PAPER

7

BROKERING THE LOCAL\GLOBAL DIALECTIC

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ABSTRACT: The relationship between the experts who produce counterfactual knowledge, and the individuals who apply it, is central to the challenge of responding to climate change. Awareness of the possibility of human induced climate change is foremost a product of modern science, yet local access to this highly abstract knowledge is necessarily limited. Alternatively, access by experts to the particularities of local circumstances, typically presumed by various methodologies of rational analysis, is also inherently limited. In this chapter I adopt the position that a local\global dialectic exists in the context of climate change adaption; the challenge is to broker this relationship towards actions beneficial to local stakeholders. I develop a heuristic that is intended to aid in the exchange of knowledge between highly abstract, synoptic planning systems versus experientially and procedurally rich, local systems that are oriented to the particular. This method is intended to identify and complement the competencies of both systems within the context of climate change adaptation action. A specific case study which partners a high level of local planning acumen, (i.e. the planning community within the Regional Municipality of Halton) with expertise in climatic modeling and impacts (i.e. the Adaptation Impacts Research Division of Environment Canada) is used to demonstrate the utility of the method.

Keywords: climate, climate change, adaptation, counterfactual knowledge, local global dialectic, planning, reflexive modernization

1. Introduction

The necessity of adapting to human induced climate change is often interpreted as an imperative of planning. It is presumed that a proactive, systematic, and coordinated consideration of future-oriented possibilities (counterfactuals) is far more efficient, and offers greater opportunities for attaining multiple social objectives (i.e. an equitable distributions of wealth or risk (Beck 1992) than adaptation that emerges solely through reactive, individualistic responses to local circumstances, or market conditions. In this view, planning is understood as an overarching or top down, hierarchical operation which rationally (scientifically) considers options (possibilities) over extended scales, and then aligns system components to realize preferred system state(s). Taken *prima facie*, planning is a powerful mechanism for coordinating and directing human activities which should be vastly extended to minimize the unprecedented impacts of climatic change.

Unfortunately the promise of rational synoptic planning has often been unmet (Ackoff 1979; Churchman 1967; Lindblom 1959). Its informational requirements are enormous and are based upon a model of knowledge that is inherently flawed. At a very fundamental level, knowledge can never be complete due to the finite capabilities of the human mind and the inaccessibility of 'reality[1]'. Instead, heuristics are employed to break apart our perceptions into easily digestible portions (i.e. to classify), which are then related through theoretical constructs. These constructs can then be used to project future relationships between phenomena that can be used to inform human agency and planning. Unfortunately, the more one seeks to include phenomena into such a system, the more recalcitrant the system becomes in representing particularities (Toynbee 1961). As the system *seeks* completeness or unity[2], a tension emerges between theoretical generalities and the uniqueness of phenomena which is reflected in: the variance between historical and general knowledge, the distinction between disciplines, and the form of various structural heuristics (i.e. binary oppositions, strategic versus operational planning, top-down versus bottom-up[3], etc).

More recently there has been a trend to acknowledge the importance of local, or particular phenomena\drivers in planning systems, and to incorporate such factors through consultative or bottom-up methodologies (Beck 1992; Cohen 1997a). Though an important counterbalance to the over-emphasis on abstract, synoptic rational planning systems (Churchman 1967; Lindblom 1959), neither bottom-up nor top-down systems are complete in, and of themselves. Any attempt to focus on temporally and spatially particular knowledge inevitably becomes too unwieldy. *"In principle we could describe every site of the Earth's surface as a unique thing-in-itself, as in strict logic it is. But even if this were practically feasible, it would take us nowhere; the mere bulk of facts could not be grasped by the human mind; we must classify and that implies evaluation"* (Spate 1957). Yet, the most we can definitively say of these two forms of knowledge (i.e. the particular and the general) is that they are complementary in a heuristic sense (i.e. within the context of planning), not an absolute sense (i.e. within the context of the notion of truth).

As an interplay between the producers of scientific knowledge and their target audiences, the goals\products of scientific practise can no longer be presumed to reveal *truth*, or identify *best or optimal solutions*. Allusions to completeness

1 Kant makes a clear distinction between what we perceive (phenomena), and a thing (object or event) that exists in itself, but cannot be grasped through our senses (noumena). The quest for truth is therefore regulative, and cannot be realized. Similarly, a complete or holistic view of the world is not attainable, but serves as a useful heuristic to encourage the integration of knowledge which is always incomplete or fragmentary.

2 According to Tonybee (1961) "The human mind seeks unity but cannot approach it without paving the path with dichotomies. This is similar to Levi-Strauss' (1966) structuralist argument for binary oppositions. We do not comment on the validity of this proposition, but rather adopt it for its heuristic value.

3 See the IPCC's discussion of top down and bottom up in Working Group II, Chapter 2, Page 236. (IPCC 2007)

or certainly of knowledge[4], as manifest in various analytical methodologies or frameworks, has been removed from informed discussion[5]. Lindblom (1959) and Churchman (1967) make it clear that the assumption of synoptic or complete rationality in planning systems is not only inadequate in a methodological sense, but illegitimate in an ethical or professional sense. This disciplinary self-awareness occurred early in the evolution of Management Science and Operations Research (Ackoff 1979; Churchman 1967; Lindblom 1959; Rittel and Webber 1973), yet the full implications of such insights were obscured by continued attempts at *salvaging* a *'core rationality'* (Beck 1992). It is now clear that disciplinary self-critique[6] is part of a larger, reflexive trend in science as seen in the sociology of Mannheim, in the falsificationism of Popper or in Kuhn's historical critique of normalivism in the theory of science (Beck 1992).

> In the model of primary scientization ... (r)esults worked out scientifically ... are enforced in an authoritarian way from top to bottom. Whenever this encounters resistance, irrationalities must still hold sway, according to the self-understanding of the scientists, and these can be overcome by `raising the level of rationality` among practitioners. This authoritarian model of deductivist application can no longer be maintained under the conditions of reflexive self doubt of the sciences. (Beck 1992)

In this chapter, a perspective is adopted that moves away from either a top-down or a bottom up methodological framework. An approach is developed that will allow planners to envision the tension between the highly abstract counterfactual knowledge associated with climatic change and local knowledge associated with the lives of stakeholders in particular localities. This chapter suggests that the relationship between the users and producers of scientific knowledge has changed so profoundly that it must be explicitly represented and considered in the planning process. In so doing, a local\global dialectical (LGD) framework is offered in the context of climate change adaption; the challenge will be to broker these relationships towards beneficial action. This chapter begins by describing a simple planning system with a discussion of its inherent limitations. This model is then extended to take advantage of both local and global knowledge in the context of current methodological and theoretical trends.

4 See Dewey's (1929) 'The Quest for Certainty'.

5 "Uttering the word 'truth' in scientific circles signals ignorance, mediocrity, unreflected use of ambiguous, emotion-laden words from everyday language" (page 166) - Beck, U. (1992)

6 Or *nest-fouling* as Beck (1992) would call it.

2. Adaptation Planning

The simplest adaptive system[7] consists of an actor, or population of actors, which responds directly to changes or perturbations in its environment (see Figure 1). Such systems are *simple* in that they are not anticipatory, nor are they directed; individual action is initiated only *after* an environmental event (change) has been experienced by an actor[8]. In our case this means that a change, or succession of changes in climate (or the impacts of climatic change) must first be detected and\or experienced before adaptive action is undertaken. Various biological (i.e. evolutionary systems) and socio-economic (i.e. economic markets) systems are presumed to operate quite successfully under this guise of unconstrained myopic, individualistic behaviour (i.e. the adaptationist argument (Kates 1997)).

Nevertheless, the *simplicity* of this fundamentalist perspective is deceptive; biological and socio-economic systems are a complex mix of physiological, social, behavioral and cultural traits which have developed over expansive periods of time to deal with environments that may hold little resemblance to current conditions[9]. In other words, although such systems have shown themselves to be exceedingly robust, they are nevertheless the product of an historically specific evolutionary process (Gould 1986) and can therefore fail[10] under unique or novel conditions.

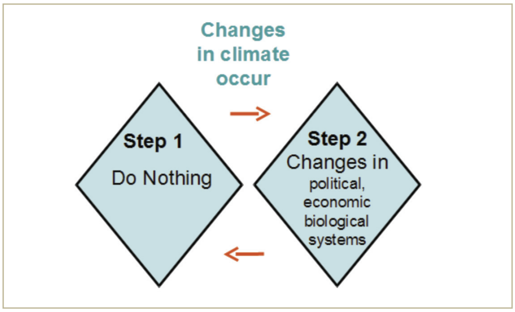


FIGURE 1
Simple two-stage climate change adaptation response system.

7 Although the term *system* may now appear intuitive, it is often difficult to determine where one system starts and another system ends Tansley (1935). See Herbert Simon's (1981) discussion on inner and outer systems.

8 The term *actor* is used to denote an individual or as a population of individuals.

9 This concept is understood as the *discordance hypothesis* (Eaton *et al.* (1988); it notes that evolutionary systems require time scales on the order of millennium to affect genotypic change and my thus be out-of-sync with current conditions. There has also been some discussion of the evolved nature of economic systems in the context of current conditions (Hirshleifer,. 1977).

10 In an extreme sense there is always the possibility of market failure, societal collapse, or ultimately extinction (Leslie, 1996).

Alternatively, a proactive, response system anticipates change and takes directed action in accord with those projections[11] (see Chapter 1). The advantages are clear insofar as knowledge about the future can be used to prepare for the future, either by changing (influencing) external or internal systems. The simplest of such decision frameworks (see Figure 2) involve three successive steps: 1) determining future climate; 2) determining the impacts of future climate change; and 3) formulating and implementing a response(s) (Fussel 2007). This approach is dependent upon the production of future-oriented, counterfactual knowledge in the form of climate projections (see (Weart 2003)) against which impacts are assessed, and courses of actions evaluated. A fourth overarching step 4) includes intentional learning (i.e. adaptive management techniques, or reflexive methodologies) which can be applied to the previous three stages. Given the intimately coupled nature of such systems, developmental programs often seek to create integrated support platforms that incorporate all these elements to generate strategic solutions applicable across scales.

In a practical sense, such systems combine information, computer and non-computer based tools and services, in a structured procedural framework that is intended to improve both the process and outcomes of decision-making. Unfortunately this necessarily structured, one-system-fits-all approach can have serious limitations. Monolithic systems ignore the diversity of adaptive mechanisms, the particularities of local decision-making, the uncertainties in projecting future possibilities and responses, the evolving nature of knowledge\techniques, and the tradeoffs and synergies that exist between individual and societal goals. In fact, no discrete system can seamlessly bring together all these elements in a manner that identifies the correct or optimal adaptive strategy. According to Fussel (2007) the basic linear decision framework is complicated by factors such as current climate variability, future climate change, non-climate factors and their development; policy and management context; current and future climate risks; sustainable development goals; mainstreaming of adaptation; and other policy criteria such as political structures, markets, entitlements, and cultural norms.

11 "Modernity is inherently future oriented such that "future" has the status of counterfactual modeling. ... Anticipations of the future become part of the present ..." (Giddens 1990).

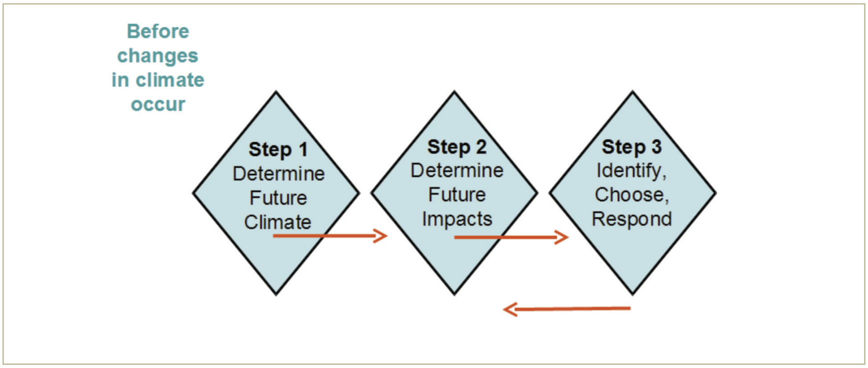


FIGURE 2
A three-stage (task), proactive climate change adaptation planning process, as widely acknowledged in the literature.

Developing a workable decision support system to deal with all these contingencies, is not simply a matter of overcoming technical, institutional and logistic barriers. The problems these systems seek to address are hyper-complex or wicked (Conklin 2005; Rittel and Webber 1973): a) they have no correct formulations; b) there are numerous stakeholders, and perspectives; c) there are no stopping rules; d) no criteria to judge 'goodness' of decisions exists; e) there is an inability to test decisions except by execution; and f) no enumerable or exhaustible describable set of possible solutions exists (Rittel and Webber 1973). And there is no way around such *hyper-complexity* through further scientization (rationalization); even if scientific results do not openly contradict each other *"they do not complement each other either, but generally assert different, even incomparable things"* (Beck 1992). In other words, no single answer exists for such decision support systems to find, which *virtually force[s] the practitioner to make his own cognitive decisions"* (Beck 1992).

Rather than 'solving' such problems, Roberts (2000) suggests three coping strategies that have typically been employed to deal with them: authoritative, competitive and collaborative approaches. Authoritative strategies place the problem in the hands of a few stakeholders who have the authority to define the problem and devise a solution. Alternatively, competitive strategies assume a 'zero-sum game' wherein the winner acquires the power to define and solve the problem. Thus while authoritative strategies artificially diminish the inherent level of social conflict in resolving such problems, competitive solutions harness it. Both approaches may be unsatisfactory in that they access a limited set of solutions, and typically lack a broad base of support for implementation.

Collaborative strategies on the other hand, seek win-win solutions by joining stakeholders in a collective framework to assume a 'variable sum game' which seeks to 'enlarge the pie' for all parties involved (Roberts 2000). Partnerships, and alliances (i.e. between governments, businesses, NGOs and citizens groups) seek collective understanding of the problem and its resolution. And though more players make the process more complex, they also expand the potential for creativity by providing input into an evolving, future-oriented planning process (Conklin 2005). A diversity of mechanisms or techniques exists to facilitate such collaboration as evident in the climate change adaptation literature (IPCC 2007) and expressed through a local or sectoral problem-solving orientation that highlights the unique or particular aspects of each case.

> The rational-choice, hierarchical, means-end model of politics (which was probably always fictitious, but cultivated for a long time by bureaucracy research and decision theory) has begun to crumble. It is being displaced by theories that emphasize consultation, interaction, negotiation, network: in short, the interdependency and process character in the context of the responsible, affected and interested agencies and actors from the formulation of programs through the choice of measures to the forms of their enforcement. (Beck 1992)

The generic solution for 'solving' complex dilemmas would therefore appear to be the empowerment of local stakeholders. Under the pretext of decentralisation, polyarchy, mainstreaming and/or re-embedding, the climate change adaptation community has favoured participatory approaches (Chapter 2), which permit local stakeholders to guide the decision process (Cohen 1997b). This trend would appear to diminish the top-down influence of higher levels of government (national or federal) and their technocratic solutions. Yet the local\global nature of the climate change issue precludes a total devolution towards the local: 1) a ton of carbon emitted locally by any means (e.g. running an air conditioner, producing cement, driving a car, etc.) affects the entire world's climate, thus both a global as well as a local solution is required; and 2) the expertise required to project future climate regimes is simply not available locally. As such, it is unlikely that the world will *"collapse outward into decentralized organizations"* but will rather *"interlace the local and the global in complex fashion"* (Giddens 1990).

3. The Local Global Dialectic

Science has fundamentally changed our relationship with the environment. Expert knowledge does not just provide a passive calculus of risks and benefits, it creates the universe of events in which we exist (Giddens 1990). In the case of climate change, the abstract knowledge systems that form the basis of the industrial revolution have not only provided the technical foundations of modernity, but facilitated a massive release of stored green house gases, thereby creating the potential for an unprecedented ecological crisis. And while the lay person[12] must ride this *juggernaut,* general public acceptance is less a *"leap to commitment"* than an acceptance of circumstances in which alternatives are largely foreclosed (Giddens 1990).

Ironically, as the physical impacts attributable to science have increased, the social influence of scientists has diminished. This is not so much the result of external action on the part of the public (e.g. a backlash against the dominance of the techno-scientific community) as a trend within science itself. The scepticism of science has been successfully turned back upon itself, resulting in a *demonopolisation of scientific knowledge claims* (Beck 1992). In other words, scientists can no longer claim to reveal truth, nor the social status that went along with this role. They are forced more and more emphatically to *"display before the public their awkwardness, all their limitations and their birth defects, all of which have been well known internally"* (Beck 1992). The subsequent decline in the authoritarian power of science has profound implications for the relationship between experts and the lay public.

As experts compete amongst themselves for academic currency their individual findings become less and less definitive as a basis for influencing public policy, and decision making, thereby opening the door for other producers of knowledge. The traditional distinction between *lay public and experts shrivels* (Beck 1992) as both become involved in the production and validation of knowledge claims. This is a *dialectical* process because although the globalizing mechanisms of science continually impose new knowledge claims upon localities (i.e. directly through education, or indirectly through technological advances, etc.), the interpretation and acceptance of these claims lies in the hands of locally embedded individuals. Outcomes are therefore not necessarily generalizable from global influence to local manifestation, but consist in mutually opposed tendencies. The local and the global, in other words, have become inextricably

12 And as Giddens notes (1990) we are all *lay public* when confronted with environmental issues. As an endeavor to understand the environment and our impact upon it, science has become so specialized that all anyone can hope to master is one small niche of the overall process.

intertwined in a dialectical interplay, where globalizing forces become manifest through local action (Giddens 1990).

For the target groups of science, such changes open up new possibilities of influence and development in the processes of production and application of scientific results (Beck 1992). Scientific knowledge is augmented by external public input through scepticism, selection, sorting, and by deliberate enrichment with practical knowledge (i.e. chances of adoption, informal power relationships and contacts and the like) (Beck 1992). Reflexive scientization therefore opens the door to the criteria of *usefulness* in assessing the value of knowledge. This is clearly a pragmatic[13] interpretation in that it assesses a concept or idea's meaning in relation to the *"conduct it is fitted to produce"* (James 1907). This primacy of action, also lies at the basis of Giddens' (1990) *radical engagement* with the processes of modernization[14], and is the foundation for new forms of science (i.e. Mode 2 (Gibbons *et al.* 1994), post normal (Funtowicz and Ravetz, 1993), Triple Helix (Shinn 2002).

The goal of the following exercise will be to create a framework for *brokering* the relationship between the producers and the users of knowledge towards adaptive action (a pragmatic mandate). This is accomplished by embedding local stakeholders more directly in the global production of scientific knowledge through a process of scientific disclosure, feedback and learning. The state of climate change adaption science will be presented to practitioners through a bibliometric analysis (Chapter 2), in a regulative act of holism. The interpretation and application of this information will then be facilitated or *brokered*, towards local action. Local response will then feed back into a national framework to inform scientists and facilitate reflexive consideration of research priorities, the further development of methods, and knowledge production.

4. The Heuristic

Awareness of the possibility of human induced climate change is foremost a product of modern science, yet local access to this abstract knowledge is limited by a highly skewed distribution of expertise. Equally problematic is the constrained access of analysts to local particularities (i.e. determinants of the

13 Pragmatism is derived from Greek pragma, means action, from which our words 'practice' and 'practical' come.

14 The other adaptive reactions include: 1) Pragmatic acceptance: concentration on surviving, the events as they occur are outside the realm of individual influence; 2) Sustained optimism: a continued faith in providential reason – technological solutions can be found; 3) Cynical pessimism: cynicism used to dampen the anxieties of potential catastrophes (Giddens 1990).

initial conditions and parameters in their modelling exercises)[15]. For understanding and acting upon *"concrete phenomena, be it in nature or in society, both kinds of knowledge .. the [particular] and the theoretical .. are equally required"* (Hayek 1955). The Local Global Dialectic (LGD) heuristic presented here, presumes that a two-way relationship exists between the local and the global, which may be formalized to facilitate both forms of knowledge production, as oriented towards pragmatic action.

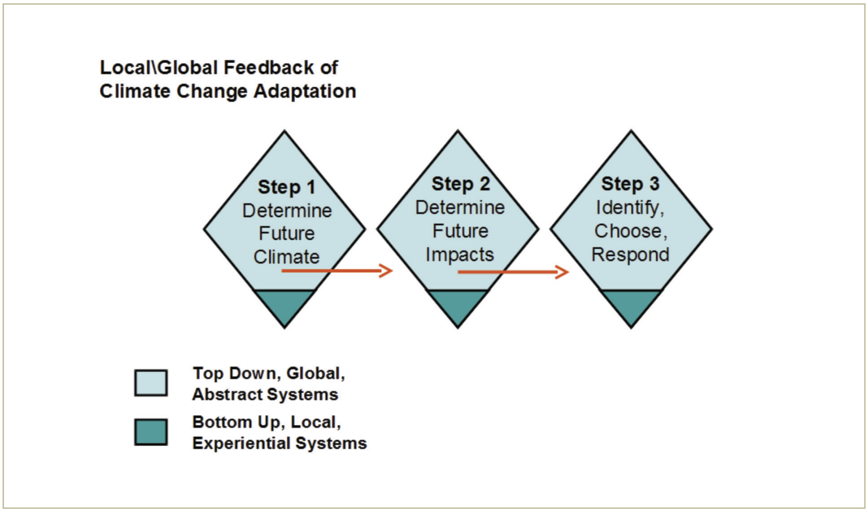


FIGURE 3
A three-stage (task), proactive climate change adaptation planning process, illustrating the distinction between the producers of generalizing counterfactual knowledge (light blue portion) and the producers of experiential, locally oriented knowledge (dark blue portion). This figure is indicative of a local\global dialectic (LGD), where abstract expert systems dominate the adaptation process.

As seen in Figure 2, a proactive climate change adaptation system is composed of three basic parts: 1) determining future climate; 2) determining the impacts of future climate change; and 3) formulating and implementing a response(s). Figure 3 expands upon this illustration to include the traditional distinction

15 Herbert Simon's agent of limited cognitive means is the satisficer (Simon, 1956).

between those whom produce scientific knowledge and those who consume it. The diamond shape is representative of a single structured task[16] within the overall planning system. Its shape loosely indicates where *effort* (i.e. in the form of research or analysis undertaken by individuals or institutions) occurs along a vertical gradient of abstraction that moves from highly theoretical knowledge at the top, to pragmatic or applied knowledge at the bottom. In an idealized sense, most effort occurs towards the middle of the diamond (the bulge), but implicit involvement in particular tasks also comes from either end of the spectrum: from theoretical scientists at one end, and from the lay public at the other end.

In the first task (Step 1 in Figures 2 & 3), various groups of climate modellers produce a base set of climatic scenarios as standardized in the IPCC SERS framework (IPCC 2000). This scientific activity represents the top tip of the diamond figure. Generally speaking though, more experts (scientists, planners and policy makers) are involved in interpreting, and\or regionalizing these scenarios as represented in the middle bulge of the diamond. Local involvement is typically not a large part of the Step-1 process (the lower half of the diamond), but is implicit insofar as the need for regionalized downscaled scenarios has been a policy priority of government since the middle 1980s (Weart 2003).

Step-2 (the second diamond) in Figures 2 & 3 is also dominated by scientists insofar as expert knowledge is typically used to project the impacts of climate change upon the subjects of various arenas of research. This diversity is readily apparent in the wide cross section of disciplines that produce climate change sectoral analysis as seen in the CCA bibliometric (Chapter 2) analysis represented in Table 1. Once again, a small number of more theoretically minded individuals typically supply a discipline with its abstract and technical background, which is then applied by greater number of practically oriented researchers[17] or planners. Local knowledge is implicit in this task, as the particularities of local ecological, sociological, cultural and economic conditions become part of the analysis.

Step-3 of Figures 2 & 3 is also dominated by highly trained professionals who produce knowledge which can then be applied locally with minimal public input. Operations Researchers and Management Scientists (Winston 1990) have developed powerful analytical techniques including: queuing theory, dynamic

16 This could be represented by a work contract, a deliverable, an output from a planning process etc.

17 Of course the same researchers often both produce and apply theory, but for our purposes we will assume an idealized distinction.

TABLE 1

Classification of the climate change adaptation literature (adapted from Paper 3 of this volume).

Climate Change Adaptation

Theories Concepts 11%	Academics 28%	Methodology 16%	Sectors Res. 61%	Place 57%
Adaptation 17%	Economics 8.9%	1 Data 17.5%	Agri. 19.9 %	Land-use Policy Issues 4%
Adaptation & Mitigation 22%	Political Sc 8.1%	2 Predictive 12.5%	Water 16.6 %	Local 9.4%
Adaptation, Mitigation & Sustainable Development 11%	Sociology 4.7%	3 Vetting 30.0%	Forestry 7.4 %	Regional (National) 18.2%
Vulnerability' & Resilience 17%	Develop. 2.9%	Scale 9.38%	Health 5.1 %	National 19.6%
History, Integration Scale etc 33%	Ethics 2.3%	Integration\Testing 23.75%	Infra. 4.3 %	Regional (International) 9.8%
	Communication & Edu. 1.0%	Uncertainties\Risk 6.88%	BioEcosys 2.7 %	International 1.7%
	Psych. 0.4%		Tourism 1.5 %	
	Anthro. 0.4%		Energy 1.5 %	
	Law 0.4%		Fisheries 1.0 %	
			Emerg. 0.7 %	
			Transport 0.3 %	
			Service S. 0.1 %	

programming, linear programming, simulated annealing, multi-objective analysis, AHP, etc., to rationally identify appropriate or optimal solutions. The advantages of such techniques lay in their ability to augment decision-making processes in light of finite human computational capabilities (MacLellan 2006) and faulty decision heuristics (Kahneman 1994; Tversky and Kahneman 1974). Such methods point to solutions that could not have been anticipated either intuitively, or through collective decision making processes.

Nevertheless, the knowledge and techniques provided by expert systems are ultimately limited with respect to wicked or hyper-complex problems (Roberts 2000). It is now evident that science cannot (and never could) provide the all encompassing, big answers to complex inter-related problems; *"the flood of findings, their contradictoriness and overspecialization, turn reception into participation, into autonomous process of knowledge formation with and against science"* (Beck 1992). Yet it is not solely a question of becoming more inclusive; from the perspective of minimising the detrimental (maximising the positive) effects of climate change[18], achieving greater collaboration or equality between the local and the global is not the primary goal (although it may be the best means to obtain it). Rather, the inclusion of participants is dependent upon what they can bring to the process.

18 This is not to suggest that justice and empowerment are superseded in our considerations, only that there are other valid reasons for the inclusion of local participation.

'Core competency' (Prahalad and Hamel 1990), indicates the particular strengths of an actor in terms of their knowledge, skill set, and cultural attributes, relative to other actors. It is a broad term used in business to represent numerous inter-related factors that go towards the competitive production of a product which has value to consumers. Its underlying message is that agents should focus on what they do well (i.e. their competitive advantages) in the context of system goals. In the sense that we appropriate the term, it suggests assigning suitable tasks in the overall decision process based upon the relative skills\knowledge\roles of the various actors (i.e. the local and the global representatives).

This does not imply that one definitive orientation of system resources exists, or is somehow best. *A different computer, a different specialist, a different institute [results in] a different 'reality'* (Beck 1992) and thus, a different set of potential decisions and actions. It is rather in revealing structural options to the participants of the process, that the LGD heuristic has merit. This is based upon the premise that decision makers and stakeholders will be in a better position to make decisions if they understand the decision process, including the individual and institutional roles of its various participants. The purpose of the heuristic therefore, is in representing or visualizing the mix of system resources in a way that exposes the relationships, roles, and core competencies between the various actors. In providing this perspective, the assumptions of the system as a whole become open to local interpretations and preferences, as well as reflexive consideration.

As we move from Figure 3 to Figure 4 our focus changes from dominance by experts systems to local systems of knowledge production and decision making. Nevertheless, Step-1 remains firmly within the domain of climate modellers since it is the modelling community which produces the counterfactuals upon which the issue of climate change is based. It is of course trivial to state that such analysis cannot be undertaken in every locality, but this does highlight the special status of this academic community and suggest implications for decision making (e.g. the requirement of trust in these highly abstract systems (Giddens 1984) and the need for appropriate safeguards). For Steps 2 and 3 though, emphasis can fundamentally shift towards local involvement and decision making. In Step 2, future impacts can be ascertained by having locals identify responses to past climate extremes. And in Step 3 the focus can switch towards mainstreaming climate change decisions into local political planning frameworks. Thus the planning exercise can take place at local institutions composed of locally embedded individuals. The broader purpose of this LGD heuristic though, is to seek an appropriate (or acceptable) combination of planning resources by iteratively adjusting the components of the process between the conceptual end points represented in Figures 3 and 4.

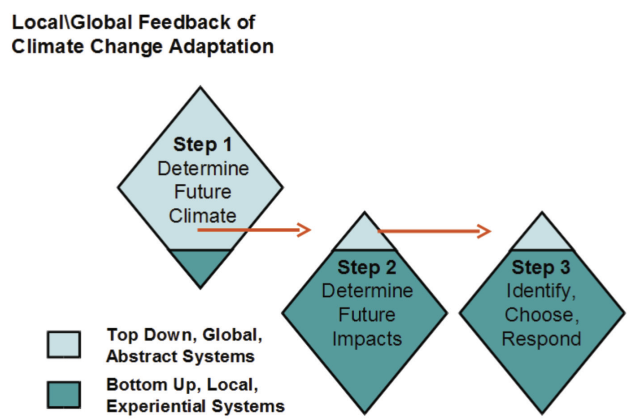


FIGURE 4
A three-stage (task), proactive climate change adaptation planning process. In this figure local experiential knowledge dominates Stage-2 and Stage-3.

5. The RAICC Approach

In this section we utilize the LGD heuristic to assign the tasks of the RAICC (Rapid Assessment Impact for Climate Change – Chapter 4) planning process among climate experts (top down) and local planners\stakeholders (bottom-up) in the Regional Municipality of Halton. RAICC is a rapid, low-cost, scoping exercise set within a larger climate change adaptation planning platform that provides institutional support, tools, methodologies, data, expertise, and national and international linkages. The approach connects climate models to policy and decision-making by identifying the risks of climate change to various social and economic sectors as well as the natural environment within a given locality, or municipality. It is premised on the idea that local governments require an initial overview of the potential impacts of climate change and a means of prioritizing those impacts for further consideration. The process should reflect local circumstances, yet also inform regional, national and international programs through an upscaling procedure.

Specifically, RAICC involves creating a regional climatic profile representing both past (i.e. historic weather patterns) and future (i.e. climatic predictions) weather patterns, which is correlated to past and future impacts\adaptations as derived from the literature, institutional networks, and solicited from stakeholders. The climate/adaptation profile and associated relative risk assessment are meant to inform regional policy analysis and decision making. The five stages of the RAICC approach can be accommodated within the planning framework of Figure 2 as follows:

A) Building a history of climate extremes → Steps 1 in Figure 2.
B) Selecting a model for climate futures → Step 1 in Figure 2.
C) Building a future of climate extremes → Step 1 in Figure 2.
D) Linking climate indices to adaptation thresholds → Step 2 in Figure 2.
E) Conducting a relative risk assessment of impacts → Step 2 in Figure 2.

The first stage of RAICC, involves building a history of past climatic extremes as a baseline for assessing climate models, and anchoring anticipatory adaptation in past adaptive behaviour. Climate histories represent measures of temperature, precipitation, humidity, etc, over various temporal and seasonal scales. Using historical data derived from a regional weather station(s) (i.e. chosen to maximise the period of consistent weather observations), a historic climatic profile is created, which not only reveals past regional climatic trends, but also reflects extreme events. In brief, results for the Regional Municipality of Halton indicate historical increases in temperature and decreases in precipitation over the past 28 years (Chapter 4).

In the second and third stages of RAICC, a future climatic profile is created. The first step in this process is to choose a climate model (or suite of climate models) from which a future climate profile is projected. Choosing a model is not trivial whether considered from an epistemological, theoretical, or practical viewpoint. There are numerous forms of climate models (e.g. global, regional, or downscaled), each with a particular methodological focus (Weart 2003). In this case, an appropriate model (or set of models) is identified by applying criteria as defined by the IPCC, and by assessing how well each model reflects past climatic conditions within the Halton region (Chapter 4). The Coupled Global Climate Model (CGCM3) was chosen to project future climates for Halton over three different SRES (IPCC 2000) scenarios to produce a set of weather indicators (i.e.

the Gachon Indices of Climate Extremes) up to 2050. Results suggest continued increases in temperature above and beyond the observational trend of the past 28 years, mostly in the minimum temperatures ranges. Changes in precipitation should level off by mid-century with a slight increase by the year 2100.

With the historic\future climatic profiles established, the impacts of climatic change can be ascertained or projected (Step-2 in Figure 2). Unfortunately, a dilemma immediately arises regarding the choice of socio-economic and ecological factors to analyse, the means to represent them, the methods to project them, and the manner of prioritizing possibilities. Potentially endless arrays of indicators and indices vie to represent the socio-economic and ecological possibilities resulting from climate change, yet a finite level of resources exists to undertake analysis and interpret results. The discretion of individual researchers/analysts could be relied upon to choose the appropriate combinations of indices, their priorities, as well as potential solutions to such impacts (Figure 3). Unfortunately, such perspectives frame the issue in a manner that is not inclusive of local preferences or input.

Given the large uncertainties involved in climate change research, the potential for academically trained researchers and analysts to introduce a constraining bias into the adaptive process is not only likely, it is inevitable. Instead, a coarse, transparent, arms-length impression of the state of the field was created by employing simple bibliometrics (Chapter 2). This improves the link between research and adaptation decisions, affords the analyst a measure of distance from the issues, and subjects CCA science to a continuous review. Specifically, a bibliometric analysis and planning-oriented categorization of peer reviewed literature, is used to inform discussions surrounding climate impacts and adaptation options. In a broad brushstroke it defines the field (see Table 1) in a way that is accessible to stakeholders, provides indices for local impact analysis, and allows for reflexive critique through the use of a standardized lens (i.e. CCA planning), and means of analysis (i.e. bibliometrics).

Using this procedure (Chapter 2) ten sectors were identified for consideration: tourism, water quality, forests, built environment, biodiversity, human health, fisheries, energy, transportation, and agriculture. A preference ranking for climate change issues is not provided, rather the relative status[19] of each issue

19 The relative status is ascertained by determining the volume of literature associated with the subject (i.e. the number of articles addressing the particular sector) in relation to a representative set of the overall climate change adaptation field. This of course is not a true measure of importance, but does indicate the level intellectual activity associated with a particular subject.

(sector) in the literature is used as a proxy for its relative importance. The range of climate change impacts for Halton are then determined by applying the indices accompanying the literature. Reconciling the differences between this global perspective, and what stakeholders view as important, is the essential point of the exercise. In this manner, not only are local stakeholders informed of the range of climate change issues considered by scientists, but scientists have the opportunity to learn what is of concern across various localities.

Stage five describes the relative regional risks associated with the ten sectors. Data from Halton regional weather observations and models, were combined with indices (i.e. formulas that determine the impacts of climate upon specific phenomena and process) to reveal past and future changes in climate impacts. Results showed significant changes (as a percentage of total change) in the frequency of the risk to the built environment, agriculture, forests, energy (cooling) and biodiversity (see Table 2). Next, the risk frequencies were combined with model uncertainty (as measured by the ability of models to reflect past sectoral changes) to provide a relative risk assessment on the impacts of climate change at Halton Region. In this step, there is a tradeoff between the relative importance of the changes associated with climate projections for given sectors and the confidence in the modelling of projections.

TABLE 2
The Relative Risk Matrix for climate change in the Halton Region.

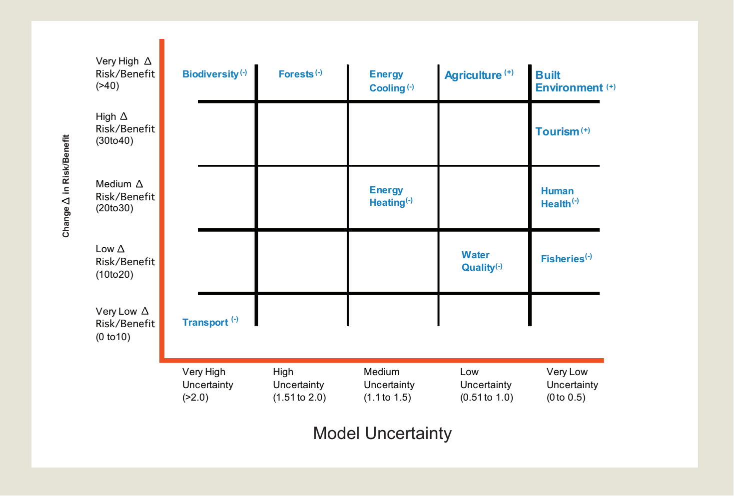


Table 2 represents a single perspective regarding further consideration and analysis for a particular region. It is entirely a top-down, rational perspective insofar as the framing of the problem, the model scenarios and the calculation of potential impacts are all derived from global, expert systems (as defined by Giddens (1990)). It is therefore a global product. The top left portion of the graph (see Table 3 for an idealized schematic) represents large changes in a particular sector, with high model uncertainty. At the other end of the scale, the lower right portion of the graph represents great confidence in the model's projections, but little change in indices. In either case, further analysis seems unwarranted. The dominant argument for further sectoral consideration rests in the top right portion of the graph where large impacts coincide with high confidence in modelled projections. In this case, tourism, agriculture and the built environment appear as the sectors where there is both a large change projected and high model confidence. These sectors are offered as candidates for more detailed impact analysis, and for the consideration of adaptation options.

Although the expertise embodied in Table 2 is relatively sophisticated, it must be remembered that this is just one perspective of a hyper-complex issue that is highly uncertain and negates much local detail and input. The interesting question is what to do with this perspective? There are a number of pathways that can be followed: the default position is to do nothing; results may imply that the region has little to respond to in the short term, or that modelled uncertainty is so high that a wait-and-see attitude is prudent. Decision-makers might also decide that the region's adaptive capacity is sufficient to handle any negative outcome that may arise. Canada is considered one of the most adaptive societies in the world and may even receive short term, economic benefits from climate change (Lemmen *et al* 2007). At the other extreme, a full assessment of all sectors may be desired. In this case all available data and modeling capabilities would be marshalled to paint an overall picture of CCA in the specified region (Cohen 1997a; Mortsch *et al.* 1997). This is the ideal in terms of thoroughness, but far from the norm.

Most municipalities have limited budgets and resources to undertake large scale planning exercises. RAICC was created to respond to this middle ground where planning resources are restricted, and a ranking scheme is required for the strategic prioritization of planning options and next steps. Prioritization can be taken directly from the relative ranking in Table 2, proceeding immediately to the consideration of adaptation options for specified sectors. This approach has the advantage of being quick, efficient, and quantifiable. In this instance the three sectors that fall into the high risk\low model uncertainty category in Table 2 are considered for further analysis. But the advantages of RAICC are also its weaknesses; it inherits a strong global, academic bias, with low model resolution, no local input, and is representative of only what can be quantified, and rationally analyzed. Stakeholders are left with a cartoon delivered with patronizing disregard for its end use, and the validity of local understanding and knowledge[20].

Alternatively, if we take a slight detour, we can expand the scope of our prioritization scheme to include local input and produce a perspective more tailored to Halton, more open to reflexive consideration, and more inclusive of local perspectives. In this secondary step we expand the scientific process of self-doubt by including greater, and more locally oriented, knowledge and scepticism. *"More and more people are able to play the role of assessors of science [which] is something irritating for scientists"* (Beck 1992). To do this though, we need to first understand what is provided in the relative risk matrix (Table 2). The basis of this analysis is: global models of climate, the literature on impacts, indicators and adaptation thresholds. It thus provides an entirely outside perspective on what would be important to the Region of Halton, while concealing a fair degree of uncertainty. It is also ambiguous in terms of the relationship between relative risks.

For instance, can a priority ranking actually be given in terms of each of the 25 sections in Table 2? Which is more important, agriculture or tourism?; energy or biodiversity? A definitive ranking is not possible for the obvious reason that it compares apples and oranges (e.g. monetized versus non-monetized sectoral impacts), but also because it requires that sectoral changes be ranked according to model certainty. If we divide the table into four zones (see Table 3): a) high risk, low uncertainty; b) high risk, high uncertainty; c) low risk, low uncertainty; and d) low risk, high uncertainty, the relationships become more readable. Nevertheless if the entire top row of the table is associated with high risks for society, why should we be complacent of any of these dangers, simply because they cannot be modelled well?

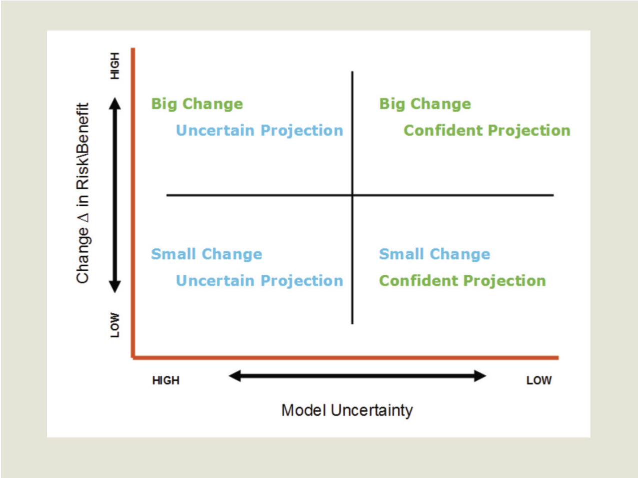
To respond to these more specific questions, the planning stages in Figures 3 & 4 have been extended in Figure 5. In this example, Step 2 is further decomposed into Steps 2.1 and 2.2 to take advantage of local, experiential systems. Step 2.1 represents the development of the Relative Risk Ranking as discussed previously;

20 Beck (1992) points out the 'patronizing' cognitive dictates of the experts as referred by (Illich 1979).

by adding Step 2.2, an opportunity is offered to rank impacts according to local experiences and preferences. This additional step, inserted at a strategic position in the decision process, offers the ability to redefine how the process is undertaken for the remainder of the analysis. Step 2.2 is itself a two-staged affair: the results from the Relative Risk Matrix are presented with recommendations for further analysis (Step 3); stakeholders then rank what they feel is important and worthy of further analysis. In this simple framework then, the local\global chasm is traversed by providing a direct opportunity for local feedback.

TABLE 3

A stylized version of the Relative Risk Matrix highlighting the distinction between regions of the graph (adapted from Chapter 4).



The problem with the approach in its current form is that stakeholders do not have access to an awareness of the limitations of the knowledge provided, nor a means to assess the different forms of knowledge produced by different disciplines. This is particularly acute given the cross-cutting nature of climate change adaptation, and its dependence upon numerous disciplines for analysis. Thus the onus is placed upon the lay public to be informed of the debates that exist within and across academia, which is hardly realistic. To overcome this we modify the process slightly by having the inherent shortcomings of the RAICC methodology, and the science upon which it is based, explained by a *broker*.

This step is intended to reveal the *'awkwardness and limitations'* of RAICC so that stakeholders may make more informed decisions regarding appropriate and beneficial adaptive action. The broker's role is proactive in that she\he seeks to secure a commitment to action.

The approach begins by having the results, and the recommendations for future analysis (Step 2.1) presented to stakeholders (Step 2.2). The job of the broker is to simply place this analysis into a broader context, both in terms of information and the relative uncertainty of knowledge. This can be done passively by presenting more information to stakeholders, or proactively by challenging stakeholders to consider a larger set of options which are not necessarily amenable to quantification. In this case, the source material for the broker's critique comes from the bibliometric analysis in (Chapter 2) and employs a History\Philosophy of Science perspective (Okasha 2002; Weart 2003). The results and critique are presented in a way that is sensitive to the language of the stakeholders (Cohen 1997b), which is partially accomplished by focusing on a planning-oriented framework.

In Step 2.2, there is no right or wrong answer, stakeholders are simply asked to identify where they feel more analysis is warranted. This extension of analysis can occur both in terms of impacts (which could be represented as an additional Step 2.3), or a direct continuation of the process towards the consideration of adaptation options (Step 3). As a next step, (Step 3 in Figures 2, 3, & 4) the consideration of adaptation options can be accomplished relatively easily by surveying local stakeholders to identify and select appropriate adaptation options from which the most preferred is chosen. Although valid, this approach would likely limit the potential options considered, and be subject to inconsistent and biased analysis. As previously discussed, Operations Researchers and Management Scientists have developed techniques to examine options and select the most appropriate action in a more rigorous manner. These methods are based upon the premise that the domain of feasible adaptation strategies can be quantified, and a search algorithm applied to identify solution(s) which maximize human utility.

There are numerous shortcomings with such synoptic methodologies, but one of the most profound lies in the definition of the adaptation state space. The presumption that a formula can be created to represent the range of adaptation action(s) that can be undertaken is simply wishful. No generic, adaptation strategy generator exists, partially because the range of adaptation options is so great, and encompasses so many inter-related factors. Equally problematic is the representation of the indefinable, yet critically important set of novel or creative solutions for responding to climate change (i.e. new technologies, changes in the market, biological mutations, etc.). Inevitably simplifications must be imposed by experts, and justifications made for the use of these toy representations (Ackoff 1979).

Nevertheless, numerous benefits may be garnered by structuring a problem to take advantage of the global repository of adaptation options (as derived from the academic literature and the IPCC process) and the insights of quantitative analysis (i.e. the comparison of adaptation options in a formal, quantifiable framework). Therefore to account for the advantages of both bottom-up and top-down methodologies, Step 3 (Figure 5) is divided into three sub-steps. In Step-3.1 the adaptation domain associated with the chosen climate change issue is defined by listing generic options from the literature, and by soliciting broad based, local, experiential knowledge. The *effort* of task 3.1 is therefore apportioned equally between experts and local stakeholders. In Step-3.2, choosing preferred solutions from the potential set generated in Step-3.1, is a quantitative exercise (using search algorithms) dominated by experts. The insights generated here,

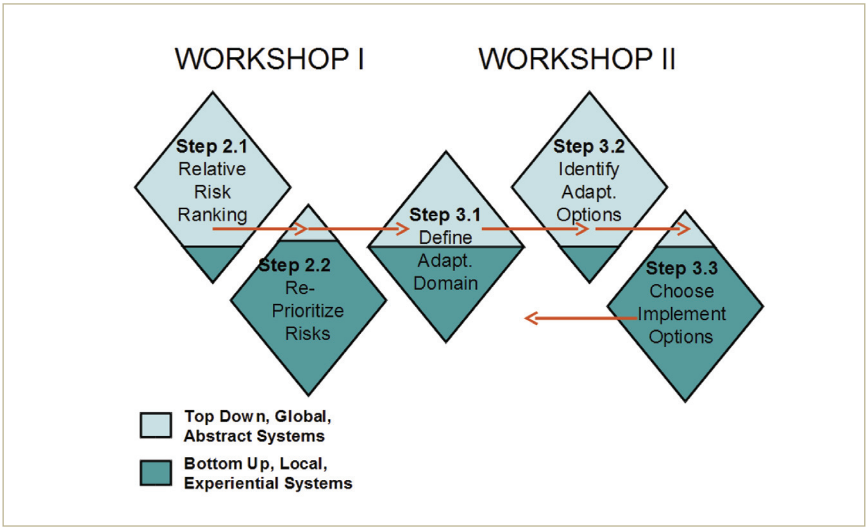


FIGURE 5
The three basic steps of adaptation planning (Figure 2) can be further decomposed into develop more specific tasks, each of which has a relative mix of idealized input from either abstract expert systems or localized, experiential systems. In this case Step-2 is decomposed into two complementary steps and Step-3 into three steps.

will then be presented to stakeholders in Step-3.3, where adaptation solutions will be chosen and implemented by local decision makers.

It is evident that the continuation of the process in Step-3 will require both expert and local input. The role of the broker will therefore be required to facilitate this exchange. But as previously discussed, this is not only a matter of getting information into the hands of stakeholders (a one way exchange). General and particular knowledge are complementary, and their exchange can facilitate learning and reflexivity. The information gleaned from this LGD process can therefore be moved up the information ladder to inform national and international policy, thereby closing the information loop.

6. Conclusion

> In the reflexive phase, the sciences are confronted with their own products, defects and secondary problems, that is to say, they encounter a second creation in civilization. (Beck 1992)

To effectively respond to the conditions of a *risk society*, scientists must not only deal with the secondary products of science (e.g. human-induced climate change), but with the inherent biases, limitations, and uncertainties of scientific practice. The social status that scientists once enjoyed as impartial purveyors of *truth,* and by extension, bestowers of *solutions*, can no longer be maintained given the atmosphere of doubt and skepticism that surrounds their activities. How then, are scientists to address the hyper-complexity of environmental problems such as climate change?

While scientific knowledge may be losing its luster as a result of its own reflexive scrutiny (Beck 1992; Giddens 1992), the 'demonopolisation of scientific knowledge claims' also creates opportunities for the inclusion of other forms of knowledge in the planning process. The trend towards participatory decision-making through consultation, interaction, and negotiation are a strong indication of this new potential. Yet becoming more inclusive is not an end in itself; the nature of climatic change precludes a total surrender to the local.

Awareness of the climate change issue originates and is maintained (Weart 2003) within highly abstract expert systems (i.e. the producers of counterfactual knowledge, or climatic simulations) and involves physical processes (i.e. the carbon cycle) which emerge locally, but impact globally. Climate change solutions must clearly span both the global and the local if they are to be efficacious. By formalising what Giddens (1992) identifies as the 'local global dialectic', the core competencies of scientific practitioners and local constituents can be identified and supported to produce solutions which are sensitive to multiple scales.

The LGD (Local Global Dialectic) heuristic developed within this chapter, lays bare the relationships between traditional knowledge producers and consumers as a caricature (MacLellan 2006). To the extent possible, an exclusively global perspective of a specific region is assembled from peer reviewed literature (i.e. as derived from the knowledge, tools and techniques offered therein). This incomplete viewpoint (i.e. an example of the generalizing tendencies of science) is placed within the context of a standard decision framework, and presented with the help of a broker, to local stakeholders for interpretation, evaluation and augmentation. The reflexive loop is closed by providing scientists with information regarding the particularities of the specific locality (i.e. an example of the historical or particular aspects of knowledge), its' local preferences and adaptive novelties, which can then be aggregated across cases to reveal larger trends.

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