experiment with innovative practices in the face of uncertainty and a capacity to adapt existing practices easily to new circumstances. It is helpful in this connection to distinguish between Type I governance, which is a matter of devising supplementary practices to augment rather than to replace regulatory measures in managing volatile oscillations, and Type II governance, which is a matter of devising new governance strategies to address needs for governance arising during periods of transformation and in the settings that become the new normal following major state changes. There is no need to discard familiar regulatory strategies. Rather, the challenge is to devise innovative steering mechanisms to augment the existing toolkit to meet needs for governance in the 21st century.

Keywords: complex systems; connectivity; directional change; emergent properties; nonlinearity; Type I governance; Type II governance

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1. Introduction

It is common to equate governance with the creation and implementation of regulatory measures. Those endeavoring to solve largescale collective-action problems (e.g., the depletion of marine fisheries) or to internalize social costs (e.g., the impacts of plastics on marine ecosystems), for example, regularly approach these challenges as a matter of reaching agreement on the content of a set of rules applicable to the behavior of a relatively well-defined group of subjects, formalizing these rules through the promulgation of regulations, applying the regulations to the circumstances prevailing in specific cases, and devising mechanisms designed to maximize compliance with the regulations on the part of individual subjects [1]. Most of those who operate within this regulatory paradigm regard it as advantageous to formalize the resultant arrangements by making the rules legally binding, and to clarify and sharpen the operational content of the associated regulations by resorting to judicial or quasi-judicial procedures designed to determine how they apply to a range of real-world fact patterns [2]. From the perspective of those who work within the ambit of this paradigm, it is natural to think of governance in terms of the well-known idea of the rule of law and to frame the central challenge as a matter of "making law work" [3].

Some international regimes do fit the regulatory paradigm in a relatively straightforward manner. The regime for Antarctica articulated the 1959 Antarctic Treaty and subsequent extensions, for example, contains well-defined prohibitions (e.g., no stationing of military forces in the region, no commercial mining activities) and requirements (e.g., opening scientific stations to inspection on demand). The 1973/1978 International Convention for the Prevention of Pollution from Ships (MARPOL) contains a series of annexes prohibiting the discharge of noxious substances and wastes or restricting the locations where such discharges are permissible [4]. For its part, the regime governing world trade requires those subject to its rules to grant most favored nation status to each other and prohibits restrictions on trade justified by reference to production processes (e.g., methods of catching tuna that kill large numbers of dolphins in the process) [5]. It is not surprising, under the circumstances, that most of us bring a regulatory mindset to our thinking about governance in world affairs.

Nevertheless, complex systems of the sort we encounter today with increasing frequency in a variety of settings have a number of characteristics that make it difficult—in some cases virtually impossible—to meet needs for governance successfully through the creation and operation of familiar regulatory measures [6]. High levels of connectivity make it hard to establish boundaries regarding the identity of the subjects to whom regulations would/should apply. Directional changes reduce the usefulness of rules expected to apply to behavior that occurs repeatedly in more or less similar settings over indefinite periods of time. Nonlinear patterns of change heighten the need to establish arrangements that are capable of adapting agilely to rapidly changing circumstances. Above all, the centrality of emergent properties produces frequent surprises that raise questions about the continued usefulness of established governance practices.

This does not mean that regulatory strategies are no longer useful in meeting needs for governance. But it does mean that we are in need of new intellectual capital that can underpin our efforts to devise strategies for governing complex systems now and during the foreseeable future. In this article, I address this topic in three steps. The first substantive section explores the distinctive characteristics of complex systems that give rise to difficulties in using regulatory arrangements effectively. The next section probes in more detail the reasons why the standard repertory of practices associated with the regulatory paradigm become problematic in situations where needs for governance arise in connection with complex systems. This sets the stage for the final section devoted to an initial discussion of innovative strategies for meeting needs for governance arising in such settings. The point is not to issue a call for abandoning the regulatory paradigm altogether. Rather, I argue that we need to expand our repertory of governance strategies to supplement regulatory measures in many settings and even to replace them in some settings that are becoming more prevalent as we move deeper into the era now widely characterized as the Anthropocene [7]. In developing this argument, I introduce a distinction between Type I governance centered on managing increasingly volatile fluctuations in oscillating systems and Type II governance focused on addressing challenges of governance arising in the wake of transformative changes or bifurcations. This analysis is preliminary in nature; it is intended to sharpen our thinking about issues coming into focus today rather than to provide the last word regarding how to handle these issues. But if I am right, we will find it imperative to think hard about new governance strategies during the coming years.

2. Distinctive Features of Complexity

Complexity is not a dichotomous variable. Systems can and do vary along a spectrum ranging from extreme simplicity to great complexity. It is probably accurate to say that problems generating needs for governance in international society have always been relatively complex. Still, there are good reasons to conclude that we have entered a world characterized by levels of complexity that are unprecedented in modern human experience [8]. This is why simple prescriptions, whether they are rooted in the faith of conservatives regarding the role of self-generating institutions and spontaneous order or the belief of those on the left in the virtues of central planning or what the Europeans call dirigisme, seldom produce effective solutions to problems giving rise to needs for governance in the contemporary world. To give this observation substance, however, it will help to probe a little more into the characteristics of complex systems that pose problems for familiar ways of thinking about governance. In the following paragraphs, I comment of matters of connectivity, nonlinearity, directionality, and emergence.

By definition, all systems feature some measure of connectivity, whether the links are biophysical or anthropogenic in character. But two rising forms of connectivity are of particular importance to those responsible for meeting needs for governance under contemporary conditions. One of these forms is captured in the concept of coupled systems; the other is reflected in the idea of telecouplings. Coupled systems are marked by critical interactions between anthropogenic and biophysical drivers. It is not so much that we now inhabit a world of human-dominated systems as some observers have argued [9]. Rather, the point is that we cannot understand the dynamics of these systems without thinking hard about how anthropogenic and biophysical drivers interact with one another in ways that often produce surprising and even counterintuitive outcomes [10]. This is one of the key reasons why the behavior of the Earth's climate system is so difficult to understand at any given point in time, much less to predict over any length of time. Even the best of the general circulation models, focus on biophysical processes, leaving the determinants of anthropogenic emissions of greenhouse gases (GHGs) to be addressed through the development of scenarios that identify a range of plausible emissions trajectories but contribute little to our knowledge of the dynamics of coupled systems.

For its part, the idea of telecouplings refers to the impacts of drivers—both anthropogenic and biophysical—that are far removed from their origins and that seem counterintuitive, at least until we are able to identify the mechanisms that produce them [11]. Prominent examples of current interest include the dramatic recession and thinning of Arctic sea ice associated with greenhouse gases emitted into the Earth's atmosphere in the mid-latitudes, the growth of oceanic dead zones arising from agricultural practices that play out hundreds or even thousands of kilometers inland, and changes in the species composition of marine ecosystems caused by the role of the oceans as sinks for carbon dioxide injected into the atmosphere from land-based anthropogenic sources. Feedback mechanisms regularly heighten the impact of these telecouplings. The recession of sea ice in the Arctic Basin, for example, produces open water whose dark surface absorbs more solar radiation than ice, a connection that plays a role of some significance in raising average temperatures at the Earth's surface.

The recent spate of writings on the idea of "tipping points" has heightened awareness of the importance of nonlinearity in complex systems. But popular usage has resulted in a lack of clarity or precision in discussions of this phenomenon [12]. It is important in this connection to think about both thresholds and trigger mechanisms producing nonlinear patterns of change [13]. In the absence of a trigger mechanism, a system may remain poised at the threshold of nonlinear change for some time, a situation that can produce a false sense of stability on the part of observers. In such situations, the operation of a trigger (e.g., the storming of the Bastille in Paris on 14 July 1789 or the events of the summer of 1991 in Moscow) can produce dramatic consequences that are generally not anticipated, that seem disproportionate to the strength of the trigger, and that typically take most everyone by surprise. Although it is related, the speed of nonlinear change is a distinct variable. We are used to thinking of nonlinearity in the form of explosions that produce dramatic and rapid changes, such as the collapse of the *ancien regime* in France in 1789 or the onset of World War I in the summer of 1914. But nonlinear changes may take the form of cascades of developments that play out over time leading eventually to a fundamental change of state in the relevant system. In some cases, the entire process may unfold over a prolonged period time. To take a prominent example, many analysts believe that the Greenland ice sheet has passed a point of no return and is destined to disintegrate. But it is quite possible that the process will play out over a period of decades to centuries.

A striking feature of the complex systems of greatest interest to us today is that it is difficult to identify thresholds and trigger mechanisms with any precision. Consider the debate about climate change in this light. We want to avoid "dangerous anthropogenic interference with the climate system", and the international community has decided that this means keeping average temperature increases at the Earth's surface below 2 °C and if possible below 1.5 °C [14,15]. But this formula masks a high level of uncertainty. For one thing, there is likely to be great spatial variation regarding temperature increases; a global average of 2 °C, for example, may translate into 3 °C in Subsaharan Africa, a difference likely to produce catastrophic consequences for affected populations. What is more, we do not know the exact relationship between concentrations of GHGs in the Earth atmosphere and increases in average temperatures at the Earth's surface. Those who adopt a precautionary approach typically say we should try to avoid concentrations over 450 ppm CO_{22e} [16]. But given the costs of meeting this target, those concerned with other high priority objectives like fulfilling the UN's Sustainable Development Goals relating to poverty and human health are apt to adopt positions that marginalize or at least water down this precautionary approach. Nor is the case of climate change unusual in this regard. Similar remarks are in order regarding the suite of what are often called "planetary boundaries" and the resultant conclusions about what is required in each case to maintain a "safe operating space for humanity" [16].

Another important feature of complex systems involves directionality or directional change. In the language of systems analysis, we can differentiate between oscillations and what are known as bifurcations [13]. Oscillating systems are characterized by cycles of change that recur in relatively similar patterns. Sometimes, these patterns allow for confident predictions. We know exactly when the shortest and longest days of the year will occur, at least over any future time period of interest to human beings. Although the pattern is certainly less rigid, we also can say with a fair amount of confidence that presidential elections will occur in the United States on a four-year cycle. In other cases, oscillations are far less regular; high levels of volatility may generate legitimate doubts about whether a given cycle is breaking out of the pattern observed in the past. With regard to biophysical cycles, the oscillation between El Nino events and La Nina events provides a case in point. A particularly prominent anthropogenic example involves the occurrence of business cycles in which periods of growth and recessions follow one another with some regularity. The problem in this case is that the pattern is far from uniform, and the causal mechanisms involved are not well understood. Under the circumstances, it is easy to understand the fears evoked by the recession of 2008–2009, although it is by no means clear that the macro-economic initiatives launched to combat the recession played a decisive role in preventing the cycle from degenerating into a full-fledged depression.

Bifurcations, on the other hand, feature directional changes that are not expected to take the form of cycles. Simple examples involve evolutionary changes in living organisms and macro-social changes of the sort exemplified by transitions from hunter-gatherer systems to agrarian systems and from agrarian systems to industrial and post-industrial societies. It is pointless to look for recurrent patterns in such processes; once a transition from one state to another is made, there is no going back to the status quo ante or anything like it. Of course, bifurcations may play out over substantial periods of time, and it may be difficult to identify the trajectory of change during the early phases of bifurcations. It would have been difficult for anyone looking at China in 1979–1980, for example, to anticipate the scale and speed of industrialization and urbanization occurring in that society over the succeeding thirty-five years. Still, there are compelling reasons to believe that the shift from the Holocene to the Anthropocene on a global scale constitutes a bifurcation. There can be no doubt that the suite of developments often called the Great Acceleration have brought about fundamental changes in the relative weight of anthropogenic and biophysical drivers in the Earth system that are directional in character and that must be taken seriously in thinking about what we now describe as Earth system governance [10,17]. I will return to this point later. But suffice it to say for now that the challenge we face in the Anthropocene is not simply one of regulating some more or less regular cycle but rather one of maintaining a "safe operating space for humanity" in a system featuring volatile fluctuations and directional changes that may unleash turbulent forces.

In a sense, emergence is an outgrowth of connectivity, nonlinearity, and directionality rather than a distinct phenomenon. The essential point is that complex systems are full of surprises. Relatively small changes in initial conditions can produce dramatic differences in the behavior of complex systems. In fact, the same initial conditions can trigger very different dynamics in such systems. That is why those who build models of complex systems typically run these models many times to determine whether patterns emerge in the outcomes in repeated iterations. It is also why they vary individual elements of the models experimentally to engage in what we generally think of as sensitivity analysis. Are the systems whose behavior we are seeking to understand robust in the sense that small changes in particular variables do not change their behavior dramatically? Are they robust with regard to changes in some variables but not others? Without doubt, there is merit in analyses of this sort. There is a lot at stake with regard to the behavior of key systems like the Earth's climate system; any forms of analysis that can help us to grasp the dynamics of such systems are worth a great deal.

Nevertheless, the fact remains that we live in a world of emergent properties or, in other words, a setting in which there is no way to avoid decisionmaking under a high degree of uncertainty [18]. What is more, it is seldom possible to determine with any degree of precision whether the prescriptions offered by different segments of the policy elite have more or less merit. Consider the case of macroeconomic policy where prescriptions calling for tax cuts intended to stimulate private investment or austerity measures designed to reduce public indebtedness reemerge again and again in the absence of any clear evidence regarding their efficacy or, more modestly, evidence regarding the specific conditions under which they can be expected to yield the desired results [19]. Some observers are inclined to interpret this phenomenon as a reflection of the interests of particular policymakers or the segments of society whose views they represent. Tax cuts benefit the wealthiest members of society, for instance, whether or not they stimulate economic growth. But the fact is that emergent properties in complex systems make it impossible or nearly impossible to arrive at decisive judgments regarding the effectiveness of specific prescriptions in such settings. The implications of this feature are in some respects counterintuitive. Policymakers habitually present their preferred prescriptions with great conviction in the interests of convincing others to support their efforts to formulate policies relating to current problems and to implement them faithfully over time. But efforts to solve problems arising in complex systems call for a more experimental approach in which initiatives are introduced on a trial basis and monitored closely, combined with a willingness to adjust them or even to replace them as evidence regarding their consequences accumulates [20].

3. Governance Challenges under Complexity

The onset of complexity does not mean that we should simply abandon regulatory strategies in efforts to meet needs for governance arising today. There are situations in which it makes sense to employ requirements and prohibitions; a focus on compliance remains critical in such cases. There is no doubt, for example, that requiring double-hull construction in new tankers and prohibiting attempts to stake jurisdictional claims in international spaces (e.g., celestial bodies) constitute desirable regulatory measures [21,22]. Nevertheless, the growth of complexity raises questions about what we have come to know as the problem of institutional fit [23]. Are there tensions or even outright conflicts between conditions associated with the characteristics of complexity discussed in the preceding section and key features of the regulatory paradigm that dominates mainstream thinking about ways to deal with governance problems in largescale systems? In this section, I consider this question, in order to pave the way for an effort in the following section to add to our repertory of governance strategies as we prepare to meet needs for governance in the Anthropocene.

Increases in connectivity produce situations in which needs for governance arise as unintended side effects of the actions of distant causal agents. Acid rain, for example, is a consequence of emissions of sulfur dioxide and nitrogen oxide from tall smokestacks located hundreds or even thousands of kilometers away from the point of impact. Similar observations apply to the occurrence of marine dead zones resulting from runoffs following the use of chemical fertilizers and pesticides in distant agricultural areas. In this regard, the processes through which injections of greenhouse gases into the Earth’s atmosphere cause sea level rise, warming seas, and ocean acidification on a global basis are an extreme case. In this situation the causal agents are large in number, widely dispersed in terms of location, and often far removed from the impacts of their actions. If we are concerned about the bleaching of corals on Australia’s Great Barrier Reef, the collapse of Arctic sea ice, or the destabilization of the Greenland ice sheet, for instance, we must look to emissions of GHGs in the mid-latitudes rather than to more proximate causes in order to develop strategies that will make a difference in avoiding destructive outcomes or in relieving pressures on systems experiencing severe stress.

The problem with regulatory measures in such cases arises from the disconnect between the locus of the problem and the location of the causal agents who see themselves as normal self-interested actors minding their own business with no intention of causing harm to distant ecosystems or human communities. Not only is it often hard to identify the causal connections in such cases with confidence; it is also difficult politically to curb the behavior of actors giving rise to distant problems that they do not understand well and that they are reluctant to accept responsibility for when that means making costly adjustments in their own activities. This is particularly true when the problems are cross-border in nature in the sense that the causal agents are located in one jurisdiction, while the problem manifests itself in another jurisdiction. Regulatory measures are not irrelevant in such cases. Consider the effort to reduce long-range transboundary air pollution in North America under the terms of the US Clean Air Act Amendments of 1990 and the subsequent US-Canada Air Quality Agreement of 1991 [24]. But there can be no doubt that regulatory strategies become more difficult to use effectively as the separation between the locus of the problem and the location of the causal agents increases.

Nonlinearity poses another set of challenges regarding the use of regulatory strategies to meet needs for governance. To start with, there is the problem of identifying thresholds and determining what is required to maintain a safe operating space for humanity on a case-by-case basis. Sometimes this gives rise to analytical disagreements among members of the science community. There is a vigorous debate, for example, regarding the proportion of a stock of fish that can be removed without damaging the reproductive success of the remaining fish [25,26]. In other cases, efforts to identify thresholds are hampered by unusually high levels of uncertainty. It makes sense intuitively to speak of a planetary boundary with regard to the stability of the Earth's climate system. But where exactly is the threshold regarding what is commonly described as "anthropogenic interference in the Earth's climate system"? One obvious response to the resultant uncertainty is to adopt the precautionary principle, making an effort to stay well within the relevant boundaries. But this strategy has its drawbacks. To the extent that we do not know the location of the relevant thresholds, it will be difficult to determine just what a precautionary approach entails. And a precautionary approach—even when it is limited in nature—imposes costs, particularly on those whose livelihoods are tied directly or indirectly to the activities that must be curbed or eliminated in the name of precaution.

Even more serious is the fact that nonlinearity gives rise to changes of state in key systems (e.g., the Earth's climate system). What worked to meet needs for governance in a prior state may not work in the new state; it may even produce behavior that is counter-productive from the perspective of effective governance. To meet needs for governance under such conditions requires an ability to adjust governance strategies easily and quickly to adapt to changing circumstances. But this can often run counter to the normal practices associated with the regulatory paradigm. Whereas those making use of regulatory arrangements place a premium on hardening individual obligations by making them legally binding and making their operational meaning as clear as possible as a means of ensuring compliance, nonlinearity calls for adaptability in the face of more or less dramatic and sometimes fast-paced changes [1,2]. Several examples will help to clarify this aspect of the problem of institutional fit. A regulatory approach seeks to entrench the rights and rules governing withdrawals of surface or subterranean freshwater in the interests of minimizing disruptive conflicts among competing users. But this will not help much in solving problems arising from state changes that reduce sharply the overall amount of water available for allocation [27]. A regulatory approach imposes rules regarding the harvest of total allowable catches from fish stocks. But this will not help much in cases where biophysical changes (e.g., changes in water temperature) lead to fundamental changes in the population dynamics of the relevant fish stocks [28]. The point is not that regulatory measures are irrelevant in such cases. Rather, the state changes involved may call for innovative governance strategies that are difficult to introduce when regulatory arrangements have been locked in or hardened in order to maximize compliance with their requirements and prohibitions.

Turn now to the issue of directionality. Looked at from a regulatory perspective, much of governance is a matter of taking steps to manage "normal" oscillations, containing them within boundaries established on the basis of human needs. We seek to manage business cycles by stimulating economic activity during periods of recession and taking steps to dampen overheated economies. We worry about whether there is a need to intervene when levels of inequality become so extreme that they threaten to disrupt social systems. We seek to counter forces that may drive species to extinction, while controlling invasive species that show signs of driving out indigenous and especially endemic species in given ecological settings. The fundamental idea in all these cases is to make use of feedback mechanisms as a means of maintaining order or limiting the range of oscillation in the behavior of the relevant systems. Negative feedback mechanisms, in such forms as wealth taxes or measures to control invasive species, help to limit disruptive forces. Positive feedback mechanisms, in such forms as economic stimulants or introducing measures to protect endangered species, help to strengthen normal systemic functions.

Governance as a matter of regulating "normal" oscillating processes is obviously important, especially when these processes threaten to spiral out of control in the absence of management mechanisms. Yet complex systems are characterized by a tendency to generate extreme volatility in oscillating processes and even to produce the transformative changes known as bifurcations. High volatility inevitably requires decision making under uncertainty. Bifurcations are irreversible changes that have profound consequences for the behavior of the relevant systems. Under such conditions, the challenge is to devise new governance strategies that are designed to operate effectively under changed conditions rather than to shore up unstable systems using regulatory measures that were more or less effective under prior conditions. Of course, it is critical to be able to determine when the onset of a bifurcation occurs. This may prove difficult to do, especially lacking the benefit of hindsight. This is what makes the current debate about transitioning from the Holocene into the Anthropocene both difficult to resolve and highly significant [29]. Once it becomes clear that a bifurcation has occurred, new ways of thinking about governance will become essential. In fact, trying to use old governance strategies to solve the sorts of needs for governance arising under the new order may do more harm than good. In the case of climate change, for example, we are witnessing increasing doubts about the efficacy of a governance strategy that focuses attention on the negotiation of a conventional intergovernmental agreement featuring the articulation and implementation of requirements and prohibitions.

What ties these observations together is the idea of emergence. Complex systems may seem stable most of the time. But they are full of surprises in the sense that they are prone to dramatic shifts that even close observers find difficult to anticipate and that we are seldom prepared for in terms of our repertory of governance practices. We assume that systems are more or less stable, that change when it does occur will be incremental or gradual in character, and that we will be able to adapt our governance practices to new circumstances as the need arises. This mindset encourages a tendency to assume, implicitly if not explicitly, that business as usual will prove adequate with regard to meeting needs for governance. From time to time, however, the systems we rely on experience state changes that we do not anticipate and have not prepared for in advance. When these state changes are planetary in scale (e.g., nonlinear changes in the Earth's climate system), the costs of being unprepared may become extreme. There are two distinct, albeit related, challenges arising in this connection. One is to deepen our understanding of the relevant systems in order to improve our ability to anticipate the onset of state changes. This is clearly essential. As the case of climate change makes clear, we have a long way to go in moving from projections to predictions in such cases, even if the predictions we aspire to make are only probabilistic in nature. The other challenge focuses on the development of innovative governance practices that can be deployed quickly and effectively when the need arises. This is, to put it mildly, difficult to do. It requires a capacity to continue to make use of existing governance strategies while at the same time developing alternative measures to the point where they can be deployed quickly when oscillation turns to bifurcation. There is some experience with shifts of this kind in cases where governments have assumed war powers allowing them to bypass normal governance practices and to introduce new ones during states of emergency [30]. But few arrangements of this type have been worked out carefully in advance, and such transitions sometimes do more harm than good, particularly in the long run. Yet an ability to manage a two-track system capable of performing effectively in a business as usual mode most of the time while maintaining fundamentally different practices on call to be used to address needs for governance arising out of bifurcations may be the hallmark of effective governance in complex systems.

One way to capture the essence of this discussion of the implications of complexity is to introduce a distinction between Type I governance and Type II governance. Type I governance is a matter of managing oscillating systems that become increasingly volatile with the goals of preventing them from breaking out of the bounds of their normal fluctuations and alleviating certain outcomes that are undesirable even if they do not trigger the onset of a bifurcation (e.g., levels of inequality that violate social norms). Type II governance, by contrast, becomes essential as systems break out of oscillating cycles and experience the transformative changes associated with bifurcations. There is much to be done to improve the effectiveness of both types of governance in an age of complexity. Type I governance is a matter of devising supplementary practices that may be used to augment rather than to replace regulatory measures in managing volatile oscillations. Type II governance, by contrast, is a matter of devising new governance strategies to address needs for governance arising during periods of transformation and in the settings that become the new normal following major state changes.

4. Governing Complex Systems

Where should we look for institutional innovations that can supplement or replace the regulatory paradigm in efforts to address the problem of fit in a world of increasingly complex systems? It is worth noting at the outset that practices already emerging on a global scale offer an initial response to this question. Consider the developments of the last twenty-five years in efforts to come to grips with the problems of climate change and the loss of biological diversity. What stands out in an examination of these experiences is a rising interest in the roles that goals and principles can play as steering mechanisms in contrast to a focus on the development of requirements and prohibitions that we associate with the regulatory paradigm.

The climate regime began life in the 1990s as a relatively conventional regulatory arrangement with the signing of the UN Framework Convention on Climate Change in 1992 followed by the adoption of the Kyoto Protocol in 1997. The basic idea was to devise a top-down arrangement relying on legally-binding commitments on the part of the industrialized states combined with a set of mechanisms intended to provide assistance to developing states willing to make an effort to move toward the acceptance over time of binding commitments of their own. With the passage of time, however, it became apparent that this arrangement was not only failing to slow the course of climate change but also and most importantly involved assumptions that were fatally flawed, at least as applied to the case of efforts initially to halt increases in emissions of GHGs and ultimately to bring about substantial reductions in global emissions.

Superficially, the Paris Agreement adopted at COP 21 in December 2015 may appear to be another step in the progressive development of the climate regime. But, in reality, it reflects a fundamental change in thinking about effective governance strategies for coming to grips with climate change [15]. The centerpiece of the agreement is a general commitment to a common quantified goal of limiting temperature increases at the Earth's surface to no more than 2°C, together with a promise to make a good faith effort to stay below 1.5°C. Parties to the agreement make pledges known as Nationally Determined Contributions (NDCs) regarding what they are prepared to do individually to meet the common goal. There is no presumption that the pledges will be uniform or even calibrated in terms of a common metric. The pledges themselves are non-binding. But they are to be reviewed at regular intervals with the expectation that parties will ramp up their NDCs in the light of systematic assessments regarding what is required to fulfill the common goal. Known as the Global Stocktake, this process of ratcheting up is to occur at five-year intervals. Critically, each party is allowed to decide for itself how to fulfill the pledge set forth in its NDCs. There is no expectation that parties will comply with a uniform set of requirements and prohibitions as envisioned in regulatory arrangements.

Taken together, these changes add up to a new strategy for addressing the need for governance associated with climate change. Some have argued that we can characterize this development as a shift from a top-down strategy to a bottom-up strategy. But this may not be the best way to capture the essence of the new strategy embedded in the terms of the Paris Agreement. A better characterization of the shift emphasizes that it reflects a transition from governance as rule making to governance as goal setting. The distinctive features of goal setting as a governance strategy are the establishment of priorities that serve to galvanize the efforts of participants to join forces to achieve well-defined goals usually within a specific timeframe and with the benefit of an operational metric for measuring progress. Rather than steering through the adoption and implementation of regulatory measures, goal setting seeks to steer by galvanizing collective efforts to fulfill common goals within a specified period of time [31].

The Convention on Biological Diversity, also opened for signature in 1992, illustrates another emerging practice relevant to the pursuit of governance in a world of complex systems [32]. This arrangement sets aside earlier approaches treating genetic resources as the common heritage of humanity open to access by all without restrictions. In its place, it highlights the principle of fair and equitable sharing of benefits arising out of the utilization of genetic resources. In this connection, it acknowledges the value of traditional knowledge regarding genetic resources (CBD, Art. 8j) and emphasizes the principle of prior informed consent on the part of those whose knowledge plays a part in efforts to develop new uses of genetic resources (CBD, Art. 15). Of course, there are legitimate differences regarding procedures for operationalizing these principles. The 2010 Nagoya Protocol, for example, makes a concerted effort to achieve greater clarity and precision in this realm [33]. But note that the principle of fair and equitable sharing of benefits is not a simple requirement allowing for straightforward assessments regarding compliance or noncompliance. Rather, it is intended to serve as a social norm or ethical principle that should inform the initiatives of parties (including corporations and other nonstate actors) and provide guidance to their activities in a wide range of specific circumstances. Although there is often confusion regarding the distinction between principles on the one hand and rules and regulations on the other, principles can serve as a steering mechanism that offers a degree of flexibility regarding application to concrete situations that is lacking in the use of regulatory measures [6].

These innovations are certainly significant. But they are largely matters of Type I governance. The fundamental goal is to manage complex systems in such a way as to prevent oscillating processes from becoming increasingly volatile and triggering bifurcations in such forms as drastic climate change or a catastrophic loss of biological diversity. To be sure, such measures involve departures from business as usual in the realm of environmental governance. Still, the motivation underlying the turn to goal setting and the development of ethical principles as steering mechanisms can be characterized as an effort to respect planetary boundaries and to enhance the prospects of maintaining the Earth system in a state that offers a safe operating space for humanity.

With all due respect to the importance of these emerging practices, however, they offer no basis for ignoring the larger challenges of Type II governance. The transition from the Holocene to the Anthropocene is triggering the onset of far-reaching changes that are both biophysical and socioeconomic in nature. Despite recent experiments with innovative responses, we are on a trajectory leading to profound changes in the Earth's climate system that will drive us further into the sixth great extinction event [34]. Advances in knowledge relating to matters like artificial intelligence, synthetic biology, and geoengineering almost certainly will catalyze profound changes in human societies [35,36]. It is not necessary to conclude that all the consequences of these developments will be harmful or destructive. At least in the short run, such developments will produce both winners and losers. But there are compelling reasons to think hard about Type II governance, rather than limiting our focus to the development of supplementary governance strategies designed to minimize the prospects of transformative change by improving our ability to manage oscillations.

As a point of departure for the study of Type II governance, it is helpful to distinguish between initiatives aimed at shifting the discourse underlying our thinking about transformative changes and processes designed to develop ways to steer the behavior of various subjects once transformative changes occur. Governance systems that make a difference generally reflect, either explicitly or implicitly, prevailing discourses or narratives regarding the nature of the problem to be solved and the preferred strategies for addressing the problem [37]. For example, neo-liberal economics underpins the world trade regime; the idea of the common heritage of mankind (now humanity) is embedded in key provisions of the law of the sea [38,39]. As these illustrations make clear, prevailing discourses are not equivalent to laws of nature; they may become frayed or even collapse under pressure from both biophysical and socioeconomic developments [5]. What we are coming to understand in this connection is that a major part of governance lies in the development of new ways of framing and prioritizing issues in contrast to the development of mechanisms designed to influence the behavior of those who are identified as important actors in efforts to meet emerging needs for governance [40].

An important observation, in this connection, is that we are seeking to deal with needs for governance arising in an age of complexity using a conception of world order that emerged in the wake of the transformative changes occurring in the seventeenth century [41]. We assume that this order features a society of sovereign states that have the exclusive authority to deal with domestic affairs and that cannot be subjected to systemic restrictions on their freedom of action without their explicit consent [42]. We commonly regard this social structure as a fact of life, so that any effort to address needs for governance in the Anthropocene must start from this assumption as a point of departure [43]. But there is no need to cling to this assumption in thinking about the nonlinear changes associated with bifurcations. There are good reasons to conclude that the prevailing world order lacks the capacity to manage the dynamics of the Earth system in an age of complexity. Any serious effort to develop the intellectual capital needed to address the challenges of Earth system governance, therefore, needs to begin with a rigorous effort to think about fundamental changes in the character of international society. Clearly, it would be naïve to focus on these matters to the exclusion of what I have termed Type I governance. But a failure to think about transformative change in an age of complexity is equally naïve.

It is pointless to endeavor to devise innovative governance strategies for a new order whose essential features we are unable to characterize at this stage in any meaningful way. But we can identify some of the attributes that such strategies should have. Consider the following examples to make this observation concrete. Type II governance will require a highly developed capacity to operate under conditions of uncertainty. This suggests a need not only to control for the sorts of distortions identified in work in the area now known as behavioral economics [18,44] but also to take advantage of opportunities to engage in experiments to see how proposed governance strategies are likely to work in practice [20]. Holistic strategies will become increasingly important in settings featuring high levels of connectivity that give rise to telecouplings and the dynamics of coupled systems. Efforts to find ways to deal with marine issues that do not include the impacts of climate change, for example, are virtually bound to fail. An ability to respond with agility to nonlinear changes will be critical. If this raises questions regarding the use of traditional methods for maximizing compliance with regulations, new ways of addressing the problem of compliance will be needed. Observations of this sort do not provide a basis for constructing a detailed blueprint for Type II governance; any effort to develop such a blueprint at this juncture would be premature and likely counterproductive. But such observations do point to a set of basic requirements for governing largescale systems in the future that can provide analysts interested in Type II governance with a rich agenda of issues to explore systematically going forward.

5. A Concluding Observation

I have argued that the mainstream approach to thinking about the governance of largescale systems, which I call the regulatory paradigm, hinders efforts to find effective ways to meet needs for governance arising in an age of complex systems. The point is not that prescribing requirements and prohibitions is never useful. Rather, there is a need to supplement regulatory strategies to cope with the dynamics of complex systems. In this regard, I distinguish between Type I governance, which is a matter of managing increasing volatility in oscillating systems, and Type II governance, which is a matter of devising new governance strategies in the wake of transformative change producing bifurcations. Emerging practices arising in efforts to cope with issues like climate change and the loss of biological diversity reflect ways of thinking that go beyond the regulatory paradigm. Such efforts are progressive and need to be made more focused and systematic. But there is a need for disciplined thinking about Type II governance as well. We have a limited capacity to anticipate the nature of needs for governance likely to arise following transformative change, but we can identify with some confidence a number of features that will feature prominently in any plausible post-transformation setting, such as uncertainty, connectivity, and the need for high levels of adaptiveness. It is not too early to begin now to think rigorously about governance strategies that can prove effective under such conditions.

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References

1. Chayes, A.; Chayes, A.H. *The New Sovereignty: Compliance with International Regulatory Agreements*; Harvard University Press: Cambridge, MA, USA, 1995.
2. Abbott, K.W.; Keohane, R.O.; Moravcsik, A.; Slaughter, A.-M. The Concept of Legalization. *Int. Organ.* **2000**, *54*, 401–419. [CrossRef]
3. Zaelke, D.; Kaniaru, D.; Kruzikova, E. *Making Law Work: Environmental Compliance and Sustainable Development*; Cameron May: London, UK, 2005.
4. Mgonigle, R.M.; Zacher, M.W. *Pollution, Politics, and International Law*; University of California Press: Berkeley, CA, USA, 1979.
5. Matsushita, M.; Schoenbaum, T.J.; Mavroidis, P.C.; Hahn, M. *The World Trade Organization: Law, Practice and Policy*; Oxford University Press: Oxford, UK, 2017.
6. Young, O.R. *Governing Complex Systems: Social Capital for the Anthropocene*; MIT Press: Cambridge, MA, USA, 2017.
7. Steffen, W.; Grinevald, J.; Crutzen, P.; McNeil, J. The Anthropocene: Conceptual and Historical Perspectives. *Philos. Trans. R. Soc. A* **2011**, *369*, 842–867. [CrossRef] [PubMed]
8. Johnson, N. *Simply Complexity: A Clear Guide to Complexity Theory*; One World Publications: Oxford, UK, 2009.
9. Vitousek, P.M.; Mooney, H.A.; Lubchenco, J.; Melillo, J.M. Human Domination of Earth's Ecosystems. *Science* **1997**, *277*, 494–499. [CrossRef]
10. Steffen, W.; Sanderson, A.; Tyson, P.D.; Jäger, J.; Matson, P.A.; Moore, B.; Oldfield, F.; Richardson, K.; Schellnhuber, H.J.; Turner, B.L.; et al. *Global Change and the Earth System: A Planet under Pressure*; Springer: Heidelberg, Germany, 2004.
11. Liu, J.; Hull, V.; Batistella, M.; DeFries, R.; Dietz, T.; Fu, F.; Hertel, T.W.; Izaurraide, R.C.; Lambin, E.R.; Li, S.; et al. Framing Sustainability in a Telecoupled World. *Ecol. Soc.* **2013**, *18*, 26. [CrossRef]
12. Gladwell, M. *Tipping Point: How Little Things Can Make a Big Difference*; Little Brown: New York, NY, USA, 2002.
13. Lenton, T.; Held, H.; Kriegler, E.; Hall, J.W.; Lucht, W.; Rahmstorf, S.; Schellnhuber, H.J. Tipping Elements in the Earth's Climate System. *Proc. Natl. Acad. Sci. USA* **2008**, *105*, 1786–1793.
14. UNFCCC. 1992. Available online: unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf (accessed on 10 April 2017).
15. Paris Agreement. 2015. Available online: unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf (accessed on 10 April 2017).

16. Rockström, J.; Steffen, W.; Noone, K.; Persson, Å.; Chapin, F.S.; Lambin, E.F.; Lenton, T.M.; Scheffer, M.; Folke, C.; Schellnhuber, H.J.; et al. A Safe Operating Space for Humanity. *Nature* **2009**, *461*, 472–475. [CrossRef] [PubMed]
17. Scheffer, M. *Critical Transitions in Nature and Society*; Princeton University Press: Princeton, NJ, USA, 2009.
18. Kahneman, D. *Thinking Fast and Slow*; Farrar, Straus and Giroux: New York, NY, USA, 2011.
19. Silver, N. *The Signal and the Noise: Why So Many Predictions Fail—But Some Don't*; The Penguin Press: New York, NY, USA, 2012.
20. Kroeber, A. *China's Economy: What Everyone Needs to Know*; Oxford University Press: Oxford, UK, 2016.
21. Mitchell, R.B. *International Oil Pollution at Sea: Environmental Policy and Treaty Compliance*; MIT Press: Cambridge, MA, USA, 1994.
22. Young, O.R. The Effectiveness of International Environmental Regimes: Existing Knowledge, Cutting-edge Themes, and Research Strategies. *Proc. Natl. Acad. Sci. USA* **2011**, *108*, 19853–19860. [CrossRef] [PubMed]
23. Young, O.R.; King, L.A.; Schroeder, H. *Institutions and Environmental Change: Principal Findings, Applications, and Research Frontiers*; MIT Press: Cambridge, MA, USA, 2008.
24. Munton, D.; Soroos, M.; Nikitina, E.; Levy, M. Acid Rain in Europe and North America. In *The Effectiveness of International Environmental Regimes*; Young, O.R., Ed.; MIT Press: Cambridge, MA, USA, 1999; pp. 155–247.
25. Pauly, D. *5 Easy Pieces: The Impact of Fisheries on Marine Ecosystems*; Island Press: Washington, DC, USA, 2010.
26. Hilborn, R. *Overfishing: What Everyone Needs to Know*; Oxford University Press: Oxford, UK, 2012.
27. Owen, D. *Where the Water Goes: Life and Death along the Colorado River*; Riverside Press: Rolling Meadows, IL, USA, 2017.
28. Dobbs, D. *The Great Gulf: Fishermen, Scientists, and the Struggle to Revive the World's Greatest Fishery*; Island Press: Washington, DC, USA, 2003.
29. Purdy, J. *After Nature: A Politics for the Anthropocene*; Harvard University Press: Cambridge, MA, USA, 2015.
30. Goodwin, D.K. *No Ordinary Time: Franklin and Eleanor Roosevelt: The Home Front in WW II*; Simon and Shuster: New York, NY, USA, 1995.
31. Kanie, N.; Biermann, F. (Eds.) *Governing through Goals: Sustainable Development Goals as Governance Innovation*; MIT Press: Cambridge, MA, USA, 2017.
32. Convention on Biological Diversity. 1992. Available online: https://www.cbd.int/convention/ (accessed on 5 April 2017).
33. Oberthür, S.; Rosendal, J.K. *Global Governance of Genetic Resources: Access and Benefit Sharing after the Nagoya Protocol*; Routledge: London, UK, 2013.
34. Kolbert, E. *The Sixth Extinction: An Unnatural History*; Henry Holt: New York, NY, USA, 2014.
35. Friedman, T.L. *Thank You for Being Late: An Optimist's Guide to Thriving in the Age of Accelerations*; Farrar, Straus and Giroux: New York, NY, USA, 2016.
36. Harari, Y.N. *Homo Deus: A Brief History of Tomorrow*; Harper: New York, NY, USA, 2017.
37. Young, O.R. Governing International Spaces: Antarctica and Beyond. In *Science Diplomacy*; Berkman, P.A., Lang, M.A., Walton, D.W.H., Young, O.R., Eds.; Smithsonian Institution Scholarly Press: Washington, DC, USA, 2011; pp. 287–294.
38. Ruggie, J.G. International Regimes, Transactions, and Change: Embedded Liberalism in the Postwar Economic Order. In *International Regimes*; Krasner, S.D., Ed.; Cornell University Press: Ithaca, NY, USA, 1983; pp. 195–231.
39. Friedheim, R. *Negotiating the New Ocean Regime*; University of South Carolina Press: Colombia, DC, USA, 1992.
40. Young, O.R. *Governance in World Affairs*; Cornell University Press: Ithaca, NY, USA, 1999.
41. Young, O.R. International Relations in the Anthropocene. In *International Relations Theory Today*; Booth, K., Erskine, T., Eds.; Polity: Cambridge, MA, USA, 2016; pp. 231–251.
42. Bull, H. *The Anarchical Society*; Columbia University Press: New York, NY, USA, 1977.
43. Biermann, F. *Earth System Governance: World Politics in the Anthropocene*; MIT Press: Cambridge, MA, USA, 2014.
44. Thaler, R.H. *Misbehaving: The Making of Behavioral Economics*; W.W. Norton: New York, NY, USA, 2015.