Taking Uncertainty Seriously: Adaptive Governance and International Trade

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Abstract

The problem of uncertainty presents a major challenge for institutions of international governance. In this article we draw lessons from a variety of literatures, including ecology and environmental management, for understanding and responding to uncertainty. From them we derive a model of 'adaptive governance' as a way to respond to the extensive and pervasive uncertainty confronting decision-makers in international institutions. Adaptive governance accepts and responds to uncertainty through promoting learning, avoiding irreversible interventions and impacts, encouraging constant monitoring of outcomes, facilitating broad participation in policy-making processes, encouraging transparency, and reflexively highlighting the limitations of the knowledge on which policy choices are based. Here we assess the World Trade Organization as an institution of adaptive governance, taking for our focus the WTO's treatment of national measures to counter the spread of invasive alien species, an arena in which particularly challenging and persistent uncertainties are faced. We find that while some aspects of the WTO's operation already fit within an adaptive governance model, in other important respects the WTO fails to encourage (and sometimes inhibits) effective policy responses to persistent uncertainty.

1 Introduction

The problem of uncertainty is one of the major challenges facing those involved in the construction of institutions of international governance. Our knowledge of the social and natural systems that we seek to govern is less dependable than is commonly acknowledged, and our ability to predict the consequences of our interventions into

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EJIL (2007), Vol. 18 No. 3, 523–551 doi: 10.1093/ejil/chm030

them is more limited than we like to believe. In this article, we offer a model of 'adaptive governance' as one way to respond to the pervasive uncertainty that we believe confronts many decision-makers in international institutions. At its heart, adaptive governance accepts and responds to uncertainty by promoting learning in and through the policy-making process. It does so in a number of ways: by avoiding irreversible interventions and impacts, by encouraging constant monitoring of outcomes; by facilitating the participation of multiple voices in transparent policy-making processes; and by reflexively highlighting the limitations of the knowledge on which policy choices are based.

We illustrate our concept of adaptive governance by applying it to the World Trade Organization, and in particular to the treatment by the WTO of national trade measures addressing the problem of invasive alien species. This problem is a serious one, and involves grappling with particularly challenging uncertainties. Our focus on invasive species, however, should not obscure the more general applicability of our ideas on adaptive governance to other areas and other institutions – the point, rather, is to paint a more concrete picture of adaptive governance than is possible through abstract generalities, and to offer some preliminary suggestions on the particular institutional forms that adaptive governance may take in specific contexts.

The structure of the article is as follows. In Section 2 we provide some background on the environmental problems posed by invasive alien species. Following other commentators, we note the role that international trade plays as an important vector for the spread of invasive alien species, and introduce the WTO's Agreement on the Application of Sanitary and Phytosanitary Measures, which disciplines governmental attempts to address these problems by restricting trade. Section 3 introduces ecological thinking on the nature, sources, and extent of uncertainty in environmental management, focussing in particular on the presence of persistent and largely irreducible uncertainty. In Section 4, the heart of this article, we set out the core characteristics of 'adaptive governance' as one response to pervasive and irreducible uncertainty. Our ideas in this section are drawn from a number of literatures, but most directly borrow from new approaches to environmental governance developed since the 1970s under the rubric of 'adaptive management'. This then leads to Part 5, in which we make a preliminary evaluation of the WTO as an institution of adaptive governance, and suggest some avenues for further developing the WTO along these lines.

2 Invasive Alien Species and Global Trade: Background and Context

Put simply, 'alien species' are species which have been introduced into environments in which they do not naturally occur. They include virtually all life forms, from viruses, fungi, algae, and plants, to invertebrates, fish, reptiles, birds, and mammals. Alien species introduced into a novel environment typically lack co-evolved predators, competitors, and pathogens, and can therefore proliferate dramatically and rapidly. Such

alien species are termed 'invasive' if and to the extent that such proliferation occurs, and causes adverse impacts.[1]

Invasive alien species (IAS) have a wide range of direct and indirect adverse effects on national economies, human health, food security, local livelihoods, ecosystems, and biodiversity. They have been known to: disrupt agriculture, forestry, transportation, and tourism; cause or spread disease in humans, crops, livestock, and wildlife; impact adversely water supplies, food stores, and production; and cause extinction, disruption, or decline of native species and ecosystems.[2] In the United States, for example, the economic cost of a sub-sample of invasive species was estimated in 2000 at US$137 billion per year.[3] This is not just a problem in the developed world: water hyacinth alone is estimated to cost developing countries over US$100 million annually, and can jeopardize both local development and the success of donor interventions.[4] Furthermore, IAS are now recognized as posing the second most serious threat to global biodiversity, second only to habitat loss and destruction.[5] As the delay between entry of an alien species and its proliferation and detection may be many decades,[6] current impacts may actually represent only a small fraction of the ultimate harm caused.

Importantly, the impacts of IAS are typically both unpredictable and irrevocable. Once established, IAS may proliferate rapidly, making efforts to eradicate them untenable, and efforts to mitigate them or their impacts extremely difficult and costly. Only a tiny fraction of invasives are successfully eradicated.[7] Their effects are highly idiosyncratic and require novel and intensive intervention strategies. This means that prevention is typically the only strategy for effective avoidance of impacts and virtually always the cost-effective option.[8]

1 J. A. McNeely *et al.*, *A Global Strategy on Invasive Alien Species* (2001).

2 Cohen, 'Changing Patterns of Infectious Disease', 404 *Nature* (2000) 762; Mack *et al.*, 'Biotic Invasions: Causes, Epidemiology, Global Consequences, and Control', 10 *Ecological Applications* (2000) 689.

3 Pimental *et al.*, 'Environmental and Economic Costs of Non-indigenous Species in the United States', 50 *BioScience* (2000) 53.

4 McNeely *et al., supra* note 1 .

5 IUCN, *A Global Species Assessment* (2004).

6 Abbott, 'Spatial Dynamics of Supercolonies of the Invasive Yellow Crazy Ant, Anoplolepis Gracilipes, on Christmas Island, Indian Ocean', 12(1) *Diversity & Distributions* (2006) 101; Crooks and Soulé, 'Lag Times in Population Explosions of Invasive Species: Causes and Implications', in O.T. Sandlund *et al.* (eds.), *Invasive Species and Biodiversity Management* (1999), at 103–125.

7 Simberloff, 'The Politics of Assessing Risk for Biological Invasions: The USA as a Case Study', 20(6) *Trends in Ecology and Evolution* (2005) 216. For example, the 'mile-a-minute' vine (*Mikania micrantha*), introduced deliberately into Asia, can grow 27mm a day. A single plant can cover more than 25 sq. m. in a few months, and produce up to 40,000 seeds a year (discussed in McNeely, 'An Introduction to Human Dimensions of Invasive Alien Species', in J. A. McNeely (ed.), *The Great Reshuffling. Human Dimensions of Invasive Alien Species* (2001), at 5).

8 C. Shine *et al.*, *A Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species* (2000); S. Burgiel *et al.*, *Invasive Alien Species and Trade: Integrating Prevention Measures and International Trade Rules* (2006).

International trade is a major vector for movement of invasive species.[9] Some species are introduced intentionally, as agricultural commodities, pets, or garden plants, or for forestry, fisheries, or pasture improvement. Other introductions are unintentional, as organisms or their eggs, larvae, or seeds move along trade 'pathways': on cargo, in containers, in ships, in packaging material, in wood, plants, and seeds, or in the ballast water that ships take on in one port and disgorge in another. Increased flows of international trade therefore increase the chance of the introduction of IAS, which in turn raises the likelihood of successful establishment. Similarly, the greater the variety and means of available transport, the greater the array of species that may be moved and the more numerous their pathways for transfer. Faster transport also improves the chances of survival in transit.[10]

The relationship between the movement of IAS and the intensification of global trade flows places conflicting pressures on national and international regulatory authorities. On one hand, there is a clear need for comprehensive programmes for the prevention, assessment, management, and eradication of IAS. Inevitably, such programmes will involve monitoring, and in many circumstances restricting, the flow of international trade. On the other hand, there is an equally clear interest in ensuring that any impediments to trade which arise as a consequence are not unjustified or unnecessary. A mechanism is needed, therefore, to balance these potentially competing interests, to distinguish legitimate from illegitimate trade-restrictive measures, and to ensure that regulatory processes embody an appropriate accommodation of these two imperatives.

The WTO's SPS Agreement offers one such mechanism, based (in part) on an appeal to scientific expertise as an arbiter of regulatory rationality. As is well known, Article 2.2 of the WTO's SPS Agreement requires Members to ensure that sanitary and phytosanitary measures are 'based on scientific principles' and are 'not maintained without scientific evidence'. Article 5.1 sets out an obligation to ensure that SPS measures are 'based on a risk assessment . . . of the risks to human, animal or plant life or health'. Where there is insufficient evidence to conduct a risk assessment, Article 5.7 establishes a right[11] provisionally to adopt protective measures 'on the basis of available pertinent information'. The SPS Agreement also establishes the SPS Committee, which is broadly tasked with monitoring and facilitating the operation of the agreement, and providing a forum for consultations on matters relating to it.

[9] Perrings *et al.*, 'How to Manage Biological Invasions Under Globalization', 20(5) *Trends In Ecology & Evolution* (2005) 212; G. Ruiz and J. Carlton (eds.), *Invasive Species: Vectors and Management Strategies* (2003); Burgiel, *et al.*, *supra* note 8; Jenkins, 'Free Trade and Exotic Species Introductions', 10 *Conservation Biology* (1996) 300; McNeely, *supra* note 7.

[10] Ruiz and Carlton, *supra* note 9.

[11] *EC – Biotech*, WT/DS291/R, paras. 7.2969, 7.2997.

These 'science provisions' of the SPS Agreement have been the subject of considerable criticism.[12] Some of this criticism has come from what might be termed a development perspective: on the one hand, concern that exporters from developing countries may not have the resources to meet stringent safety standards imposed by developed country regulators; on the other, concern that developing country regulators face severe scientific and technical capacity limitations. But more relevant in the present context are criticisms of the very notion that environmental restrictions ought to be subject to international scrutiny in relation to their scientific justification. Some have suggested that the framework structurally subordinates the goal of environmental protection to that of trade liberalization: the requirement for positive scientific evidence of potential harm, it is argued, reflects an implicit presumption that traded goods or trade pathways are environmentally safe until evidence indicates otherwise. Where risks are complex and poorly understood, it is said, or where resources to gather such evidence are lacking, this presumption may lead to significant unintended damage. Others have suggested that these provisions rest on naïve assumptions about the objectivity, reliability, and certainty of scientific knowledge.[13] Regulatory models relying too heavily on traditional risk assessment techniques, it is noted, risk becoming dysfunctional where these assumptions do not hold – that is, where scientific processes fail objectively to identify the nature and existence of risks to be addressed with adequate certainty and reliability. Furthermore, it is argued that these provisions may lead WTO dispute settlement bodies to 'second-guess' scientific authorities, or to attempt to arbitrate between plausible competing scientific viewpoints. Regulators may thereby be discouraged from putting appropriate safeguards in place where there is a perceived inadequacy or insufficiency of presently-existing scientific knowledge about potential risks.

Although few of these criticisms have been made specifically in the context of the problem of IAS, they are highly relevant to it. As outlined earlier, the risks posed

[12] For a selection of the commentary see Wirth, 'The Role of Science in the Uruguay Round and NAFTA Trade Disciplines', 27 *Cornell In'l LJ* (1994) 817; Walker, 'Keeping the WTO from Becoming the "World Trans-science Organization": Scientific Uncertainty, Science Policy, and Factfinding in the Growth Hormones Dispute', 31 *Cornell Int'l LJ* (1998) 251; Charnovitz, 'The Supervision of Health and Biosafety Regulation by World Trade Rules', 13 *Tulane Environmental LJ* (2000) 271; Christoforou, 'Settlement of Science-based Trade Disputes in the WTO: A Critical Review of the Developing Case Law in the Face of Scientific Uncertainty', 8 *NYU Environmental LJ* (2000) 622; Howse, 'Democracy, Science, and Free Trade: Risk Regulation on Trial at the World Trade Organization', 98 *Michigan L Rev* (2000) 2329; Victor, 'The Sanitary and Phytosanitary Agreement of the World Trade Organization: an Assessment after Five Years', 32 *NYU J Int'l L and Politics* (2000) 865; Bohanes, 'Risk Regulation in WTO Law: A Procedure-based Approach to the Precautionary Principle', 40 *Columbia J Transna'l L* (2002) 323; Sykes, 'Domestic Regulation, Sovereignty, and Scientific Evidence Requirements: A Pessimistic View', 3 *Chicago J Int'l L* (2002) 353; O. Perez, *Ecological Sensitivity and Global Legal Pluralism: Rethinking the Trade and Environment Debate* (2003); Motaal, 'Is the World Trade Organization Anti-Precaution?', 39 *J World Trade* (2005) 483; Winickoff *et al.*, 'Adjudicating the GM Food Wars: Science, Risk, and Democracy in World Trade Law', 30 *Yale J Int'l L* (2005) 81.

[13] See, e.g., Perez, *supra* note 12 ; Winickoff *et al.*, *supra* note 12 , among others.

by IAS are indeed complex and poorly understood, and traditional processes of risk assessment are therefore arguably less effective in this area. The core issue at the heart of this article is thus squarely raised: what are the implications of 'scientific uncertainty' for the WTO – not only for the application and interpretation of the SPS Agreement, but more generally for the way it goes about overseeing and reviewing the trade-restrictive environmental regulation of its Members? The next section begins to address that question by exploring ecological thinking on the nature and sources of the uncertainty facing decision-makers in this area.

3 Understanding Uncertainty: Lessons from Ecology

A relatively recent article by Walker serves as a useful starting point for discussing the origin and extent of scientific uncertainty in risk assessment.[14] Walker carefully breaks down the process of risk assessment, and identifies numerous different sources of uncertainty: uncertainty about which models and categories to use to generate hypotheses; uncertainty derived from the unreliability and invalidity of measurement techniques; uncertainty as to the representativeness of the sample used to generate data; and uncertainty about the extent to which statistical associations imply causation. He also makes the important point that our knowledge of the risks posed by our actions is always and necessarily limited. Risks can never be assessed in a wholly objective manner, but rather must always be in some degree a product of contestable choices and decisions on the part of those producing assessments of risk. Walker uses the notion of scientific uncertainty, then, to highlight the extent to which processes of scientific risk assessment can never provide a 'neutral arbiter' of actual risk, but rather are inevitably 'value-laden'.

Ideas from ecological science on the nature and sources of scientific uncertainty overlap with, and complement, these ideas in important ways. Instead of focussing on uncertainties which result from limitations in our ways of knowing the world, ecological perspectives tend to emphasize the extent to which uncertainty is a function of the complex properties of the phenomenon under study.

In recent decades, our scientific understanding of the dynamics and behaviour of ecosystems has been transformed.[15] Classical ecological models assume that nature is governed by mechanistic natural laws, discoverable though scientific inquiry. Ecosystem

[14] Walker, 'The Myth of Science as a "Neutral Arbiter" for Triggering Precautions', 26 *Boston College Int'l and Comp L Rev* (2003) 197. See also Walker, 'The Siren Songs of Science: Toward a Taxonomy of Scientific Uncertainty for Decisionmakers', 23 *Connecticut L Rev* (1999) 567.

[15] See, e.g., Holling, 'Resilience and Stability of Ecosystems', 4(1) *Annual Review of Ecology and Systematics* (1973) 1; Walters and Holling, 'Large-scale Management Experiments and Learning by Doing', 71 *Ecology* (1990) 2060; Scoones, 'New Ecology and the Social Sciences: What Prospect for a Fruitful Engagement?', 28 *Annual Review of Anthropology* (1999) 279; Wallington *et al.*, 'Implications of Current Ecological Thinking for Biodiversity Conservation: A Review of the Salient Issues', 10(1) *Ecology And Society* (2005) 15.

dynamics and characteristics are presupposed in such models to be predictable, and to involve movement toward a stable, identifiable, equilibrium state, which can provide a clear reference point for management and decision-making. The inadequacy of such models, however, has been progressively highlighted since the 1970s. The 'new ecology'[16] emphasizes the prevalence of disturbance and disequilibrium dynamics within ecosystems in a constant state of flux. It is grounded in the recognition that ecosystems must be understood as *systems*, which involve an interacting multiplicity of biotic and abiotic components – plants, animals, microbes, climate, hydrology, pollination, symbiosis, predation, competition, and so on. They cannot be reduced to their component parts, but show emergent properties: phenomena arising at higher organisational levels which cannot be straightforwardly predicted from knowledge of interactions at lower levels. Complex systems are dynamic rather than static – rather than maintaining stable equilibrium states, they continually change, evolve, and adapt. Furthermore, they are not susceptible to precise prediction. While individual interactions or sub-sets can be mapped and modelled, the entirety cannot. Generalizations across systems are also problematic, as the structure, composition, and dynamics of an ecosystem may be contingent on its specific history and spatial context. Non-linear dynamics, discontinuous behaviour, and threshold effects are to be expected. Small disturbances in one variable or interaction, for instance, can cause dramatic changes, and these may 'cascade' through other levels of the system with unpredictable impacts. Ecosystems may have a variety of locally stable states, may 'flip' from one to another due to poorly understood interactions, and such state changes may be irreversible.

The result is that environmental risks can be very difficult to predict. They often cannot be specified by a few precisely determined variables, but may instead be driven by the interaction of changes taking place at very different temporal and/or spatial scales. For instance, local pest outbreaks may be driven by long-term land-use intensification and ecosystem simplification coupled with short-term weather conditions. Furthermore, many environmental threats may increasingly reflect slow changes, the decades- or centuries-long accumulation of human influences on the environment, which can nonetheless cause abrupt changes. Slow long-term change in freshwater nutrient levels, for example, can lead to sudden toxic algal blooms. The drivers of threats couple local to global – national problems such as changing climate or freshwater degradation may be driven by factors both local and across the world. Finally, ecological threats are mediated by both natural processes and human cultural, economic and trade dynamics, so understanding the behaviour of a system requires the inclusion of human activities and processes.

This array of characteristics means that our knowledge of complex systems is characterized by uncertainty of a particularly fundamental and persistent kind. A good deal of the present discussion of scientific uncertainty and the WTO emphasizes what may be called 'epistemic' uncertainty: uncertainty resulting from inadequate knowledge, or

[16] Scoones, *supra* note 15.

from inherent cognitive limitations in our ways of knowing the world. This kind of uncertainty includes, for instance, limited and inaccurate data, incomplete knowledge, measurement error, imperfect models, and subjective judgement. While these forms of uncertainty may characterize our understanding of ecosystems, more challenging still is what can be characterized as 'variability' or 'ontological' uncertainty.[17] This form of uncertainty derives from the variability, randomness, or unpredictability of the system under investigation. Crucially, it is inherent and persistent, and is not susceptible to being reduced or resolved by more research. More information, analysis, and science may increase our understanding, but has no necessary impact on predictive power. 'In co-evolving systems of humans and nature', as one author notes, 'surprises are the rule, not the exception'.[18]

Recognition of the prevalence of irreducible uncertainty and ignorance in confronting environmental problems and threats has prompted many to question both classical scientific methods and traditional frameworks for environmental management. In the domain of scientific practice, the limitations of classical scientific techniques of precise prediction, modelling, and risk analysis for environmental problems have been highlighted, and substantial effort has focussed on the development of scientific techniques that recognize and respond to inherent uncertainties of dynamic, complex systems. These have been developed under the rubrics of (among others) 'post-normal' science[19], 'sustainability science',[20] and 'science for sustainable development'[21]. In the domain of environmental management, there has been a sustained effort to construct new approaches, which are based on expectations of surprise and unpredictability, which take into account the potential for abrupt, unpredictable, and irreversible change, and which are sensitive to interactional and system-wide effects. The following section addresses some aspects of this literature, setting out some recent thinking on the implications of pervasive uncertainty for environmental management.

[17] Walker *et al.*, 'Defining Uncertainty. A Conceptual Basis for Uncertainty Management in Model-based Decision Support', 4 *Integrated Assessment* (2003) 5.

[18] Gunderson, 'Resilience, Flexibility and Adaptive Management – Antidotes for Spurious Certitude?', 3(1) *Conservation Ecology* (1999) 7.

[19] Funtowicz and Ravetz, 'Science for the Post-normal Age', 25(7) *Futures* (1993) 739; Giampietro, 'Sustainability, the New Challenge of Governance, and Post-normal Science', 18(2) *Politics And The Life Sciences* (1999) 218; Giampietro, 'Complexity and Scales: The Challenge for Integrated Assessment', 3(2/3) *Scaling in Integrated Assessment* (2003) 247; Saloranta, 'Post-normal Science and the Global Climate Change Issue', 50(4) *Climatic Change* (2001) 395; Ravetz, 'The Post-normal Science of Precaution', 36(3) *Futures* (2004) 347; Giampietro *et al.*, 'Science for Governance: the Implications of the Complexity Revolution', in A. Guimaraes-Pereira *et al.* (eds.), *Interfaces Between Science and Society* (2006).

[20] Gallopin *et al.*, 'Science for the 21st Century: From Social Contract to the Scientific Core', 16 *Int'l J Social Science* (2001) 168; Swart *et al.*, 'The Problem of the Future: Sustainability Science and Scenario Analysis', 14(2) *Global Environmental Change-Human And Policy Dimensions* (2004) 137.

[21] Funtowicz *et al.*, 'Challenges in the Use of Science for Sustainable Development', 1(1) *Int'l J Sustainable Development* (1998) 99; J. A. Sayer and B. M. Campbell, *The Science of Sustainable Development: Local Livelihoods and the Global Environment* (2003).

4 Responding to Uncertainty: Lessons from Adaptive Management

When ignorance, surprise, and uncertainty are viewed as unavoidable aspects of scientific inquiry – when, indeed, their prevalence is *confirmed* by scientific inquiry – new models of policy-making may be required, guided by different principles, and based on a different understanding of the relation between science and policy-making. One sustained attempt to develop a new approach has arisen in the literature on 'adaptive environmental management'. This approach had its genesis in the 1970s in the fields of ecology and environmental management,[22] and in the decades since has grown into a substantial body of work.[23] Adaptive management describes an approach to managing ecological resources which recognizes and responds directly to the uncertainty and complexity characteristics of large-scale ecosystems. It sets out principles and approaches to decision-making and management in circumstances where it is not possible reliably to predict ecosystem behaviour, including risks of adverse states or outcomes. The concept and practice of adaptive management have now been developed and elaborated by a range of different writers and practitioners across a range of contexts, from fisheries, community forestry, and waterfowl protection to riparian regimes and grazing land restoration. It has provided an influential conceptual framework for approaching environmental management, and has been widely endorsed at both the international and national levels as reflecting best practice across a broad range of environmental areas.[24] Its development has led to calls for 'adaptive governance' – policy and governance structures that support and enable these adaptive responses to uncertainty (see Section 5).[25]

Before setting out some key characteristics of adaptive management, it is worth pausing to draw attention to the relationship between this scholarship and some cognate literatures in the social sciences. Over the last three or so decades, a number of

[22] Holling, *supra* note 15; C.S. Holling (ed.), *Adaptive Environmental Assessment and Management* (1978).

[23] See, e.g., Holling, *supra* note 15; Holling (ed.), *supra* note 22; C. Walters, *Adaptive Management of Renewable Resources* (1986); Walters and Holling, *supra* note 15; Gunderson, *supra* note 18; Lee, 'Appraising Adaptive Management', 3(2) *Conservation Ecology* (1999) 3; Folke *et al.*, 'Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations', 31(5) *Ambio* (2002) 437; J. Oglethorpe (ed.), *Adaptive Management: From Theory to Practice* (2002); F. Berkes *et al.*, *Navigating Social-ecological Systems: Building Resilience for Complexity and Change* (2003).

[24] See, for instance, the UN Food and Agriculture Organization Code of Conduct on Responsible Fisheries (1995), Forest Stewardship Council (FSC), *Principles and Criteria for Forest Stewardship,* FSC-STD-01-001 (Apr. 2004); Convention on Biological Diversity Decision V/6, *Ecosystem Approach;* Convention on Biological Diversity Decision VII/12, *Principles and Guidelines on Sustainable Use,* available at: http://www.cbd.int/decisions/cop-05.shtml?m=cop-05 and http://www.cbd.int/decisions/cop-07.shtml?m=cop-07.

[25] Wallington *et al.*, *supra* note 15 and see Folke *et al.*, 'Adaptive Governance of Social-ecological Systems', 30 *Annual Review of Environment and Resources* (2005) 441, for an exploration of this concept.

broad fields of study have grown and developed within the social sciences, which are united (with each other, as well as with work on adaptive management) by a common focus on three related themes: the complexity and uncertainty associated with various aspects of social life; the need for some intensified form of 'social learning' (broadly defined) as a response to this uncertainty; and the role of institutions and governance systems in facilitating such learning processes. Three fields of study are worth mentioning in particular. First, the increasing complexity and volatility of modern markets has led many to focus on the role of innovation and adaptability in economic life. This has given rise to research into processes of learning within organizations (firms),[26] as well as the problem of creating reflexive institutional frameworks to facilitate such constant learning and innovation.[27] While focussed primarily on national and regional levels of economic governance, this literature has recently begun to focus greater attention on institutions at the international level.[28] Secondly, primarily within international relations scholarship, there is a body of work on the behaviour of states in circumstances of complex interdependence. Some writers in this area concentrate on the need to develop flexible and adaptive international institutions, to respond to rapidly changing global conditions, as well as to changes in our knowledge of the causes of global problems. Others focus on the role that international institutions currently play in facilitating action in the face of potentially paralysing uncertainty, including by helping states to develop cognitive models through which to make sense of a complex

[26] Some important or introductory works include: Arrow, 'The Economic Implications of Learning by Doing', 29(2) *Review of Economic Studies* (1962) 155; March and Olsen, 'The Uncertainty of the Past: Organizational Learning under Ambiguity', 3 *European J Political Research* (1975) 147; J. G. March and J. P. Olsen, *Ambiguity and Choice in Organizations* (1979); C. Argyris and D. A. Schön, *Organizational Learning II: Theory, Method and Practice* (1996); M. Easterby-Smith and M. A. Lyles, *The Blackwell Handbook of Organizational Learning and Knowledge Management* (2003).

[27] Sabel, 'Learning by Monitoring: The Institutions of Economic Development', in N. J. Smelser and R. Swedberg (eds.), *The Handbook of Economic Sociology* (1994); Cooke, 'Institutional Reflexivity and the Rise of the Region State', in G. Benko and U. Strohmayer (eds.), *Space and Social Theory: Interpreting Modernity and Post-Modernity* (1997); P. Cooke and K. Morgan, *The Associational Economy: Firms, Regions, and Innovation* (1998); M. S. Gertler and D. A. Wolfe, *Innovation and Social Learning: Institutional Adaptation in an Era of Technological Change* (2002).

[28] See, e.g., the chapters by Wolfe, Porter, and Salter in Gertler and Wolfe, *supra* note 27, S. G. Reddy and C. F. Sabel, *Learning to Learn: Untying the Gordian Knot of Development Today* (2002) Columbia Law and Economics Working Paper No. 308, available at SSRN: http://ssrn.com/abstract=944619; and specifically in relation to the WTO, Hoekman *et al.*, 'Special and Differential Treatment of Developing Countries in the WTO: Moving Forward After Cancun', 27(4) *World Economy* (2004) 481; Hoekman, 'Making the WTO More Supportive of Development', 42 *Finance and Development* (2005) 14; Hoekman, 'Operationalizing the Concept of Policy Space in the WTO: Beyond Special and Differential Treatment', 8 *J Int'l Economic L* (2005) 405.

world, and to identify their interests in it.[29] Thirdly, there is an important body of work in the area of public law and administration, describing and theorizing the recent development of learning-centred alternatives to traditional command-and-control regulatory frameworks, variously described as 'experimentalist' governance, 'reflexive governance', or 'new governance approaches'.[30] In all of these three literatures, one finds ideas which overlap considerably with those put forward, in a very different context, under the rubric of adaptive management.

Our description of adaptive management in this section is firmly anchored in the environmental literature. However, it is informed in a variety of different ways by work from these disparate branches of the social sciences. For one thing, our reading of these literatures has helped to persuade us that these ideas have useful application outside the area of ecological management. More specifically, we focus on features of adaptive management which are also found in the three literatures just described, and are therefore already somewhat familiar in the study of economic behaviour and international institutions. We also augment the concepts of adaptive management

[29] A number of different sub-literatures are relevant here. See, e.g., the literature on epistemic communities, particularly those works which deal with the trade regime: E. B. Haas, *When Knowledge is Power: Three Models of Change in International Organizations* (1990); P. M. Haas, *Knowledge, Power and International Policy Coordination* (1992); Wolfe, 'Farms, Phone and Learning in the Trade Regime', in Gertler and Wolfe, *supra* note 27, at 25; Drake and Nicolaïdis, 'Ideas, Interests and Institutionalization: "Trade in Services" and the Uruguay Round', 46 *Int'l Org* (1992) 37; Ikenberry, 'A World Economy Restored: Expert Consensus and the Anglo-American Postwar Settlement', 46 *Int'l Org* (1992) 289, see also Rosenau, 'Before Cooperation: Hegemons, Regime and Habit-Driven Actors in World Politics', 40 *Int'l Org* (1986) 849. (Interestingly, this literature has had some impact on the environmental adaptive management literature, e.g., K. N. Lee, *Compass and Gyroscope: Integrating Science and Politics for the Environment* (1993).) On the concept of social learning in international relations literature see Nye, 'Nuclear Learning and US-Soviet Security Regimes', 41 *Int'l Org* (1987) 371; Levy, 'Learning and Foreign Policy: Sweeping a Conceptual Minefield', 48 *Int'l Org* (1994) 279. On the need to create flexible international institutions see, e.g., Keohane, 'International Institutions: Two Approaches', 32 *International Studies Quarterly* (1988) 379; A. Chayes and A. H. Chayes, *The New Sovereignty: Compliance with International Regulatory Agreements* (1995); Haas and Haas, 'Learning to Learn: Improving International Governance', 1 *Global Governance* (1995) 255; Pan, 'Authoritative Interpretation of Agreements: Developing More Responsive International Administrative Regimes', 38 *Harvard Int'l LJ* (1997) 503. Also relevant is constructivist scholarship on the role of persuasion and argumentation in international life, and the role of institutions in facilitating such discursive processes, e.g. Yee, 'The Causal Effects of Ideas on Policies', 50 *Int'l Org* (1996) 69; M. E. Keck and K. Sikkink, *Activists Beyond Borders: Advocacy Networks in International Politics* (1998); Barnett and Finnemore, 'The Politics, Power, and Pathologies of International Organizations', 53 *Int'l Org* (1999) 699; T. Risse-Kappen *et al.*, *The Power of Human Rights: International Norms and Domestic Change* (1999); Risse, "Let's Argue!": Communicative Action in World Politics', 54 *Int'l Org* (2000) 1; Checkel, 'Why Comply? Social Learning and European Identity Change', 55 *Int'l Org* (2001) 553; Johnston, 'Treating International Institutions as Social Environments', 45 *International Studies Quarterly* (2001) 487; M. N. Barnett and N. Finnemore, *Rules for the World: International Organizations in Global Politics* (2004).

[30] J. Scott and G. de Bùrca (eds.), *Law and New Approaches to Governance in the EU and US* (2006), Dorf and Sabel, 'A Constitution of Democratic Experimentalism', 98 *Columbia L Rev* (1998) 267; J. Scott and G. de Bùrca (eds.), *The Changing Constitution of the EU: From Uniformity to Flexibility?* (2000); J. Braithwaite, *Restorative Justice & Responsive Regulation* (2002); Lobel, 'The Renew Deal: The Fall of Regulation and the Rise of Governance in Contemporary Legal Thought', 89 *Minnesota L Rev* (2004) 342, among a much larger literature.

with concepts drawn from these literatures. Furthermore, our efforts to apply the framework of adaptive management to the WTO (in Section 5) are heavily influenced by the ways in which these literatures have already started to apply similar concepts to other international institutions and other aspects of social life. Finally, and most broadly, we take from this literature a deep analogy between complex biological systems and complex social systems (such as the international trading system): both can usefully be understood as exhibiting similar uncertainty characteristics, and therefore both may benefit from a similar learning-centred governance framework.

In the remainder of this section, we set out five related characteristics of what may be called 'adaptive governance', which we believe are of particular relevance in the context of analysis of the WTO and the SPS Agreement, and illustrate them within the context of regulation of IAS.

A *Learning*

Perhaps the defining characteristic of adaptive governance is its focus on facilitating continuous learning as a necessary part of any response to pervasive uncertainty and systemic unpredictability. This reflects the premise that a single 'snapshot' of the world, scientific or otherwise, is inadequate to reflect a dynamic and evolving reality and to respond to continually changing information and understanding. All minimally functional policy-making processes, of course, involve some mechanism for encouraging policy learning. In adaptive governance structures, however, learning plays a uniquely central role. It occurs regularly and self-consciously rather than solely on an *ad hoc* or isolated basis. It becomes part of an institution's or policy's central tasks or objectives rather than a supplementary function. The four further characteristics listed below all follow, to some degree, from this focus on learning.

Two different forms of learning are usefully distinguished. 'Simple learning' refers to the acquisition of information, the development of new skills, and the building of new competencies.[31] It refers to a process by which actors involved in the regulatory process receive new and updated information, learn how to resolve defined problems more effectively over time, and adapt their problem-solving skills to changing conditions. In the policy-making context, this typically involves change to the 'levels' or 'settings' of policy instruments, or the techniques used to achieve fixed policy goals.[32] 'Complex learning' is of a different sort. If simple learning is a response to inadequate information, complex learning is a response to the fundamental limitations of human cognition. Rather than learning better solutions to defined problems, complex learning involves redefining the problem to be addressed, and revisiting the question of what constitutes relevant 'knowledge' about a particular problem.[33] It also involves

[31] The distinction between simple and complex learning is a very common one – see, e.g., Levy, *supra* note 29 – but we take this formulation from Gertler and Wolfe, 'Innovation and Social Learning: an Introduction', in Gertler and Wolfe, *supra* note 27, at 1, 13.

[32] See the chapter by Porter in *ibid.*, at 45.

[33] Sabel, *supra* note 27; Haas and Haas, *supra* note 29; Scott and Trubek, 'Mind the Gap: Law and New Approaches to Governance in the European Union', 8 *ELJ* (2002) 1; Wolfe, *supra* note 29.

developing critical awareness of the inherently limited nature of our knowledge, and therefore acknowledging the extent of our intrinsic ignorance and capacity for mistake. In the parlance of certain international relations scholars, this form of learning can involve the reconstitution of actors' preferences, identities, and principled beliefs.[34] It involves also the destabilization and reconstruction of the 'cognitive map' which policy-makers use to make sense of the world and define their role within it. Crucially, our vision of adaptive governance includes the facilitation of both forms of learning, and therefore goes beyond the emphasis on mere technical improvement associated with simple learning.

The regulation of IAS is an excellent example of the need to facilitate and promote learning in governance structures. First, as pointed out above, scientific capacity to predict the nature and likelihood of potential impacts of alien species is extremely limited, so there is a clear justification for continually revisiting and reassessing decisions in the light of new information, insights, and experiences on a global scale. Secondly, in the case of IAS the system or subject under examination – the alien species in a novel environment – is itself a dynamic, evolving entity.[35] Species are not static entities, but adapt and evolve within new environments, and their host environments likewise change. Climate change, for example, will shift the ranges in which species are able to establish and proliferate. Even in the short term, factors such as further introductions can dramatically alter IAS impacts. Accumulating this sort of rapidly changing and increasing information encourages simple learning, but can also facilitate a degree of complex learning – about, for instance, the nature and scope of ignorance and uncertainty, the dynamic nature of risk, and the limits of science-based predictive strategies.

B *Policy-making as Experimentation*

Policy interventions have typically been understood as distinct from, and subsequent to, processes of knowledge accumulation and risk analysis. Adaptive governance approaches, on the other hand, understand policy-making as an integral part of an ongoing learning process. They emphasize processes of 'learning by doing', and treat policy interventions as quasi-experiments. Since surprise and unpredictability are expected, unforeseen consequences are treated as valuable opportunities for learning.

There are at least three corollaries of this experimentalist approach to policy-making. First, it will often be necessary to take action despite a high level of uncertainty. Because they are designed precisely to *enable* action in conditions of radically incomplete knowledge, adaptive governance approaches do not 'postpone action until "enough" is known but acknowledg[e] that time and resources are too short to defer *some* action, particularly actions to address urgent problems'.[36] Secondly, policy interventions in

[34] This is a standard formulation of constructivist scholarship, e.g., M. Finnemore, *National Interests in International Society* (1996); Keck and Sikkink, *supra* note 29; A. Wendt, *Social Theory of International Politics* (1999).

[35] G. W. Cox, *Alien Species and Evolution* (2004).

[36] Lee, *supra* note 23 .

the context of adaptive governance are specifically designed to produce critical information, which may help to reduce uncertainty and broaden the base of knowledge and experience. In the environmental management context, so-called 'active' adaptive management may involve deliberate experimental perturbations of the system in order to produce information.[37] Of course, active interventions of this kind should be viewed in light of the need for reversibility: there is always a serious risk that such strategies may over time become little more than excuses for risk-taking.[38] They will therefore only be appropriate where the system in question has some resilience, that is, where the changes induced by adaptive management interventions do not risk unacceptable and/or irreversible outcomes, and where adequate supervisory and accountability mechanisms are in place.[39] This third corollary (avoiding irreversibility) is addressed in more detail below.

In the context of IAS, taking action in the face of uncertainty will typically mean taking action to prevent the introduction of IAS even where there is less than conclusive evidence of potential harm. There is abundant evidence of the serious impacts that IAS can cause, most of them unintended or unforeseen. At the same time, preventive measures to combat IAS will often be coupled with more positive policy interventions designed to produce knowledge about the system under investigation. Clearly any uncontrolled introduction of species raises unacceptable risks of serious irreversible damage, even if it would provide useful information. Where there is a strong case for introduction of an alien species, however, there may be a range of other policy options, involving tightly controlled, quantitatively limited, and geographically circumscribed introduction, which may produce information useful for management.

C *Avoiding Irreversible Harm*

Recognition of the uncertain, dynamic, and evolving character of environmental, social, and economic systems leads to a strong emphasis on maintaining the *resilience* of a system.[40] Given that it is not possible precisely to predict what a complex system will do, or precisely to engineer the maintenance of a static desired state, one important goal of policy and management becomes the maintenance of a system's resilience, and its ability to adapt and evolve. The first requirement of this is to seek to avoid irreversible negative environmental states. These severely curtail future policy options and preclude opportunities for experimentation and learning. Adaptive governance approaches therefore prefer highly provisional and reversible policy interventions, in respect of both form and consequences, as well as the development of strict

[37] Walters, 'Challenges in Adaptive Management of Riparian and Coastal Ecosystems', 1(2) *Conservation Ecology* (1997) 1.

[38] We are indebted to Jacqueline Peel for drawing our attention more closely to this danger.

[39] 'Adaptive management cannot be applied when the risks of failure are socially and legally unacceptable': Gunderson, *supra* note 18.

[40] Holling, *supra* note 15 ; Gunderson, *supra* note 18 ; Folke *et al.*, *supra* note 23.

oversight mechanisms to encourage or ensure this reversibility. Policy interventions should seek the quality of robustness to uncertainties – even if assumptions or judgements are wrong, irreversible damage has been avoided and the opportunity for better decisions is left open.

With respect to IAS, avoiding irreversible damage mandates a strong emphasis on prevention of entry of potentially invasive species. As discussed earlier, only a tiny proportion of successfully established invasions are reversed, and even should future techniques have more success invasions may cause irreversible impacts, such as destruction of ecological communities, species extinction, and soil erosion. Policy which does not place a high premium on preventing entry of invasive species, in the face of uncertain and unreliably predictive risks, forecloses future policy options, learns too late to avoid damage, and will struggle continuously with negative and irrevocable 'surprise'.

D *Monitoring and Feedback*

Policy-making in the context of adaptive governance is an iterative process of review and revision. Scientific knowledge is not seen as definitive or final, but provisional and subject to review in the light of new information and new priorities. The smooth functioning of this iterative process depends crucially on the development of mechanisms for monitoring the substantive outcomes of policy on an ongoing basis. Such monitoring mechanisms should take account of the specificity of outcomes both across space and time: the impact of an action or intervention will not necessarily be the same in different systems or at different points in time. In addition, the outcomes of the monitoring process should routinely be fed back into the policy-making or management process, to reassess goals, assumptions in models, and policy objectives themselves. Such self-conscious monitoring and feedback mechanisms can help facilitate learning, not only by fine-tuning the particular policy instruments chosen, but also by drawing attention to relevant knowledge gaps, revealing the shortcomings of the chosen problem-definition, highlighting the limitations of the forms of knowledge deployed in the policy-making process, and creating a culture of openness and experimentation in the conduct of policy.[41]

There is a growing awareness of the inadequacy of current monitoring mechanisms in the prevention of IAS, and of the need for regulators to be responsive to the continually changing state of information on the impact of specific invasives, the state of invasion of particular areas, and the changing underlying environmental/economic/social matrix which determines invasion risks. While local knowledge is essential, adaptive management approaches also emphasize the development of more effective mechanisms of global information sharing. Across the world information is rapidly accumulating about the impacts of IAS, much of which is being gathered and made available in a wide range of databases. However, even very recently, this information and these sources were not well-known or widely shared.[42] Further, the full

[41] Sabel, *supra* note 27.

[42] McNeely *et al.*, *supra* note 1.

impacts of IAS on biodiversity and ecosystems have typically been incompletely and poorly recorded, compared with impacts on productive sectors such as agriculture and transport. While there have been calls for the establishment of an international framework for monitoring of invasives, this has yet to be developed. Efforts are underway, led by the Global Invasive Species Programme, a consortium of government and non-governmental partners, to establish constantly updated and globally shared and accessible databases and an Early Warning System for invasions.[43] Additional mechanisms would also be required to ensure that this information systematically feeds into the policy-making processes of all relevant organizations with an impact on IAS policy.

E *Pluralism and Process*

The final characteristic is an important one. Although our vision of adaptive governance focuses on learning, we do not conceive of knowledge production as solely or even primarily a technical, expert-driven process. Rather, we understand the production of knowledge to be always and inevitably in part a social and political process. And we understand science-based decision-making necessarily to involve fundamental value choices. To the extent that uncertainty results from the necessary incompleteness of any single vision of knowledge, and of human cognition generally, adaptive governance approaches therefore necessitate a pluralist approach to knowledge.[44] In this context, the purpose of governance structures is not so much to identify a single, correct body of knowledge to guide policy, but in part to marshall alternative knowledges, map out uncertainties, and enable a disciplined process for decision-making in areas of uncertainty.[45] The aim of policy-making is not solely to accumulate more or better knowledge, as if that were in itself enough, but also to discover and highlight the inadequacies of prevailing knowledge frameworks. And policy-making is less about the attainment of a single optimal solution – as if 'best practice' were simply a question of efficiency – and more about providing a forum for the ongoing creation of consensual knowledge and agreed processes to guide policy.[46]

One implication of this is that policy-making processes should be open and transparent. In particular, the underlying assumptions and judgements implicit in knowledge claims should be made transparent, explicit, and open to scrutiny. Furthermore, adaptive governance approaches emphasize the importance of open forums for discursive and communicative interaction – discussion, mutual sharing of information, problem-centred negotiation – in the formulation of policy. A second implication is

[43] See www.gisp.org.

[44] Sabel and Reddy, *supra* note 28, at 2.

[45] Giampietro *et al.*, *supra* note 19; Guimaraes-Pereira *et al.* (eds.), *supra* note 19.

[46] Leach, 'Plural Perspectives and Institutional Dynamics: Challenges for Community Forestry', in J. Oglethorpe (ed.), *Adaptive Management: From Theory To Practice* (2002), at 73. For examples of claims about the importance of international institutions in generating consensual knowledge see Kratochwil and Ruggie, 'International Organization: A State of the Art on an Art of the State', 40 *Int'l Org* (1986) 753; Wolfe, 'Decision-making and Transparency in the "Medieval" WTO: Does the Sutherland Report have the Right Prescription?', 8 *J Int'l Economic L* (2005) 631.

the need for broader participation in the production and deployment of knowledge. Adaptive governance prioritizes recognition and accommodation of the diverse values and knowledges of different stakeholders. In part, this is because approaches integrating multiple perspectives tend to produce better outcomes. But it is also because, to the extent that it is recognized that no single optimal solution to policy problems exists, 'efficient' public policy becomes redefined as policy which responds as far as possible to the values, interests, and concerns of all stakeholders.

5 Learning to Learn at the WTO: Adaptive Governance and the International Trading System

So far, we have shown that much environmental policy-making occurs under conditions of pervasive and fundamental uncertainty, and we have argued that such pervasive uncertainty demands new institutions and new processes for making environmental policy. We called this 'adaptive governance'. In this section, we argue further that this model of governance has important implications for the WTO. The justification for this claim is twofold. First of all, we believe adaptive governance is potentially relevant not only to environmental policy itself, but also to policy disciplines such as trade, which must respond to environmental risks and have important environmental impacts. Secondly, to the extent that international economic systems are characterized by similar complexity and uncertainty as that which characterizes ecological systems, adaptive governance is equally important in the field of international economic governance as it is in environmental management.

This section therefore maps out some initial thoughts on the form that adaptive governance might take in the WTO, in the particular context of efforts to address the problems posed by IAS. To what extent are the current rules and institutional forms of the WTO compatible with the demands of adaptive governance? In what ways might they be improved by more fully embodying adaptive governance principles? These questions in turn give rise to two distinct lines of enquiry. First, it is necessary to explore the extent to which the WTO can and does permit, facilitate, and promote learning (both simple and complex) in lower levels of governance such as national governments. Secondly, it is also necessary to examine how the WTO may incorporate adaptation and learning into its *own* mode of governance, and its own institutional and legal forms. These two lines of enquiry are examined in turn.

A *The WTO as Facilitator of National Adaptive Governance*

1 Enabling 'Precaution'

A great deal of the current literature concerns the need for governments to take 'precautionary' approaches as a response to scientific uncertainty. To a large extent, the debate has come to be about the appropriateness of using the precautionary principle, the definition of the principle, and the extent to which disciplines under the SPS

Agreement do in fact permit a precautionary approach.[47] Some have argued generally on the use of the precautionary principle as a guide to interpretation of the SPS Agreement as a whole.[48] Others have suggested the inclusion of the precautionary principle in some form in the text of the SPS Agreement or the Preamble to the WTO Agreement.[49]

Our emphasis on learning as a response to uncertainty cuts across this debate. On one hand, it is clear that in some circumstances, precautionary approaches are fully consistent with, and indeed an important element of, adaptive governance. Taking protective action despite incomplete and uncertain information, in the face of serious and/or irreversible harm, is not necessarily a departure from 'sound science', but rather is often fully consistent with – and indeed a direct response to – rigorous ecological science. Thus, one element of an adaptive governance agenda at the WTO is to ensure that its rules permit precautionary approaches where and to the extent appropriate.

To a large extent, it is now clear that the SPS Agreement provides considerable scope for the adoption of precautionary approaches by WTO Members.[50] Nevertheless, there are at least three specific points of concern that arise in the context of regulation of IAS.

First, the Appellate Body has made it clear that a risk assessment under Article 5.1 must identify and address a risk with a high degree of specificity, including a specified form of harm, a specified mechanism by which that harm might be caused, and a specific degree of likelihood of harm.[51] As discussed earlier, however, our ability to understand and predict precise causal mechanisms in complex ecological systems is limited, and our power to predict specific outcomes even more constrained. Crucially,

[47] See, e.g.: Barcelo, 'Product Standards to Protect the Local Environment – the GATT and the Uruguay Round Sanitary and Phytosanitary Agreement', 27 *Cornell Int'l LJ* (1994) 755; Wirth, *supra* note 12; Cromer, 'Sanitary and Phyto-sanitary Measures: What They Could Mean for Health and Safety Regulations', 36 *Harvard In'l LJ* (1995) 557; Cross, 'Paradoxical Perils of the Precautionary Principle', 53 *Washington and Lee L Rev* (1996) 851; Walker, *supra* note 14; Charnovitz, *supra* note 12; Bohanes, *supra* note 12 ; Dobos, 'The Necessity of Precaution: The Future of Ecological Necessity and the Precautionary Principle', 13 *Fordham Environmental LJ* (2007) 375; Guzman, 'Food Fears: Health and Safety at the WTO', 45 *Virginia J Int'l L* (2004) 1; Jenkins, 'International Law Related to Precautionary Approaches to National Regulation of Plant Imports', 39 *J World Trade* (2005) 895; Motaal, *supra* note 12; Chaoimh, 'Trading in Precaution: A Comparative Study of the Precautionary Jurisprudence of the European Court and the WTO's Adjudicating Body', 33 *LIEI* (2006) 139. See also *EC – Hormones*, Appellate Body Report, WT/DS26/AB/R, paras. 120–125; *Japan – Apples*, Appellate Body Report, WT/DS245/AB/R, para. 233 ff.

[48] E.g., Bohanes, *supra* note 12.

[49] Charnovitz, *supra* note 12, 292, referring to, among other things, World Wildlife Fund, *A Reform Agenda for the WTO Seattle Ministerial Conference* (1999).

[50] Forceful arguments to this effect include: Motaal, *supra* note 12 and Jenkins, *supra* note 12, though it should be acknowledged that these two commentators are more sanguine than most. See also the supportive argument of Burgiel *et al.*, *supra* note 8.

[51] *EC – Hormones*, *supra* note 47, para. 199ff (on the need for the evidence considered in a risk assessment to address the specific pathway at issue) and para. 186 (on the need for a risk assessment to address identifiable risks rather than generalized theoretical uncertainty); *Japan – Apples*, *supra* note 47, paras. 200–206 (Japan's risk assessment was not directed to a specific agent and vector of contamination) and paras. 239–242 (on the issue of theoretical uncertainty generally).

the case for action against risks posed by any particular species or pathway for invasion is typically built not from consideration of that species or pathway alone, but from consideration of the vast range of unforeseen and unanticipated previous invaders and impacts. The risks posed by one organism may often be assessed according to previous experience with risks posed by the introduction of similar (but not identical) organisms into similar (but not identical) environments in the past.[52] Invasives policy that requires evidence that a specific species or pathway poses a threat ignores this long history of unintended introductions and unforeseen damage. As a result, the Appellate Body's approach on this point is a cause for concern.[53]

Secondly, the Appellate Body has also expressed its doubt that protective SPS measures can be justified by reference to what it calls 'theoretical uncertainty'.[54] It is not entirely clear what the Appellate Body intends by this phrase, but it is possible to imagine a number of arguably legitimate justifications for protective measures against IAS which might be characterized as based on 'theoretical uncertainty'. For example, a regulator might wish provisionally to ban the importation of a species, not because of positive evidence of the risks it poses, but because of a general concern that surprises are the norm in ecological management, and experience with this species is extremely limited. Indeed, in the context of IAS, even years of benign experience with a particular species does not imply that damaging impacts will not occur. Increasing numbers imported can increase chances of establishment and proliferation, or the ecological context can change, prompting unexpected changes in behaviour of a species in its host environment.[55] Alternatively, a regulator may wish to take protective measures even after a clean risk assessment, on the basis that the models on which the assessment was made may have identified the wrong questions, or impeded our ability to imagine, and therefore test, relevant risks. These are not, as the Appellate Body has stressed, the kinds of risks and uncertainties which can be tested through further risk assessment – indeed, they arise precisely because of the fundamental inadequacy of the risk assessment process. There is a serious question, therefore, whether Article 5.1, which requires SPS measures to be based on a risk assessment, precludes regulators from acting on the basis of these deeper forms of uncertainty.[56]

[52] Miller, 'NIS, WTO, SPS, WIR Does the WTO Substantially Limit the Ability of Countries to Regulate Harmful Nonindigenous Species?', 17 *Emory Int'l L Rev* (2003) 1059, 1088: 'the risk from harmful invasive species is fairly easy to describe at aggregate levels but very hard to describe for particular species. The risk assessment for many potential invasive species would be likely to suggest that the risk of introduction and spread for any individual species is low, but the risk of introduction and spread of some invasive species is high, and the harm from some of the invasive species that do spread is high'. See also Sykes, *supra* note 12, 364.

[53] Walker, *supra* note 14; Perez, *supra* note 12, 136.

[54] *EC – Hormones*, *supra* note 47, para. 186; *Japan – Apples*, *supra* note 47, paras. 239–242.

[55] In Australia, for instance, years of experience with pampas grass in horticulture gave rise to no serious problems, as all plants were male. This changed suddenly when a hermaphroditic variety was introduced, causing sudden proliferation; T. Low, *Feral Future: The Untold Story of Australia's Exotic Invaders* (2002).

[56] It may be argued that Art. 5.7 may be used to rectify this problem. This seems unlikely, however, as the Panel in *EC – Biotech, supra* note 11, has apparently made clear that Art. 5.7 is no longer available as a safe harbour once a risk assessment of any sort has been completed: see, e.g., para. 7.3260.

Thirdly, on a more practical level, there is a reasonable concern that the disciplines of the SPS Agreement may impose too great a strain on the resource constraints of many developing countries. Where such a country wishes to take precautionary trade-restrictive measures, the costly procedures required by the SPS Agreement – not just the performance of specific risk assessments for an immense variety of species and pathways, but in some cases the creation of an entire administrative system of policy-makers, independent scientific panels, and so on – may discourage them from doing so, or may even make it effectively impossible for them to do so.[57]

On the other hand, a 'learning' response to uncertainty does not end with the adoption of precautionary approaches, nor does it elevate precaution to an over-riding principle on all occasions. A focus on learning reduces the excessive focus of contemporary debates on the precautionary principle, by embedding it within a much broader adaptive governance framework. In this framework, precaution is understood as a pragmatic guide for enabling action while avoiding catastrophic consequences. It is only one among a number of such guides, and its relative importance is to be assessed in each case and context. In the context of invasive alien species, for instance, the presence of both high levels of uncertainty and strong irreversibilities may argue in favour of a strong weighting. But it is necessarily accompanied by proactive measures to increase our knowledge base through policy experimentation. Furthermore, in learning approaches, policies primarily based on precaution are subject to ongoing review and revision as circumstances change and our state of knowledge advances. On this approach, therefore, the requirements under Article 5.7 that provisional measures be reviewed after a reasonable period of time and accompanied by efforts to obtain further information are appropriate, provided of course that practical resource constraints are sensitively taken into account. Precaution, then, in the context of adaptive governance is part of a larger package of principles designed to enable us to live in a world in which evidence is *never* conclusive. It is part of a framework which, far from counselling paralysis in the face of uncertainty, helps us to continue to live, act, make decisions, and innovate despite pervasive uncertainty about the consequences of our actions.

2 The 'Proceduralization' of WTO Review

Another theme of the current literature concerns the need (or not) for deference by the WTO towards the judgments and decisions of national authorities. Where there is scope for multiple plausible scientific accounts, it is argued, and where science-based decision-making includes a large degree of value-based choices, variation is perfectly legitimate and to be expected. Following this argument, the implications for the WTO are obvious: its rules should permit legitimate variation in regulatory preferences across different jurisdictions; it should by and large defer to the judgement of local decision-makers; and it should not assume the role of arbiter between different, but equally open, scientific

[57] It should be noted that the Appellate Body has made clear that a WTO Member imposing an SPS measure need not conduct risk assessment itself, but can rely on assessments carried out by others: *EC – Hormones*, *supra* note 47, para. 190.

viewpoints.[58] Thus, some commentators argue that the WTO should confine itself to determining whether or not regulatory decisions are 'minimally adequate', or scientifically 'plausible', or have 'any reputable scientific support'.[59] This core concern, that the WTO should not set itself up as an arbiter of objective science, has expressed itself in debate over a number of specific legal issues. Many relate to the proper use of scientific evidence in panel proceedings. Should scientific experts give evidence as a panel or as individuals?[60] What kinds of experts should be used, what kinds of questions are they qualified to answer?[61] What weight ought to be given by panels to minority scientific viewpoints? Others relate to the way a Panel addresses itself to scientific evidence: does, for example, the panel's obligation to make an 'objective assessment of the matter before it' require it to attempt an objective evaluation of alternative scientific views?[62]

Our learning approach mirrors these arguments for deference in some ways, but departs from them in others. On one hand, as noted earlier, policy-making in adaptive governance structures rests on a pluralist conception of science, and a conception of scientific understanding as necessarily partial and provisional. The notion that any international institution of governance acts as an arbiter of scientific truth is therefore anathema to it. To that extent, implementing adaptive governance in the WTO may involve attention to precisely those issues mentioned above. The implications of adaptive governance, however, extend well beyond limiting the intrusiveness of WTO review or ensuring that WTO Panels do not 'second-guess' domestic decision-makers. Rather, the aim is to integrate the WTO as an active partner in the process of learning and adaptation. Deference-based approaches lead to an unduly limited programme of institutional change at the WTO. By conceptualizing WTO review solely as interference with domestic regulatory choices, and by focussing on the need to contain this interference in particular ways and in particular circumstances, such approaches tend to underestimate the extent to which the WTO may be able to act to enhance national governance structures. Furthermore, these approaches say little, if anything, about the ways in which the WTO may itself provide venues for the development of ecologically sensitive forms of (economic) governance.

Adaptive governance provides a framework within which such possibilities can be investigated and imagined. In particular, our picture of adaptive governance echoes

[58] Atik, 'Science and International Regulatory Convergence', 17 *Northwestern J Int'l L and Business* (1997) 736; Walker, *supra* note 14; Victor, *supra* note 12; Winickoff *et al.*, *supra* note 12; Christoforou, *supra* note 12; Howse, *supra* note 12.

[59] Wirth, *supra* note 12 , 857; Christoforou, *supra* note 12, 648; Walker, *supra* note 14, 304.

[60] Winickoff, *et al.*, *supra* note 12, 111; Christoforou, *supra* note 12, 636.

[61] Wirth, *supra* note 12, 858 and, generally; Winickoff *et al.*, *supra* note 12, 111; Pauwelyn, 'The WTO Agreement on Sanitary and Phytosanitary (SPS) Measures as Applied in the First Three SPS Disputes: EC – Hormones, Australia – Salmon and Japan – Varietals', (1999) 2 *J Int'l Economic L* (1999) 641; Howse, *supra* note 12, 2346; Foster, 'Social Science Experts and Amicus Curiae Briefs in International Courts and Tribunals: The WTO Biotech Case', 52 *Netherlands Int'l L Rev* (2005) 433.

[62] *Dispute Settlement Understanding*, Art. 11. See generally Pauwelyn, *supra* note 61; Christoforou, *supra* note 12, 635; Guzman, *supra* note 47, 17 ff; Winickoff *et al.*, *supra* note 12, 108.

the calls of numerous commentators for the 'proceduralization' of WTO review.[63] The core claim here is that WTO review should focus on the procedures by which regulatory decisions are made, and 'should be aimed at enforcing the transparent, accountable and reasoned use of science and risk assessment'.[64] That is to say, particularly in circumstances characterized by a high degree of scientific uncertainty, the WTO-legality of SPS measures should be determined primarily by procedural criteria, rather than their substantive rationality. Some commentators, for example, have proposed process-based criteria for determining what constitutes 'arbitrary and unjustifiable discrimination' (Article 2.3), and for determining when provisional measures under Article 5.7 are legitimate.[65] Similarly, Howse has examined the interpretation of many key provisions from the perspective of their potential for enhancing deliberative democracy at the national level.[66] For us, as well as for these authors, the point of proceduralization is not primarily to ensure that the WTO interferes less substantively with democratic decisions at the national level, but rather to use the international trade regime in a more positive way to facilitate, and provide an impetus for, the development of appropriate governance frameworks at the national level.[67]

3 Encouraging the Ongoing Evolution of National Regulatory Frameworks

We noted in the previous section that one of the core characteristics of adaptive governance is the incorporation of a feedback mechanism, which closely monitors the outcomes of policy and channels the lessons learnt back to policy-making venues in an iterative process of learning. This process can help to ensure that policies are constantly and flexibly updated as new information is brought to light, and as the results of previous policy experiments come to be known.

Implementing adaptive governance in the WTO may require that the WTO permit and (to the extent consistent with its mandate) facilitate and promote the incorporation of such feedback mechanisms in national institutions of environmental governance. Clearly, it is in principle perfectly *permissible* under the SPS Agreement for Members' SPS regimes to be subject to continuous scientific review and revision.[68] But the one-off nature of WTO dispute settlement may undermine the WTO's ability to *actively facilitate* such continuous review. WTO review procedures are designed to assess the WTO-compliance of particular regulatory arrangements at a fixed moment in time, and are thus not well designed for the task of reviewing rapidly evolving regulatory structures.

[63] Wirth, *supra* note 12, 855 and generally; Perez, *supra* note 12, 152; Scott, 'International Trade and Environmental Governance: Relating Rules (and Standards) in the EU and the WTO', 15 *EJIL* (2004) 307; Winickoff *et al.*, *supra* note 12, 109 and generally.

[64] Winickoff *et al.*, *supra* note 12, 108. See also Guzman, *supra* note 47.

[65] Winickoff *et al.*, *supra* note 12, 112.

[66] Howse, *supra* note 12. See also Bohanes, *supra* note 12.

[67] See also Scott, 'European Regulation of GMOs and the WTO', 9 *Columbia J European L* (2003) 213, 232.

[68] As an aside, and as Howse and Mavroïdis note, European-level regulation of biotechnology provides for reconsideration of regulatory decision in light of new information: Howse and Mavroïdis, 'Europe's Evolving Regulatory Strategy for GMOs – The Issue of Consistency with WTO Law: Of Kine and Brine', 24 *Fordham Int'l LJ* (2000) 317, n. 368.

This can give rise to a number of practical problems. For example, given the lengthy and cumbersome nature of WTO dispute settlement, it will often be the case that both the state of scientific knowledge and the regulatory regime under consideration have changed in material ways by the time a decision is made. The *EC – Biotech* case is a good example of a case in which the measure under consideration no longer existed in the same form when the Panel decision was handed down.[69] *EC – Hormones*, too, was complicated by the appearance of new scientific evidence after the initial risk assessment was made.[70] While these difficulties are in a sense mere inconveniences, at a deeper level they point to a more fundamental problem: namely, the inability of the WTO to provide meaningful impetus for, and monitoring of, adaptive governance structures at the national level in the absence of some parallel venue for more continuous or flexible forms of supervision.

Furthermore, in some circumstances, the current WTO dispute settlement machinery may in practice provide *dis*incentives for national governments flexibly to monitor and adapt their SPS measures to the changing contours of scientific knowledge and fluctuating social demands. The more cumbersome the procedures required by the SPS Agreement, for example, and the more resources consumed in producing WTO-compliant risk assessments each time an SPS measure is materially amended, the greater the disincentive to engage in constant monitoring and review. In addition, where a particular governmental measure has been subject to WTO dispute settlement and found WTO-compliant, regulators may tend not to amend it unless absolutely necessary, for fear of further legal challenge. Similarly, if a country's SPS measure has withstood WTO challenge, there can be a tendency for regulators in other countries to adopt an analogous approach to forestall the possibility of WTO proceedings.[71] (Indeed, there seems to be evidence of precisely this process in relation to the regulation of genetically modified foods.[72]) Through this dynamic of *de facto* isomorphism, local experimentation with, and adaptation of, regulatory techniques can thereby be reduced. Greater use of softer but more continuous forms of review in the WTO may help to relieve these problems in some circumstances. Indeed, this seems to be envisaged in the SPS Agreement itself: as Winickoff *et al.* have observed, the requirement in Article 5.7 that Members seek additional information about likely risks 'within a reasonable period of time' seems to contemplate some form of ongoing supervision in relevant cases.[73] Without discounting the real risk

[69] In that case, in addition to the change in the regulatory structure itself, another time-related issue arose concerning the time at which the 'sufficiency' of scientific evidence is to be assessed for the purposes of Art. 5.7: *EC– Biotech*, *supra* note 11, WT/DS291/R, para. 3247 ff.

[70] As a result of the AB decision in that case, it is now clear, of course, that what matters is the scientific evidence presented to the Panel, not what was available to the decision-makers at the time the regulation is made: *ibid.*, paras. 188–191. The situation is perhaps not so clear where new evidence arises between the release of the Panel Report and the AB Report.

[71] Atik, *supra* note 58. Note also generally *EC – Hormones*, *supra* note 11, Appellate Body Report, para. 190 (noting that Members may justifiably rely on risks assessments carried out by another authority or Member).

[72] T. Bernauer, *Genes Trade, and Regulation: The Seeds of Conflict in Food Biotechnology* (2003).

[73] Winickoff *et al.*, *supra* note 12, 116.

that such supervision could in practice itself turn into an undue constraint on domestic regulatory freedom, it is in principle possible that the expanded application of Article 5.7-type procedures to many (perhaps most) SPS measures could provide a beneficial mix of relaxed substantive supervision, combined with forms of context-specific ongoing supervision aimed at encouraging continuous learning in particular domestic environments. Clearly, the desirability of such an expansion would be subject to the points made above concerning the need for precaution and the proceduralization of review.

B *The WTO as Venue for Policy Learning*

The implications of adaptive governance for the WTO are not limited to the role it can play in enabling and facilitating adaptive responses at national level. As a governance body which responds to a broad set of uncertain and unpredictable dynamics – environmental, social, and economic – the WTO itself could benefit by adopting adaptive governance principles in its own operations. This means understanding the WTO less as a set of rules constraining state behaviour, and more as a venue for facilitating policy learning.

1 Feedback, Monitoring and Revision in the WTO Itself

One of the characteristics of adaptive governance identified earlier was the integration of feedback mechanisms in policy-making processes. In addition to encouraging iterative review processes at the national level, such mechanisms for feedback and review may also be necessary within the WTO itself. To a limited extent, these already exist. For example, the SPS Committee is authorized periodically to review the operation and implementation of the SPS Agreement and, where appropriate, to submit proposals to amend the text of the Agreement having regard to the experience gained in its implementation.[74] Two major reviews have occurred so far – one completed in 1999 and the other in 2005 – though no formal amendments have been proposed to date.[75] In addition, the SPS Committee meets approximately three times per year to perform a variety of other review functions. It has, for example, developed guidelines and procedures for the implementation of numerous provisions of the SPS Agreement, which are themselves reviewed periodically and modified frequently.[76] Furthermore, the Committee monitors the development and use of international standards, and receives information from Members having difficulty implementing their obligations under the agreement and co-ordinates requests for technical assistance.

However, there are ways in which this review mechanism could be expanded and made more effective from the perspective of adaptive governance. Most importantly, the Committee's monitoring activities are focussed primarily on questions of compliance and implementation, rather than on reflexively evaluating the outcomes and content of the SPS Agreement itself. This criticism is applicable not just to the work of the SPS

[74] SPS Agreement, Art. 12.7.

[75] G/SPS/12 (11 Mar. 1999), G/SPS/36 (11 July 2005).

[76] See, e.g., G/SPS/15, 18 July 2000 (Guidelines relating to the implementation of Art. 5.5) and G/SPS/33, 2 Nov. 2004 (Guidelines relating to procedures for considering SDT requests).

Committee, but more broadly to the variety of monitoring mechanisms in place within the WTO.[77] There is, of course, a degree of overlap between these functions: collecting information on the challenges and constraints faced by Members in implementing their obligations can, for example, lead to a re-examination of the obligations themselves. But there is nevertheless a strong argument that the Committee should collect a broader range of information about the practical operation of the agreement. The Committee could, for example, request and collect information from Members on how the disciplines contained in the SPS Agreement are taken into account in the decision-making practices of national officials, and more particularly how the agreement has influenced the evolution of specific regulatory regimes, such as those to control the introduction of IAS.[78] The Committee could also collate information on the relationship between the intensification of international trade flows and the incidence of particular problems known to be related to trade, such as the spread of harmful IAS. The mere collation of this information would be a useful function for many trade policy-makers, and would seem to be a necessary part of building a picture of how WTO policy interventions impact on the real world. Some of this information, it should be said, is already produced elsewhere: expanding the monitoring role of the SPS Committee may therefore be most easily implemented by increasing the (already significant) number and variety of organizations with which it regularly shares information and which are granted observer status in its own proceedings.[79]

In addition to expanding the monitoring role of the trade regime, there is room to develop its revision and amendment function. Easy and effective revision of decisions is important not only to facilitate the incorporation of new knowledge into new policy, but also to increase the reversibility of WTO interventions. We noted above that no formal amendment to the SPS Agreement has been proposed or discussed within the SPS Committee. This may be partly because such amendment is not perceived as necessary, but no doubt it also has much to do with the significant obstacles facing any proposal for formal amendment of the WTO Agreements. These obstacles have been

[77] In relation to the TPRM, e.g., see the comments of Hoekman, *supra* note 28. See also the references *infra* in note 79.

[78] The precise empirical effect of WTO obligations on processes of regulatory decision-making in different policy areas across different countries remains under-researched. The same absence of reflexive self-monitoring has been noted by other commentators in the development context: see, e.g., Hoekman, *supra* note 28, 12, as well as – in a different context – WTO documents S/CSS/M/9 (in which Pakistan makes a very comprehensive case for a comprehensive assessment of the empirical impact of the GATS) and S/CSS/W/114.

[79] The WTO website lists the following organizations as enjoying observer status in the SPS Committee: FAO/WHO Joint Codex Alimentarius Commission (CODEX), Office international des epizoöties (OIE), International Plant Protection Convention (IPPC), Food and Agriculture Organization (FAO), World Health Organization (WHO), the World Bank, African, Caribbean and Pacific Group of States (ACP), Inter-American Institute for Co-operation on Agriculture (IICA), International Organization for Standardization (ISO), International Trade Centre (ITC), Organization for Economic Cooperation and Development (OECD), Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA). The Convention on Biological Diversity is a notable exception, though there seem to be quite specific political reasons for this: see J. Scott, *Agreement on the Application of Sanitary and Phytosanitary Measures: A Commentary* (2007), ch. 2. Other organizations that might usefully participate in SPS Committee work, subject to capacity constraints, include the International Maritime Organization (IMO) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

described elsewhere,[80] and are commonly recognized as a significant problem for the WTO as a whole.[81] To date, most proposals to address this problem have focussed on relatively formal legal tools: modifying voting procedures for amendments to WTO agreements;[82] using experts' panels to facilitate political agreement on necessary amendments;[83] expanding the use of authoritative interpretation under Article IX of the Agreement establishing the World Trade Organization;[84] or increasing the availability of more focussed legal tools such as waivers or variations.[85] All of these possibilities – with the possible exception of waivers – face formidable political obstacles, and are unlikely to be implemented soon.

However, little attention has been paid to the possibility of softer or more informal modes of revision, which are in fact already occurring to some extent within certain parts of the WTO system, including the SPS Committee itself. It is important to remember that the WTO legal system is more than just the WTO texts as interpreted by the Appellate Body and Panels – these rules are embedded within, and shaped by, a wide variety of informal understandings and social norms at play within the trading system. Particularly where legal texts are ambiguous, little known, or poorly understood (and this is very often the case in the WTO context), normative guidance is provided, not so much by rules themselves, but by semi-formal consensus concerning how they are to be implemented, and how they apply in particular circumstances. The point is that the SPS Committee is one venue in which such semi-formal norms are generated and revised: indeed, as Wolfe has observed, 'most 'clarification' of the SPS Agreement seems to come, not from Appellate Body decisions, but from how officials understand the WTO '*acquis*' through their ongoing negotiations with each other'.[86] In addition to the guidance notes, referred to above, which the Committee has generated on the implementation of certain obligations,[87] it has also recently been asked to issue

[80] This inflexibility results in part from cumbersome procedures for their amendment – in practice typically requiring a consensus of all WTO Members. It is also in part because of the 'hard' character of WTO law. The presumption that all new negotiated rules will be enforceable through the dispute settlement mechanism creates significant obstacles to the rapid adoption of new or amended rules: Abbott and Snidal, 'International Action on Bribery and Corruption: Why the Dog didn't Bark in the WTO', in D. L. M. Kennedy *et al.* (eds.), *Political Economy of International Trade Law* (2002), at 177, 202. Furthermore, the *quid pro quo* negotiating mentality that dominates almost all processes within the WTO also undermines its ability to respond rapidly to new information and new demands, as agreement on reforms tends to be used as a bargaining chip in other negotiations: *ibid.* See also generally, *The Future of the WTO*, Report of the Consultative Board to the Director-General, (2004), especially ch. VII.

[81] The 'sequencing' amendment to the DSU is a classic illustration, as are the immense difficulties faced during the process of agreeing the TRIPS/public health amendment.

[82] E.g., *The Future of the WTO*, *supra* note 80, ch. VII.

[83] *Ibid.*

[84] See Pan, *supra* note 29; Ehlermann and Ehring, 'The Authoritative Interpretation Under Article IX:2 of the Agreement Establishing the World Trade Organization: Current Law, Practice and Possible Improvements', 8 *J Int'l Economic L* (2005) 803.

[85] Pan, *supra* note 29.

[86] Wolfe, 'See You in Geneva? Legal (Mis)Representations of the Trading System', 11 *European J Int'l Relations* (2005) 339, 353. See also Scott, *supra* note 79, ch. 2.

[87] See *supra* note 76.

'clarifications' of certain SPS provisions, and is currently considering these requests.[88] Such activities are carefully circumscribed, so as not to change formal rights and obligations under the SPS Agreement, and they are certainly not authoritative interpretations in the sense of Article IX:2. Nevertheless, they perform crucial functions of norm generation and revision, which some have described as quasi-legislative in nature.[89] It is possible to envisage the Committee playing precisely these roles in relation to the problem of IAS: building a consensus that certain kinds of precautionary regulation are acceptable with appropriate safeguards, developing procedures for the efficient and legitimate introduction of 'black-white-grey' list approaches, and issuing non-binding clarifications of relevant SPS provisions to elaborate on their application in the specific context of IAS regulation.

At the same time, it is important to acknowledge the concerns that such a semi-formal process raises. To the extent that the SPS Committee is a body with very limited participation, and equally limited biodiversity expertise and experience, there are legitimate questions whether it is an appropriate body to be performing such norm-generating functions. Nevertheless, in our view such concerns suggest the need (fully consistent with an adaptive governance approach) to expand the level and nature of participation in Committee procedures, rather than the need to limit the Committee's function. Indeed, increasing overall levels of transparency and participation within the WTO itself is of central importance for adaptive governance approaches to work.[90] This is particularly the case in respect of those actors with interests, experience, and expertise in biodiversity matters, such as the Convention on Biological Diversity.[91] There is, after all, no reason to assume that, simply because it is a body within the trade regime, the SPS Committee need necessarily develop a culture which is insufficiently aware of, or sympathetic to, environmental concerns.

2 Problem-centred Information Exchange

The incorporation of principles of adaptive governance into international economic governance may also enourage institutions such as the WTO to create new collaborative forums for co-operative problem-solving and information exchange. Such forums would be oriented towards the reciprocal provision and dissemination of information, through regularized interactions of key policy-makers and officials.[92] This would involve a shift in the role that the WTO sees itself as playing, to include a vision of international economic institutions as 'knowledge centres or intermediaries, and as dialogue partners in the process of learning'.[93]

[88] G/SPS/36 (11 July 2005), *supra* note 75, paras. 92–95.

[89] See Scott, *supra* note 79 , ch. 2.

[90] We have not stressed this aspect as much as others, primarily because so much has already been written on it. However, this should not be understood as in any way minimizing the importance of increased participation and accountability in WTO decision-making processes in general.

[91] See CBD, 2006 Statement by the Representative of UNEP on behalf of the Convention on Biological Diversity to the Special Session of the Committee on Trade and Environment of the WTO, 6–7 July 2006, available at: http://www.biodiv.org//doc/speech/2006/sp-2006-07-13-cte-en.pdf.

[92] Hoekman, *supra* note 28, 11.

[93] Sabel and Reddy, *supra* note 28, at 9.

The WTO has been critiqued by some commentators for defining itself too narrowly as merely a forum for negotiation and adversarial dispute settlement.[94] However justified in other areas, this critique seems less true in the area of SPS measures.[95] Apart from its monitoring and review functions just described, the SPS Committee also encourages countries to submit specific concerns that they may have about the SPS measures imposed by their trading partners, for informal *ad hoc* consultations with the regulating Member.[96] There have been well over 200 such concerns raised, and it seems that they often provide an occasion for precisely the kinds of problem-centred information exchange that is valued by adaptive governance approaches. In her review of the activity of the Committee in this area, Scott notes that, in this context, '[r]elations between Members are characterised by far-reaching co-operation, leading to mutual adjustment of regulatory expectation and regulatory performance, and to collaboration in problem-solving'.[97] Wolfe, too, has drawn attention to the importance of this aspect of the Committee's work – particularly in comparison with the more formalized dispute settlement procedure – and to the benefits that it provides.[98] Interestingly, furthermore, there have been proposals to develop further mechanisms along these lines in other areas of the WTO's work.[99]

Even outside the context of specific disputes, the SPS Committee could also act as a forum for exchanging knowledge and information. Peer review in the context of the SPS Committee can encourage policy experimentation, as strategies used in one part of the world are regularly and rapidly disseminated to others, and potentially adapted for local use. It can facilitate the identification of potential issues, as policy-makers in one country learn about problems faced by others. It helps to generate important transgovernmental social and professional networks between food safety and other experts, as well as inter-departmental knowledge networks across the fields of both trade and environmental policy.[100] Furthermore, on a number of occasions international scrutiny of SPS measures has led to co-operative assistance, as importing countries transfer both knowledge and resources to exporting Members to assist in the creation of stronger and more effective regulatory frameworks to achieve their objectives.[101] It may be that interactions of this sort may serve as something of a model for other venues within the WTO system.

[94] See, e.g., Rischard, 'High Noon: We Need New Approaches to Global Problem-Solving, Fast', 4 *J Int'l Economic L* (2001) 507; Abbott and Snidal, *supra* note 80.

[95] See Wolfe, *supra* note 86.

[96] We owe this observation and its elaboration to Joanne Scott, and her important work on the SPS Committee, cited *supra* note 79, as well as to Wolfe's insightful paper, *supra* note 86.

[97] See Scott, *supra* note 79, ch. 2.

[98] Wolfe, *supra* note 86.

[99] See, e.g., the EC's 'NTB Resolution Mechanism' proposed in TN/MA/W/11/Add.8 and TN/MA/W/68/Add.1.

[100] See, for an interesting acknowledgement of this function: G/SPS/36 (11 July 2005), para. 7.

[101] Examples are given in Scott, *supra* note 79, ch. 2.

5 Conclusion

This article began as a contribution to the growing literature on the implications of scientific uncertainty for the WTO, and in particular the interpretation and application of the SPS Agreement. Most commentators in this area have focussed on a limited number of issues: the need to ensure that WTO Members maintain the ability to take precautionary protective measures; the danger of WTO dispute settlement panels attempting to arbitrate competing scientific views; and the importance of WTO panels not attempting to 'second-guess' domestic regulatory choices. While our approach encompasses and reiterates some of these claims, our aim here has been to show that the implications of pervasive scientific uncertainty for the WTO go much deeper than this, and include the model of governance on which the operation of the WTO is premised.

In ecological science, the growing recognition of the complexity and unpredictability of many ecological systems, and the consequent extent and persistence of uncertainty in our knowledge of their dynamics, has led to demands for new forms and methods of environmental management. These demands have prompted an extensive literature on 'adaptive management'. We have drawn on this (and cognate) literature to offer a much broader and more comprehensive framework for how the WTO might respond most productively to the various uncertainties which face it. We argue for the re-articulation of the WTO's operations according to the principles of 'adaptive governance': continuous learning should become a central objective of the WTO; policy-making in the WTO should become self-consciously experimentalist in nature and explicitly seek to avoid irreversible harm; the outcomes of policy-making in the WTO should be subject to continuous and close monitoring; and the review function performed by the WTO should be defined and justified primarily according to a procedural rather than substantive rationality.

We offered some preliminary and necessarily incomplete indications of what this model of governance might look like in the WTO, focusing in particular on the regulation of invasive alien species. We found that while some aspects of the WTO's operation already fit within this framework, in other important respects current widespread concerns that the WTO may restrict effective policy responses to persistent uncertainty are well-founded. For example, we drew attention to specific concerns about the operation of SPS Articles 2 and 5, which we believe may in practice hinder the adoption of proactive responses to uncertainty by national authorities, at least in some circumstances. We noted a need for more systematic processes for collecting and disseminating knowledge about the impact of the international trading system on the incidence and impacts of IAS around the world, as well as a need for more structured processes by which this knowledge influences the continuing evolution of the norms and rules of the trading system. We observed that WTO dispute settlement processes are in some ways poorly suited to the review of highly adaptive national regulatory structures, and argued for the development of forms of softer but more continuous review more suited to this task. Finally, we argued for increased focus on spaces for problem-centred information exchange in the WTO, and identified the SPS Committee as a potentially important venue for such activity in relation to the regulation of IAS.