

Adaptive Policies
Meeting the Policymakers Challenge
in Today's Complex, Dynamic and Uncertain World

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Abstract: Today's policymaker has a tough job to do. Crafting public policies to help guide the daily actions of individuals, communities and businesses to ensure our economic, social and environmental wellbeing, is challenging under the best of circumstances. But the reality is that our world is now more complex than ever – highly interconnected, owing to advances in communication and transportation, and highly dynamic, owing to the scale of impact of our collective actions. Policies that cannot continue to perform effectively under dynamic and uncertain conditions run the risk of not achieving their intended purpose, and becoming a hindrance to the ability of individuals, communities and businesses to cope with and adapt to changing socio-economic and ecologic conditions. Using insights gained from complex adaptive systems thinking, as currently being applied in range of economic sectors, and through the analysis of policies identified through hundreds of on-the-ground interviews in Canada and India, we compile in this paper a pragmatic set of approaches and tools for adaptive policies and policymaking. Adaptive policies employ a suite of specific mechanisms which help them perform effectively in the face of anticipated and unanticipated conditions. As we understand at the midway point of our four-year research project, among these mechanisms are: automatic adjustment; integrated assessment to inform policy parameters; multi-perspective deliberation; formal review and continuous learning; encouraging self-organization and networking; subsidiarity; and promoting variation.

Introduction - The Challenge Facing Policymakers

“for the first time in history, humankind has the capacity to create far more information than anyone can absorb, to foster far greater interdependency than anyone can manage, and to accelerate change far faster than anyone's ability to keep pace.”

Peter Senge on Creating a Learning Organization (1990)

Government policy must operate in an ever-changing and uncertain world. We know for example that the climate is changing, but not precisely how. We know that energy prices are highly unpredictable, and that international trade rules are in a state of flux. The scale of today's impact of our economic activity and cultural connectedness evoke types of responses in society and our ecosystems for which we have no prior experience. Crafting policies in such a setting to address acute issues, be they economic, social or environmental, is inherently complex and dynamic. This is the reality facing today's policymaker.

Experience demonstrates that policies crafted to operate within a certain range of conditions are often faced with challenges outside of that range. The result is that many policies have unintended impacts and don't accomplish their goals. Therefore, in order to help policies help people, policy-makers need ways to design policies that can adapt to a range of conditions.

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A concept of adaptive management emerged in the late 1970s which suggested that ecosystems must be managed adaptively, with experimentation and learning built in, if the management process was to be successful (Holling 1978). This insight – now well acknowledged in the natural resources management (e.g., Lee 1993; Gunderson and Holling 2003) also applies to public policy, where integrated socio-economic and ecological systems are even less well understood.

While the need for adaptive policymaking approaches is relevant to all sectors, the need is particularly acute in the water resources and agriculture sectors in light of future climate change. A group of researchers studying water governance in India and Nepal found that *“when situations are characterized by variability, uncertainty and change, conventional planning scenarios provide little guidance regarding future needs and conditions (Moench et al. 2003).”* The research revealed that although it might be possible to identify some emerging issues with conventional approaches, it is the case that *“changing conditions often render specifically targeted management proposals irrelevant or impossible to implement.”* The authors concluded that there is a *“clear need for frameworks that are adaptive – which reflect uncertainties and can respond as contexts change or unforeseen problems emerge.”*

Perhaps most interestingly these researchers note that *“specific solutions are less important than the existence of processes and frameworks that enable solutions to be identified and implemented as specific constraints and contexts change.”*

Along similar lines, Scoones (2004) points out that much can be learned from the pastoral rangelands of the world where uncertainty has always been a part of everyday life and survival. He describes these as regions “where systems are not at equilibrium, where sometimes chaotic, often stochastic, dynamics prevail and where predictability and control are false hopes.” Scoones recognized that if climatic uncertainty and variability are on the rise due to climate change – then *“we must shed our blinkered equilibrium views and solutions and search for alternatives that allow for living with uncertainty.”* He contends that conventional views of institutions as static, rule-based, formal, fixed, and having clear boundaries are giving way to views that institutions must be dynamic, overlapping, heterogeneous, socially defined, emergent from adaptive practice, and flexible.

All of these situations start from the recognition that policy systems and policy change are not linear, rational or deterministic processes. There is typically no clear causal chain to explain how a particular policy either takes shape or fails. Policies are the outcomes of iterative and opportunistic interaction among multiple factors which include perception of problems among different groups, communication of new knowledge and consensus on validity, argument, contestation, power and political opportunity.

In a project rooted in the principles of complex adaptive systems thinking, The *International Institute for Sustainable Development* (Canada) and *The Energy and Resources Institute* (India), with funding and support from the International Development Research Centre, are collaborating to compile a set of approaches and tools for making water resources and agriculture management policies more adaptive to anticipated and unanticipated conditions.

Using global climate change as the backdrop of uncertainty, surprise and change, we are identifying and studying policies which have helped people and communities adapt to historic weather-related shocks and stresses—based on the premise that such policies will be fruitful ground for researching specific adaptive policymaking mechanisms. These new and improved approaches and tools for policy-making will help policy designers address issues of climate change adaptation. But these approaches and tools will be relevant to any complex policy issue, providing a means to design and implement policies under dynamic and unpredictable socio-economic and ecologic circumstances.

Background and Conceptual Foundations for Adaptive Policies

In this section we introduce adaptive policies first by providing a working definition of policy and an illustration of an idealized policy design and implementation cycle. We then provide a brief history of the emerging notion of adaptive policies and conclude by laying the conceptual foundation for adaptive policies – complex adaptive systems thinking.

Policies and Policy Instruments

A *policy* can be thought of as a broad statement of purpose and process for addressing a particular social, economic or environmental issue. The intent of a policy is implemented via *policy instruments* such as regulatory, economic, expenditure and institutional instruments.

For purposes of this paper, any policy instrument can be considered to be made up of two components:

- **Design**- defining the rules for how the instrument is to perform; and
- **Implementation** – the actions of the people and organizations which implement the rules of the policy instrument.

These two components are illustrated in Figure 1 which presents an idealized process of policy design and implementation. Policies are designed with varying degrees of consultation with relevant stakeholders and it is typically the case that an institution or organization different from the one which designed the policy is responsible for implementing the policy.

Consider for example a law for automobile speed limits. Penalties are defined by government policy and law makers for drivers who exceed the speed limit. The policy is implemented by a police officer that stops the speeding driver. The police officer then has discretion on how to implement the policy. Depending on the actual speed of the driver and the road conditions at the time, the officer will decide on a warning or issue a speeding ticket. The police department may decide that speeding is an issue that will be given either low or enforcement priority.

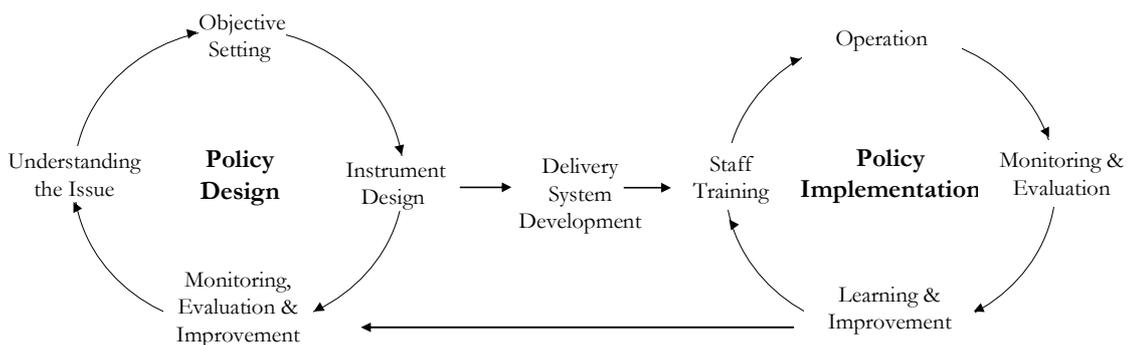


Fig. 1. Idealized illustration of policy design and implementation.

Thinking of policy and implementation as two distinct yet integrated processes is helpful from a practical perspective. Pritchett and Woolcock (2003) suggest that much more attention has to be paid to the “implementation” cycle. They argue that design and delivery of transaction intensive public services can be described using two characteristics: the degree of discretion involved in decisions, and the intensity of transactions required. In a western context, policy design, for example, requires high discretion, but limited transactions; whereas, policy implementation requires a lot of transactions, but little discretion. Pritchett

and Woolcock argue that in developing countries, policy implementation has more discretion relative to the western context given a heavy dependence on personal context, connections and experience.

Brief History of Adaptive Policies

Some of the first hints toward adaptive policymaking actually came early in the 1900s. Dewey (1927) put forth an argument proposing that “policies be treated as experiments, with the aim of promoting continual learning and adaptation in response to experience over time (in Busenburg 2001).” Over sixty years later Kai Lee appears to be one of the first to use the term “adaptive policy” in his account of integrating science and politics in the highly contested issue of salmon fisheries restoration and hydropower development in the pacific northwest of the United States. Lee describes *adaptive policy* as *a policy that is “designed from the outset to test clearly formulated hypotheses about the behaviour of an ecosystem being changed by human use* (Lee 1993).”

Walker and Marchau (2003) in a special issue of the international journal *Integrated Assessment* give direct focus to the terms adaptive policies, policy analysis, and policymaking and take them to a pragmatic level. They suggest that policies be “*adaptive – devised not to be optimal for a best estimate future, but robust across a range of futures.*” Their notion of adaptive policies includes policies *that respond to changes over time and that make explicit provision for learning*. This approach requires that learning and adaptation of the policy be made *explicit at the outset and the inevitable policy changes become part of a larger, recognized process and are not forced to be made repeatedly on an ad hoc basis* (Walker and Marchau 2003).

The U.S. National Academy of Science provides some additional practical insight into adaptive policies. Bankes (2002) recognized that “most policy problems involve complex and adaptive systems and that for those problems, the classical approaches of predictive modeling and optimization that have been used in decision support software are not appropriate.” He contends that for policies to be successful in a complex and adaptive world, policies will “*need to be adaptive themselves*”, and warns that relying on optimization techniques to develop policies based on the projections of a single model will produce static policies which make the “correct move” only for the best estimate model.

No discussion of adaptive policies would be complete without studying adaptive management. The notion of adaptive management, as it applies to the process of human intervention in ecological systems, is first attributed to the Canadian ecologist, C. S. Holling (1978). Holling describes adaptive management as “learning by judicious doing.” Adaptive management is characterized by its flexible policies and the plurality of views that inform it; no particular epistemic community can possess all the necessary knowledge to form policy. Science, models, expert knowledge, and the policies based on them are not interpreted as ultimate answers, but merely as a means to guide a cautious process of intervention in complex ecosystems. The goal of management shifts from achieving a single target to an integrated view of maintaining ecosystem resilience, avoiding for example catastrophic and irreversible “flips” to other equilibrium states (Holling 2001). It is within the context of adaptive management, which Lee (1993) first elaborates on the notion of adaptive policies.

Complex Adaptive Systems as a Theoretical Foundation for Adaptive Policies

In searching for a theoretical grounding to identify key principles for adaptive policies, we turn to the growing discourse on complex adaptive systems. A complex adaptive system has been articulated as being:

“...made up of many individual, self-organizing elements capable of responding to others and to their environment. The entire system can be seen

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as a network of relationships and interactions, in which the whole is very much more than the sum of the parts. A change in any part of the system, even in a single element, produces reactions and changes in associated elements and the environment. Therefore, the effects of any one intervention in the system cannot be predicted with complete accuracy, because the system is always responding and adapting to changes and the actions of individuals (Glouberman et al. 2003)."

Rihani (2002) believes that “at base, development is what nations do as complex adaptive systems, and what they do can be described as uncertain evolution that has no beginning or end, nor shortcuts, and few signposts on the way.” We ascribe to the idea that all policy issues involving the interaction of humans and nature through socio-economic processes, are complex and adaptive systems.

The recent study and application of complex adaptive systems can be seen in numerous fields including business management, healthcare, information technology, transportation, sustainable development and international development (Table 1). Within these fields practitioners and researchers have been thinking about how to better craft policies that can be effective in highly complex, dynamic and uncertain settings. Senge (1993) describes systems thinking as *the discipline for seeing the structures that underlie complex situations and the best leverage points for change...it is the antidote for the sense of helplessness that everyone feels in this new age of interdependence – it offers a language that begins by restructuring how we think.*

Table 1. Scan of Theoretical and Applied Complex Adaptive Systems Research in Business and Public Policy.

Sector	Application Reference
Business management	
Organizational learning	Peter Senge, 1993. <i>The Fifth Discipline: The Art and Practice of the Learning Organization</i> . New York: Currency Doubleday.
Leadership	Margaret J. Wheatly. 1999. <i>Leadership and the New Science. Discovering Order in a Chaotic World</i> . 2 nd Edition. San Francisco: Berrett-Koehler.
Health Policy	
Health policy in cities	S. Glouberman, P. Campsie, M. Gemar, and G. Miller 2003. <i>A toolbox for improving health in cities</i> . Caledon Institute for Social Policy. February.
Healthcare and healthcare administration	Mayo Clinic, Rochester, Minnesota, 2003. <i>Complexity Science in Practice: Understanding and Acting to Improve Health and Healthcare</i> . Conference, March 21-22, 2003. Available at http://www.complexityscience.org/index.php (Accessed August, 2004).
Information Policy	
Bottom-up management related to information technology	Axelrod, R. and M.D. Cohen 2000. <i>Harnessing Complexity: Organizational Implications of a Scientific</i> . New York: Basic Books. Funded by the U.S. Department of Defense.
Transportation Policy	
Airport Design	Walker, W.E., S.A. Rahman, and J. Cave 2001. <i>Adaptive policies, policy analysis, and policy-making</i> . <i>European Journal of Operational Research</i> 128: 282-289.
Sustainable Development	
Theory of adaptive change	L. H. Gunderson and C .H. Holling 2003. <i>Panarchy: Understanding transformations in human and natural systems</i> . Washington: Island Press.
Community-level resilience	F. Berkes, J. Colding, and C. Folke 2003. <i>Navigating social-</i>

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building	ecological systems: building resilience for complexity and change. Cambridge University Press, UK. [based on Panarchy]
Sustainability assessment	Kay, J. H. Regier, M. Boyle, and G. Francis 1999. An Ecosystem Approach for Sustainability: Addressing the Challenge of Complexity. Futures, Vol. 3, No. 7, pp 721-742.
Forest management	J. Ruitenbeek and C. Cartier, 2001. The invisible wand: adaptive co-management as an emergent strategy in complex bio-economic systems. Centre for International Forestry Research. ISSN 0854-9818. [note: based on Harnessing Complexity]
International Development	
Guidance for development assistance	S. Rihani 2002. Complex systems theory and development practice: Understanding non-linear realities. New York: Zed Books.
Practitioner networks	
Ecosystem management	The Resilience Alliance is a multidisciplinary research group that explores the dynamics of complex adaptive systems in order to discover foundations for sustainability and provide novel solutions to managing resilience and coping with change, uncertainty, and surprise in complex social-ecological systems. www.resalliance.org
Network of excellence	EU Complex systems network of excellence. Funded by the European Commission to develop collaboration among European researchers interested in Complex Systems, from fundamental concepts to applications, and involving academia, business and industry http://www.complexityscience.org/index.php

For example, as already noted in the transportation sector, it has been proposed that public policies be “*adaptive – devised not to be optimal for a best estimate future, but robust across a range of futures*” and that policies “*respond to changes over time and make explicit provision for learning (Walker and Marcheau 2003).*”

The United States Academy of Sciences suggests that “*adaptive policies need to be evaluated on their robustness properties, not on their performance on any single case.*” They advocate that *scenario analysis can be used to find cases that break a proposed policy, and that such worst cases can stimulate policymakers to modify the range of possible policies to allow for combinations that hedge against these worst cases (Bankes 2002).*

In the healthcare field, it is recommended that policy interventions should *promote variation* because “*introducing small-scale interventions for the same problem offers greater hope of finding effective solutions.*” This is based on the understanding that “*many interventions will fail and that such failures are simply a feature of how one develops successful interventions in complex adaptive systems (Glouberman et al. 2003).*” It is also understood that *possible solutions undergo selection* by the system. It is therefore important to include “*evaluating performance of potential solutions, and selecting the best candidates for further support and development (Glouberman et al. 2002).*”

In the forestry management sector it is suggested that foremost for intervention in complex adaptive systems, policies must *ensure that social capital remains intact* – if local groups and their networks are disempowered individually or collectively, existing social structures are in effect invalidated and undermined (Ruitenbeek and C. Cartier, 2001).

In the natural resources management field it is understood that to build resilience for complexity and change, interventions should *promote self-organization by building networks*

of reciprocal interaction and matching scales of ecosystems and governance (Berkes et al. 2003).

Toward Practical Guidance for Adaptive Policies

With a plethora of insights from a range of sectors applying complex adaptive systems thinking, we compile these as the conceptual foundation for advancing a framework for adaptive policies. To identify specific examples of adaptive policy mechanisms and to inform a pragmatic organization of these complex adaptive systems insights, we are conducting hundreds of community-level interviews in Canada and India. Using historic climate variability as a backdrop of surprise, change and uncertainty, we are identifying public policies which facilitate short-term coping and long-term adaptation measures of farmers and we are studying these for their adaptive policy features. The premise being that policies that have been helping people adapt to uncertain events, are likely to have adaptive features themselves (i.e., these policies have remained effective under highly variable conditions).

The framework for adaptive policies which has emerged from our literature and field-level research midway through this four-year research project is presented in Table 2. The framework puts forth that effective policies have the ability to adapt to both *anticipated* and *unanticipated* changes in underlying socio-economic and ecological conditions. The ability to adapt to *anticipated* conditions is founded in an understanding and appreciation of cause – effect and outcomes. Common adaptive policy approaches for anticipated conditions include Automatic adjustment; Integrated Assessment to inform policy parameters; and Multi-perspective deliberation.

The ability of a policy to adapt to *unanticipated* conditions is a newer notion. It is based on a holistic appreciation of system complexity, capacity, performance and dynamics. Common adaptive policy approaches for unanticipated conditions include: Formal review and continuous learning; Encouraging self-organization and networking; Subsidiarity; and Promoting variation.

These mechanisms are elaborated in the sections that follow.

Table 2. Framework for adaptive policies.

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Objectives	Adapting to anticipated conditions			Adapting to unanticipated conditions			
Analytical Basis	<i>Analysis of cause / effect and outcomes</i>			<i>Holistic appreciation of system complexity, capacity, performance and dynamics</i>			
Adaptive Policy Principles <i>(compiled from applications of complex adaptive systems in a range of sectors)</i>	<ul style="list-style-type: none"> ▪ Fine-tune the process¹ ▪ Integral to design are monitoring and remedial mechanisms² ▪ Understand carefully the attribution of credit³ 	<ul style="list-style-type: none"> ▪ Respect history¹ ▪ Understand local conditions, strengths and assets¹ ▪ Place effort on determining significant connections rather than measuring everything² ▪ Look for linkages in unusual places³ 	<ul style="list-style-type: none"> ▪ Gather multiple perspectives from range of stakeholders² ▪ Deliberative practice is critical to build trust and consensus⁴ ▪ Epistemic communities are important for policy learning⁵ 	<ul style="list-style-type: none"> ▪ Conduct selection¹ ▪ Policies should test clearly formulated hypotheses⁶ ▪ Evoke disturbance⁷ 	<ul style="list-style-type: none"> ▪ Create opportunity for self-organisation and build networks of reciprocal interaction^{1,7} ▪ Promote effective neighbourhoods of adaptive cooperation³ ▪ Facilitate copying of successes³ ▪ Ensure that social capital remains intact⁸ 	<ul style="list-style-type: none"> ▪ Match scales of governance and ecosystems⁷ ▪ Clear identification of appropriate spatial and temporal scale is vital to integrated management⁹ 	<ul style="list-style-type: none"> ▪ Promote variation¹ ▪ Promote variation, diversity and redundancy⁷
Adaptive Policy Approach <i>(see text for examples)</i>	Automatic Adjustment Some of the inherent variability in socio-economic and ecologic conditions can be anticipated, and monitoring can help trigger important policy adjustments to keep the policy functioning well.	Integrated Assessment Through a comprehensive and integrated assessment of policy parameters, policies can be crafted to perform well under a range of anticipated scenarios, and to perform well in a worst case scenario.	Multi-perspective Deliberation Multiple perspectives gathered through a deliberative process of stakeholder engagement offers the best chance to accurately inform policy design and to recognize and respond to emerging issues.	Formal Review & Continuous Learning Policy review undertaken on a regular basis even when the policy is functioning well, will help policies deal with “emerging” issues, and can trigger policy adjustments to conditions that could not have been anticipated.	Encouraging Self-organization & Networks For effective intervention in complex adaptive systems, leveraging (and not hindering) the self-organizing potential of people to address an issue is fundamental for effective policy intervention in complex adaptive systems.	Subsidiarity Subsidiarity recognizes that action will occur at different levels of jurisdiction, depending on the nature of the issue. It assigns priority to the lowest jurisdictional level of action consistent with effectiveness.	Promoting Variation Small-scale interventions for the same problem offers greater hope of finding effective solutions ¹ . Diversity facilitates the ability to persist in the face of change, and spreading risks is part of managing complex systems ⁷ .

References: ¹Glouberman et al. (2003); ²Holling (1978); ³Axelrod and Cohen (2000); ⁴Forester (1999); ⁵Haas (1992); ⁶Lee (1993); ⁷Berkes et al. (2003); ⁸Ruitenbeek and Cartier (2001); ⁹IUCN (2000).

Automatic Adjustment

The socio-economic and ecologic setting within which a policy is intended to perform will inevitably change over time. Some of this variability can be anticipated and monitoring can help trigger important policy adjustments to keep the policy functioning effectively.

This mechanism is informed by the following principles gleaned from the literature on complex adaptive systems.

- Fine-tune the process. Glouberman et al. (2003) note that “in complex systems, which change over time and respond dynamically to outside forces, it is necessary to constantly refine interventions through a continual process of variation and selection.”
- Monitoring and remedial mechanisms. Holling (1978) notes that integral to design are the monitoring and remedial mechanisms – these should not be post *ad hoc* additions after implementation.
- Understand carefully the attribution of credit. Axelrod and Cohen (2000) describe that the attribution of credit is the most problematic aspect of getting people to buy into a complex systems mindset. A common mistake in complex systems is to assign blame or credit to a small part of the system, when in fact the entire system is responsible. One of the most important elements of any policy discussion is the specific incentives facing individual agents.

Walker et al. (2001) provide some of the most lucid guidance directly relating to automatic adjustment. In their adaptive policymaking process, they recommend using *signposts for monitoring changes*, and to identify thresholds or *triggers for contingency plans*. More specifically, signposts are “indicators that should be tracked in order to determine whether defensive or corrective actions or a policy reassessment is needed.” Triggers are “critical values of the signpost variables that lead to implementation of defensive or corrective actions or to a policy reassessment.” *Defensive actions* are taken after the fact to preserve a policy’s benefits. *Corrective actions* are taken to adjust the basic policy in response to triggers. They also suggest that limits to the validity of the analysis should be established, such that “once violated, should lead to reassessment of the policy.”

From our field research we have observed four examples of automatic adjustment mechanisms in India and Canada, and interestingly, all from the insurance sector. Indexed-based weather risk insurance, which is being offered currently in India, is linked to the underlying weather risk defined as an index based on historical climate data, rather than the extent of crop yield loss. Unlike traditional crop insurance where settling a claim can take up to a year, private weather insurance contracts offer quick payouts triggered by independently-monitored weather indices (rather than farm loss sampling) and can improve recovery times thereby enhancing coping capacity. The automatic adjustment feature provides a simple mechanism for managing insurer risk and determining farmer eligibility for benefit payments, while also passing along incentives for farmers to adjust to long-term change by providing appropriate signals calculated on the basis of actuarial risk.

Two examples of automatic adjustment were introduced to the Canadian province of Manitoba’s crop insurance program in 2007. These include the *Pasture Drought Insurance Pilot Program* and the *Fall Frost Insurance Pilot Program*. The Pasture Drought Insurance Pilot Program is designed “to evaluate the need for a weather derivative type insurance program that compensates producers for losses to pasture production due to lack of rainfall as recorded at a specified weather station (MASC 2007a).” Producers participating in this pilot program do not need to submit a claim nor do they require an on-farm inspection of their pasture. This weather-

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triggered insurance program assigns an Environment Canada weather station to the producer's land and a claim is "triggered when their assigned weather station reports that rainfall within the area fell below 80% of normal." The Fall Frost Insurance Pilot Program is designed in a similar fashion (MASC 2007b).

This concept of automatic adjustment was understood even in the early days of crop insurance. An excerpt from the 1940 report of the Manitoba Economic Survey Board illustrates this clearly:

"Field representatives believe that the plan appealed more strongly in 1939 to farmers with high yields and low risks than to those on high risk, low yield land. If such is the case, the higher yields and low premium realities may be justified. However, there is evidence that in some counties, the level of insurance was somewhat too high. This has pointed to the need for an automatic control which has been incorporated into the 1940 program. Under this method, if the aggregate of individual insured yields and premium rates is out of line with the county actuarial data, a factor is applied to adjust them to the proper level (MESB 1940, p. 10)."

Integrated Assessment to Inform Policy Parameters

Another important mechanism facilitating the ability of a policy to perform effectively for anticipated conditions is using integrated assessment to identify important policy parameters, and building these parameters into the design of the policy instrument. The goal of this mechanism is to be as comprehensive and complete as possible in defining policy parameters at the outset. Such integrated assessment also enables a policy to perform well in a worst case scenario, or alternatively, to perform well across a range of possible future scenarios.

Integrated assessment for informing policy parameters should be guided by the following principles that are rooted in complex adaptive systems thinking:

- Respecting history. Glouberman et al. (2003) informs us that "complex adaptive systems are shaped by their past and knowledge of this history may suggest constraints on and opportunities on what can be done in the future."
- Understand local conditions, strengths and assets (Glouberman et al. 2003).
- Understand interactions with the natural, built and social environment (Glouberman et al. 2003; Holling 1978).
- Place effort on determining significant connections rather than attempting to measure everything (Holling 1978).
- Look for linkages in unusual places. It is important to assess strategies in light of how consequences spread (Axelrod and Cohen 2000).

One such example of integrated assessment to inform policy parameter observed in our policy research is the minimum support price (MSP) instrument for Agriculture Price Policy in Punjab, India. This policy takes into account a range of factors in determining minimum support prices, including changes in input prices, trends in market prices, inter-crop price parity and prices received by farmers.

The MSP instrument of the Agriculture Pricing Policy exhibited several features resembling adaptive policies and policymaking. One of the most prominent is the Commission for Agricultural Costs and Prices (CACP). The minimum support prices for major agricultural products are announced each year after taking into account the recommendations of the Commission for Agricultural Costs and Prices (CACP). The CACP takes into account all important factors including cost of production, changes in input prices, input/output price parity,

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trends in market prices, inter-crop price parity, demand and supply situation, parity between prices paid and prices received by farmers etc.

Another example is the variable transportation rate calculation in Canada's former Western Grain Transportation Act. A number of mechanisms were built into the rate calculation of the revised policy to help it perform effectively under a range of anticipated conditions. The most notable being that the rate, once fixed, would now be based on the railways' "cost of moving grain and intended to cover variable costs plus 20% toward constant costs." This cost was based on forecasts of grain volumes by the Grain Transportation Agency and on railway costs provided by the National Transportation Agency. The rate was also distance-based, designed to allow equal rates for equal distances (Producer Payment Panel 1994).

The United States Academy of Sciences provides some practical guidance for this adaptive policy mechanism. For example, Bankes (2002) suggest that "adaptive policies need to be evaluated on their *robustness properties*, not on their performance on any single case." They advocate that scenario analysis can be used to find cases that break a proposed policy, and that such worst cases can stimulate policymakers to modify the range of possible policies to allow for combinations that hedge against these worst cases (Bankes 2002).

As an example of a policy instrument that works in a range of conditions, consider the case of the Maharashtra Water and Irrigation Commission in Maharashtra, India in which water available from both surface and groundwater can irrigate at most 60% of cultivated land in the state. Excessive use of water (perhaps coupled with high fertiliser use) has also led to land degradation (Narayanamoorthy and Deshpande 2004). In such a situation, increased efficiency of water supply and use is a strategy for farmers that works in the face of climate variability and extremes. Successful examples of participatory irrigation management include the Katepurna project in eastern Maharashtra during, which achieved yearly water savings of 7.71 million cubic metres, with complete utilization of the irrigation potential, and good yield of cotton and wheat crops.

Multi-Perspective Deliberation

This adaptive mechanism positions a policy to be able to adapt to both anticipated and unanticipated conditions. Multiple perspectives gathered through a deliberative process of stakeholder engagement offers the best chance to inform policy design in a comprehensive manner, and to recognize and respond to emerging issues. This type of mechanism is supported by a range of sectors that are applying complex adaptive systems thinking.

- Gather multiple perspectives from range of stakeholders involved in the issue (Holling 1978)
- Deliberative practice is critical to build trust, collaboration, consensus, identity, values, hope and capacity for social action (Forester 1999). The outcome of deliberative practice (i.e. public decision-making which involves shared discourse, deliberation and social learning) is not abstract generalization, or discrete policy decisions, but shared meaning by the participants, and engaging narrative accounts of success or failure in their own terms (Forester 1999). Such processes, though time-consuming, have crucial transformative potential in creating new, shared vision which can motivate learning and policy adaptation.
- Public debate and social discourse are important tools to balance privileged access of technical expertise to power. (Steinemann and Norton 2003) comments that participatory processes offer opportunities for policy learning, in ways which differ from the learning models driven by expert, elite or advocacy networks.

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- Epistemic communities play a key role in policy learning – According to Haas (1992) at times of crisis or rapid change, when information is at a premium, epistemic communities (i.e., commitment to a common causal model derived from study and analysis of a common set of problems or policy linkages) can become more important and influential in the policy process. They can shed light on causal relations which had previously been unsuspected, quantify uncertainties for decision-makers, help re-define the interests of the state or of various political interests within it, and directly contribute to policy formulation (e.g. through framing alternatives).

As an example, in Manitoba, Canada to help contribute to the effective management of the provincial crop insurance program, farm producers have the option to participate on crop insurance boards, agencies and commissions, and to take part in reviews of the crop insurance program. For India's Agriculture Price Policy, the Commission for Agricultural Costs and Prices (CACPC) carries out state specific analyses for the cost of production in respect of various commodities. This is done through consultations with the State governments. After a meeting of the State Chief Ministers, the MSP/procurement prices are declared. Costs of production for the same crops varies between regions and also across farms within the same region and for different producers and this makes it a very difficult task to have a norm for the level of costs. In relation to the participatory irrigation management program in Maharashtra, India, Narayanamoorthy and Deshpande (2004) mention the untapped wisdom and local knowledge of irrigators, will help in taking quicker and more effective decisions.

Formal Review and Continuous Learning

Formal policy reviews are important for helping policies deal with unanticipated conditions. Such reviews, undertaken on a regular basis even when the policy is functioning well, will help policies deal with "emerging" issues. They can trigger policy adjustments to conditions that could not have been conceived at the outset. Additionally, the type of formal review advocated here is meant to create a closer integrated and iterative process between policy design and implementation. Taking a page from the adaptive management book, this mechanism is characterized as learning by judicious doing. In other words, policy design is never complete, because it is in a continuous state of testing, development and refinement.

This is in contrast to informal, *ad-hoc* review which is most often stimulated by unsolicited public pressure. While informal review will always remain an important aspect of policy learning and continuous adaptation, it is the intent of this mechanism to emphasize the greater role that systematic, or regularly scheduled formal review plays in policy learning and adaptation.

Formal review and continuous learning processes are grounded in principles for effective intervention in complex adaptive systems. Among these are:

- Conduct selection. According to Glouberman et al. (2003), in complex adaptive systems possible solutions undergo selection by the system. It is therefore important to include "evaluating performance of potential solutions, and selecting the best candidates for further support and development."
- Adaptive policies should test clearly formulated hypotheses. Lee (1993) advocates this notion of testing as being core to an adaptive policy. It involves understanding at the outset that the policy will need to learn and likely refine based on the observed behaviour of the ecosystem being changed by human use.
- Evoke disturbance. Berkes et al. (2003) propose that evoking disturbances in socio-ecologic systems is necessary for building resilience and adaptive capacity. Intuitively, those communities and ecosystems which have experienced shocks and stresses in the

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past, are more likely to have crafted the relationships, infrastructure and institutions that are needed to cope and adapt.

In our review of policies in India and Canada, we observed a variety of formal review processes. In Maharashtra, India, the Vaidyanathan Committee on Pricing of Irrigation Water, 1992, critically assessed the coverage and impact of water users associations (WUAs). The Ninth Five Year Plan (1999-2002) and the Maharashtra Water and Irrigation Commission (1999) formulated strategies to increase farmer participation in irrigation management. The mid term appraisal of the Tenth Plan (2002-07) reviewed the progress of takeover of irrigation systems by WUAs. It found that there were about 55,000 WUAs covering 10 million hectares, and aimed to increase this eight to ten times in order to cover all irrigated area. Except for Gujarat, it found that in most states Revenue Departments continued to collect charges and pass on a portion to WUAs for system maintenance. It has called for empowerment of WUAs to set tariff and retain a part of it, understanding barriers and simultaneously rehabilitating them so they are in a position to invest in infrastructure repairs and improvement. The Maharashtra State Water Policy also has a clause for review every five years.

In Canada, as part of a major overhaul of the Crow Rate policy into the now defunct Western Grain Transportation Act, a regular four-year review was carried out by the National Transportation Agency to take account of productivity and costing changes. Additionally, the Grain Transportation Agency was created to ensure the freight transport system remained efficient, reliable and effective with the objective of maximizing returns to producers.

We observed three examples of policy pilots in our review, all from the insurance sector. India's weather-indexed insurance was introduced on a pilot basis, as were the Pasture Drought Insurance and the Fall Frost Insurance pilot programs in Manitoba's crop insurance program.

The role of policy pilots is elaborated on here to emphasize their importance as a means for implementing adaptive policy. A recent review conducted by the Cabinet Office in the United Kingdom (UK 2003) focused on the role of pilots in policy-making. The study noted that "an important innovation in recent years has been the phased introduction of major government policies or programmes, allowing them to be tested, evaluated and adjusted where necessary, before being rolled out nationally (UK 2003)."

Among the recommendations made in the U.K. study, three in particular are relevant to adaptive policies and policymaking in the context of this paper. The first is: "a pilot should be undertaken in the spirit of experimentation. If it is clear at the outset that a new policy and its delivery mechanisms are effectively already cast in stone, a pilot is redundant and ought not to be undertaken." A second recommendation from the study deals with extending the notion of piloting beyond just an initial stage to "a continuous processes of accumulating policy relevant evidence." A third recommendation of the policy pilots study is that "appropriate mechanisms should always be in place to adapt (or abandon) a policy or its delivery mechanism in light of a pilot's findings."

These recommendations speak directly to the primary thrust of the notion of adaptive policymaking presented previously by Walker et al. (2001), which was for learning and adaptation of the policy to be made *explicit at the outset* and the inevitable *policy changes to become part of a larger, recognized process and not forced to be made repeatedly on an ad hoc basis*. So while policy pilots as they are being used most typically today are an important part of the initial stage in the life of a policy, the U.K. study concludes by making a call for the basic premise of testing, learning and adapting to become part of the ongoing policy life cycle.

Encouraging Self-Organization and Networking

For effective intervention in complex adaptive systems, leveraging the self-organizing potential of people to address an issue is perhaps the most commonly cited principle.

- Create opportunity for self-organisation and networks of reciprocal interaction. (Berkes et al. 2003; Glouberman et al.; Axelrod and Cohen 2000). Glouberman et al. (2003) recognize that complex adaptive systems “often spontaneously generate solutions to problems without external input or formally organized interventions...This self-organizing capacity is a free good that can be valuable in producing innovative and novel approaches to problems.” Berkes et al. (2003) cite this as one of four important principles for building resilience and adaptive capacity in socio-ecologic systems.
- Promote effective neighbourhoods of adaptive cooperation. Axelrod and Cohen (2000) note that like-minded individuals engaging in adaptive cooperation is usually the best long-term learning strategy. “If such neighborhoods can be identified, they should be used as the learning structure.”
- Facilitate copying and variation. Ruitenbeek and Cartier (2001) ascribe that “options should not be unilaterally removed, and that potential avenues of investigation should not be blocked. Agents should not be unduly hindered in their ability to change their strategies.”
- Ensure that social capital remains intact. Ruitenbeek and Cartier (2001) suggest that foremost for intervention in complex adaptive systems, policies must *ensure that social capital remains intact* – if local groups and their networks are disempowered individually or collectively, existing social structures are in effect invalidated and undermined.

A clear example of self-organization potential and its benefits was revealed in our analysis of devolved decision making of the Manitoba Conservation District (CD) Program in Canada. Under this provincial-level program, CD Boards are made up of local stakeholders that are able to make spending decisions based on their on-the-ground needs and changing circumstances. In this case example, the adaptive capacity largely was rooted in the initiative of the individual CD Boards. They were given some money and a fairly broad decision making mandate, within a specified institutional structure. Thus they were able to develop new ideas or make use of good ideas developed by others, in meeting what they felt to be the local priorities.

The encouragement of self-organization and networks is demonstrated through the formation of the Saskatchewan Soil Conservation Association (SSCA), through a grass-roots based awareness for the need for soil conservation practices and outreach. The SSCA incorporates networking and social capacity building through its programming, including its annual conference, extensive meetings and educational events and more specifically, through its “farmer to farmer program” that creates networks between those seeking information on an issue and those that are knowledgeable about it.

In another instance, the Ministry of Water Resources, Government of India in 1985 asked each Command Area Development Authority to introduce aspects of participatory irrigation management (PIM) in a small part of each command area as an experiment, and offered monetary incentives to farmers to form water users associations (WUAs). Formal PIM is said to have been introduced in Maharashtra in 1986, with the creation of three WUAs. By April 1998, 162 WUAs had been handed control over operation and maintenance of irrigation system below minors over a command area of 62,700 hectares. The WALMI (Water and Land Management Institute), Aurangabad, was created to train WUA office bearers and irrigation department officials in PIM. WUAs should actively involve the members inculcating amongst them a sense of ownership of

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the irrigation system (GoM 2005a). Water will be provided only through the WUA to its members. They would benefit from assured water supply, and can decide cropping patterns accordingly. It is their responsibility to administer the irrigation system and to collect charges to be financially self-sufficient.

Subsidiarity

This mechanism of subsidiarity increases the potential for a policy or policy instrument to be able to adapt to unanticipated conditions. Subsidiarity recognizes that action will occur at different levels of jurisdiction, depending on the nature of the issue. It assigns priority to the lowest jurisdictional level of action consistent with effectiveness (IISD 1994). In many respects, this mechanism is quite closely linked to self-organization. By devolving decision-making to as close to the ground as possible, the ability to self-organize is facilitated. This mechanism of subsidiarity is rooted in the following principles for effective intervention in complex adaptive systems:

- Matching scales of governance and ecosystems – Berkes et al. (2003) note that common pool resources users, closely connected to the resource system, are in a better position to adapt to and shape ecosystem change and dynamics than remote levels of governance.
- Clear identification of the appropriate spatial and temporal scale is vital to integrated management – In articulating the ecosystem approach for sustainability, IUCN (2000) remind us that policy and management efforts must be preceded by a careful determination of the best spatial scale at which to manage and govern a complex issue.

The Conservation District (CD) program in Manitoba is an example of subsidiarity. The provincial government has created a set of institutions – the CD Boards, and given them well regulated structures. But they do have fairly wide decision making latitude, as our seven examples show. So the instrument itself is inherently adaptive, in that the CD Boards, made up of local stakeholders, are able to make spending decisions based on their locally-grounded view of the needs and changing circumstances. Interestingly, the conservation district that is proving most effective at managing land drainage issues is the only CD which was defined based on watershed boundaries, involving parts or all of 15 rural municipalities. The review process for land drainage centers on the concept of building and maintaining solid local partnerships between neighbouring farmers, rural municipalities, provincial regulators, and other community stakeholders. Only one project review meeting occurs – in the field, at the actual site of the proposed drain work.

In Maharashtra, India, under the Maharashtra Management of Irrigation Systems by Farmers Act, 2005, water users associations (WUAs) would receive assured water supply, and have the freedom to decide cropping patterns accordingly, and distribute water to individual farmers. The underlying principle is that users can best understand the demand and supply position of water and make decisions accordingly. McKay and Keremane (2006) found that WUAs in Maharashtra have been successful in devising and enforcing the rules for water distribution, fee collection, and conflict resolution for over a decade.

Promoting Variation

Promoting variation is an important mechanisms for positioning policies to adapt to unanticipated conditions. This mechanism is strongly rooted in principles for intervening in complex adaptive systems and building resilience. For example, Glouberman et al. (2003) recommend that policy interventions should *promote variation* because “*introducing small-scale interventions for the same problem offers greater hope of finding effective solutions.*” This is based on the

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understanding that “many interventions will fail and that such *failures are simply a feature of how one develops successful interventions* in complex adaptive systems (Glouberman et al. 2003).”

Berkes et al. (2003) also recommend that by promoting variation and redundancy, communities can build resilience and adaptive capacity. Diversity, they note, provides a community with the ability to persist in the face of change. Spreading risks and creating buffers is part of managing complex systems. Ecological and social memory plays an important role in diversity, because it “provides a framework for accumulated experience for coping with change.

One such example of diversity is the crop insurance program in Canada’s Manitoba province. This program has evolved from a single insurance option pertaining to all crop types and one or two specific types of natural hazards, to a multitude of coverage options for different crop varieties and hazards. This evolution has been a response to the diversity of risk faced by farmers in the prairies. Similarly in India, weather-indexed crop insurance is being implemented on a pilot basis for various crops and locations through different types of delivery modes in India. Also with respect to weather-indexed insurance, this policy instrument protects farmers’ overall income, rather than being restricted to yield from a specific crop.

India’s Agriculture Price Policy in Punjab is another example of variation and diversity. This policy sets remunerative prices with a view to encourage higher investment and production using a range of policy instruments such as Minimum Support Price, Procurement Prices, Public Distribution System and zonal restrictions.

Conclusions

We endeavour through the research described in this paper to assemble a pragmatic set of approaches and tools for adaptive policymaking (as summarized in Table 2). Any policymaker needing to address a complex issue in a highly dynamic and uncertain setting, can benefit from these insights.

We have learned through this past century that policymaking is certainly not mechanistic. Bismark, the 19th century German chancellor likened policymaking to sausage making! Not always a pretty process. As we navigate progress in the 21st century, we must learn to see policymaking as adaptive – quite like gardening: muddy, attentive and experimental, because we really don’t know what growing conditions will prevail.

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