Priming the Governance System for Climate Change Adaptation: The Application of a Social Ecological Inventory (SEI) to Engage Actors in Niagara, Canada

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Abstract:

Adaptive systems of governance are increasingly gaining attention in respect to complex and uncertain social-ecological systems. Adaptive co-management is one strategy to make adaptive governance operational and holds promise with respect to community climate change adaptation as it facilitates participation and learning across scales and fosters adaptive capacity and resilience. Developing tools which hasten the realization of such approaches are growing in importance. This paper describes explores the Social Ecological Inventory (SEI) as a tool to 'prime' a regional climate change adaptation network. The SEI tool draws upon the social-ecological systems approach in which social and ecological systems are considered linked. SEIs bridge the gap between conventional stakeholder analysis and biological inventories and take place through a six phase process. A case study describes the results of applying an SEI to prime an adaptive governance network for climate change adaptation in the Niagara Region of Canada. Lessons learned from the case study are discussed and highlight how the SEI catalyzed the adaptive co-management process in the case. Future avenues for SEIs in relation to climate change adaptation emerge from this exploratory work and offer opportunities to inform research and adaptation planning.

Introduction:

Engendering effective and efficient responses to climate change is a considerable challenge. The imperative nature of this challenge is being brought sharply into focus. Past emissions combined with present global emissions are cause to re-consider initial predictions of temperature increases and the probability of a 4°C rise from pre-industrialization is gaining acceptance (Smith et al., 2008; Parry et al., 2009). Extreme weather and climate events will accordingly be altered in terms of intensity, frequency, duration and timing (Parry et al., 2009; IPCC, 2011). While anticipating the precise impacts from such temperature increases becomes very difficult due to the interconnectedness of systems and uncertainties of feedback loops (Adger and Barnett, 2009), the impacts of extreme events often push communities beyond their coping abilities (Smit and Wandel, 2006). Not only are the impacts of climate change unavoidable by the most stringent mitigation efforts (Klein et al., 2007), but questions are being raised about the prospects for adaptation under these new projections (Adger and Barnett, 2009). The window for responding to climate change is thus closing quickly, and the emphasis on adaptation is crucial (Parry et al., 2009).

Adaptation research has evolved considerably from being a handmaiden to impacts research on mitigation to a burgeoning area of research and policy (see Burton et al., 2002 for a summary). The International Panel on Climate Change (IPCC) understands adaptation to involve "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2001: 982). Adger et al. (2007) assess adaptation practices, options, constraints and capacity in the contributions of Working Group II to the Fourth Assessment Report of the IPCC. The breadth of possible adjustments in different systems is vast, multi-faceted, and often taking place for reasons beyond just climate change. This breadth and nature of these adjustments leads van Nieuwaal et al. (2009: 8) to conclude that:

> … adaptation is not only, or particularly, a technical issue, but that it can be characterised as a complex social interaction process and that it should be studied as such. Only then can adaptation to climate change also be regarded as a window of opportunities. Dealing with climate adaptation not only demands a rethink of how we arrange our social-ecological or socio-technical systems but also how we govern them.

In establishing that adaptation is a matter of governance, van Nieuwaal et al. (2009) draw upon the popular narrative of shifting from 'government to governance' to convey the decade long trend away from top-down government to less formalized forms of governance. Several types or models of governance exist (e.g., state, market, community) which often come together or hybridize in practice (Glasbergen, 1998; Lemos and Agrawal, 2006). This paper is specifically concerned with adaptive systems of governance. Adaptive systems of governance coincide with Lee's (2003) conceptualization of 'the new governance' and are defined as "… a polycentric form of social coordination in which actions are coordinated voluntarily by individuals and organizations with self-organizing and self-enforcing capabilities" (Folke et al., 2005: 449). Adaptive governance recognizes that systems are inherently dynamic and unpredictable (Gunderson and Light, 2006). Institutional arrangements which assume and manage for change as well as are integrative in orientation are thus emphasized (Gunderson and Light, 2006). Adaptive governance draws attention to the establishment of networks which connect actors at

multiple scales and that enable collaboration, learning, experimentation, knowledge exchange and decision-making (Folke et al., 2005; Olsson et al., 2006).

In their review of adaptive governance of social-ecological systems, Folke et al. (2005: 444) argue that "…adaptive governance is operationalized through adaptive co-management systems". Adaptive co-management (ACM) is frequently cited as an example of adaptive governance in practice (e.g., Classon, 2005; Nelson, 2006; Armitage et al., 2009) and its potential applicability to community climate change adaptation is starting to be recognized (e.g., Locatelli et al., 2008; May and Plummer, 2011). May and Plummer (2011), for example, argue that the transition of conventional risk management standards in the direction of participation, learning and governance for climate change adaptation can be accelerated by infusing the collaborative and adaptive spirit of ACM. Adaptive co-management, however, is recognized as process that may require considerable time to mature and develop (Berkes, 2009a; Armitage et al., 2009).

Tools that can accelerate the initiation and evolution of adaptive governance for climate change adaptation are thus of growing importance. The Social Ecological Inventory (SEI) tool has been utilized to bring about ACM in social-ecological systems. This paper explores the SEI as a tool for priming the governance system for climate change adaptation. The exploration is structured into four parts. Part one sets forth the conceptual rationale for the SEI and describes the procedural steps that comprise the tool. Part two describes a case study of the Niagara Region of Canada in which an SEI was undertaken as a precursor to an ACM process for climate change adaptation. Part three discusses the lessons learned from applying the SEI in the Niagara Region. Conclusions offered in the final part of the paper identify future avenues for research concerning SEIs and adaptive governance for climate change adaptation.

The Social Ecological Inventory Tool

Conventional tools to conduct inventories have concentrated on either natural systems or social systems. Ecological inventories aim to document the biophysical landscapes and generally omit the social processes influencing the natural system. Stakeholder inventories and analysis conversely focus on gathering information from all stakeholders that affect the decision making process, but tend to not account for biophysical components. Bridging conventional ecological inventories and stakeholder analysis is the raison d'être for the SEI (Schultz et al., 2007).

Conceptual touchstones for the SEI come from the social-ecological systems (SES) approach and the benefits from incorporating local knowledge into conservation efforts. The SES approach primarily comes from ecology and complexity theory (Cummings, 2011). This integrative view stresses the linked nature of social and ecological systems (i.e., a social-ecological inventory) and argues that their delineation is artificial and arbitrary (see Berkes and Folke, 1998; Berkes et al., 2003). Both social and ecological components of a system must be simultaneously taken into account to understand a system (Berkes et al., 2003; Folke et al., 2005; Gallopín, 2006). While specific components are singled out for greater understanding it is through the integration of both systems that the complex relationship between components become apparent (Gallopín, 2006).

Knowledge for understanding and navigating the complexities and dynamics of SES is held among a diverse array of individuals and organizations (Olsson et al., 2007). Although local

knowledge was considered less reliable than scientific knowledge because it blended knowledge and beliefs, and is embedded with cultural and social norms (Gadgil et al., 2003), its potential to enhance conservation efforts is now being advanced (Gadgil et al., 1993; Folke et al., 2005; Berkes, 2009b). The importance of complementing scientific knowledge with local knowledge about ecosystem dynamics and social dynamics is increasingly being recognized in environmental management (Gadgil et al., 2003; Schultz et al., 2007). Olsson et al. (2007) argue that combining different types of knowledge is a critical factor required for SES during periods of rapid change.

Shultz et al. (2007) pioneered the development of the SEI tool in Kristianstads Vattenrike in Sweden after recognizing the shortcomings of conventional inventories from an SES perspective and the potential gains from incorporating local knowledge. The intent was to identify local steward groups acting outside official management plans, and to utilize their collective knowledge and activities in enhancing ecosystem management (Schultz et al., 2007). Local stewards were identified, insights about the social-ecological landscape were gained, and an ACM process emerged. Inspired by the initial experiences with the SEI in Kristianstads Vattenrike, an intensive workshop was undertaken by a consortium of researchers to more fully develop the tool. The outcome of the workshop was the creation of an SEI workbook (Schultz et al., 2011) which offers a guide to researchers and practitioners.

Figure 1 illustrates the six phases of the SEI process. In the initial *preparatory phase* the goals for the SEI are defined, ground rules for researchers are set, and relevant ethics protocols are completed. In the second phase of *preliminary identification* various sources of information (e.g., the Internet, local organizations, land use maps, local telephone books, etc.) are used to generate a list of potentially important actors. The third phase *identifies key informants*. Stakeholders on the preliminary list are contracted and inquiries are made regarding their networks, interests, knowledge and activities. Key informants often suggest other individuals and organizations to contact. The frequency with which actors are identified is important because those cited most frequently are potentially critical stakeholders in the area. The fourth phase involves conducting *interviews with key informants*. The interviewing process creates an opportunity to gain in-depth insights about the values and motives of the interviewee, understand their knowledge, develop a historical perspective on activities in which the interviewee is engaged, and discover networks germane to the issues. During this phase actor interest in the aims and engagement part of the research can be created. Phase five, *enriching the picture*, is a time to pause and reflect upon the information gathered to reveal emerging trends, insights, issues and gaps in knowledge. In the final phase of *engagement*, a platform for dialogue is provided for the actors to interact and address common concerns. Engagement may take many forms such as a workshop, seminar or ACM process. While the phases are illustrated separately for communication purposes, it is anticipated that some phases may occur concurrently. Incorporation of continuous feedback is essential and in this manner the SEI process is iterative and dynamic.

Priming the Governance System for Climate Change Adaptation: A Case Study of the Niagara Region, Canada

Adaptive co-management has been applied in several resource and environmental management contexts (e.g., Plummer, 2006; Olsson et al., 2008; Fabricius and Cundill, 2009, Kallis et al., 2009). The prospects of ACM as a process for climate change adaptation are being considered (Locatelli et al., 2008; May and Plummer, 2011) as a way to operationalize adaptive governance and address the complexities and uncertainties associated with social-ecological systems. The substantial amount of time required for ACM to mature and develop (Berkes, 2009a; Armitage et al., 2009) poses a particular challenge as the timeframe for initiating planned climate change adaptation is closing quickly.

A case study was thus undertaken to investigate if the governance system for climate change adaptation could be primed by undertaking a SEI. The SEI tool was specifically applied in the Niagara Region to understand the social-ecological landscape and to catalyze the initiation of an ACM process for climate change adaptation. The six phases of the SEI process (as outlined in Figure 1) were followed. Interviews with key informants focused on three areas of investigation: perceptions of climate change impacts in Niagara, organizational capacity for adaptation, and adaptation leadership; specific activities related to climate change and the rationale for these efforts; and, networks and relationships with other actors in Niagara related to climate change. Using a snowballing technique to continuously identify key informants, a total of 38 actors were interviewed from 33 organizations in the Niagara region over a six month period. The key informants identified and interviewed using the SEI comprised six general affiliation categories – municipal (29%), education and media (18%), environmental management (16%), non-governmental organizations (16%), business and agriculture (11%), and emergency management (10%). Interviews were carried out in person or over the phone and each took between 30-45 minutes. The qualitative data from the open ended interviews were then coded, grouping similar information into categories with shared characteristics (Saldaña, 2009).

Niagara was selected for the case study because Environment Canada investigated the effects of climate variability on the Region in 1998 and an existing entity focused on climate change adaptation was not evident. The Niagara Region covers 1,852km^2 and is located in southern Ontario between Lake Ontario and Lake Erie. Approximately 431,346 live in Niagara (Statistics Canada, 2012). The Niagara Region encompasses a portion of the Niagara escarpment, which is a UNESCO Biosphere Reserve. The two Great Lakes have a moderating effect on the climate which makes the area an ideal location for agricultural production, including tender fruit and Ontario's largest wine growing area. Niagara Falls is the major tourist attraction in the Region, attracting over 30 million visitors who spend an estimated $2.3 billion annually (NEDC, 2010). The Region has a strong transportation sector with the Welland Canal system running across it to permit the movement of vessels between the Great Lakes. Historically, Niagara also had a strong automotive and manufacturing industry. However, this industry is in decline and Niagara is re-positioning itself with a focus on alternative energy, interactive media and bio-products (NEDC, 2010).

Results from the SEI are presented below. The following sub-headings correspond to each of the three main areas of investigation. In the first main area, questions were asked to actors regarding their perceptions of climate change adaptation. The underlying intent of this line of questioning is to reveal insights about their knowledge, beliefs and values regarding climate change adaptation. The second main area sought to identify present activities relating to climate change

on the landscape and understanding the rationale of actors for these efforts. The third main area of inquiry investigates existing collaborations and networks. Results are conveyed in terms major and minor themes arrived at through the coding process. Examples are used throughout the results to convey the richness of the information gained.

Actors' perceptions about climate change adaptation

In an effort to gain insights into local knowledge about the impacts of climate change, all interviewees were asked if they had observed any changes in Niagara that could be potentially related to climate change. Observed changes in Niagara that could be related to climate change were reported by most of the interviewees. Ten themes emerged from coding these responses. The most common observation was increases in seasonal temperatures (warmer winters and hotter summers). Change in insect populations (e.g., ticks, gypsy moth) was the second most common observation. Increases in extreme weather events (e.g., tornado and storm activity, summer heat waves) and reduced water levels in the Great Lakes were also commonly reported.

In an effort to further understand the state of local knowledge about climate change and how impacts may influence the Niagara SES, interviewees were asked to identify sectors and/or environmental features particularly exposed to climate change. Agriculture was identified by over half of the interviewees, who also observed that this sector was extremely sensitive to environmental change. The sectors of tourism and public health were identified by almost one third of interviewees as also being particularly exposed to the impacts of climate change. Specific exposure concerns for the public health sector included heat waves, storms, non-point source pollution from agricultural run-off associated with flash floods, diminishing water quality and quantity, invasive species, and changing flu seasons. Water resources were an environmental feature perceived to be particularly exposed to the impacts of climate change by approximately one quarter of all interviewees. This exposure came from changing weather patterns which impact water quantity (i.e., water recharge) as well as water quality. Some interviewees also perceived Niagara's transportation system and infrastructure to be exposed to impacts of climate change such as changing freeze and thaw cycles and declining lake levels. Recreation was also perceived to be susceptible to exposure due to increased algae growth, diminished water quality, reduced health of fish stocks, and declining lake levels. One quarter of all those interviewed perceived all aspects of the economy and ecosystems in Niagara to be exposed to climate change impacts.

Interviewees were asked about the relevance of climate change to their professional work. The relevance of the issue was queried to understand how interviewees perceived climate change impacts in relation to their work. Relevance from this perspective also may give an indication of interviewees' values (Sjöberg, 2000). Three major themes were identified from the responses. The first, and most common, theme was labeled 'directly relevant'. It was expressed most strongly by interviewees from environmental non-governmental organizations, education and media, business and agriculture. Interviewees with responses fitting into this theme considered climate change impacts to directly affect their work. The second theme was labeled 'indirectly relevant'. This theme was expressed most strongly by interviewees from municipalities and those associated with emergency management. Within this theme, a range of perceptions were expressed as interviewees considered climate change as an issue that will be directly relevant to

their work in the future due to its political importance and emerging impacts, is directly relevant to authorities beyond the municipal level, or is only occasional relevant to daily work. The remaining responses constituted the third theme of 'not relevant'; interviewees did not perceive climate change as an issue with any relevance to their work. Often, interviewees representing the same stakeholder group held differing perceptions of the relevance of climate change to their work.

Responding to climate change requires the capacity for adaptation. In this regard, interviewees were asked if they perceived local institutions and organizations involved in environmental management, protection, or risk management to have the capacity to adapt to climate change. Many interviewees, most representing municipalities, businesses and agriculture, and education and media, perceived some capacity in the Niagara Region to adapt to climate change. Interviewees often expressed that this capacity was contingent upon certain conditions before it could be realized. Necessary conditions described in order to achieve capacity for climate change adaptation included more collaborative approaches to planning, adequate information about potential impacts, a supportive political environment and commitments, and strong leadership. Interviewees representing non-governmental organizations and emergency management generally perceived little to no capacity for adaptation to climate change in Niagara. Responses by this group identified a lack of specific policy direction provincially and the absence of necessary resources to undertake adaptation planning.

Leadership is an essential component for building capacity for adaptation, and interviewees were asked if they perceived there to be leadership for adaptation to climate change in Niagara. Coding the responses to this question revealed a disjuncture in perceptions regarding leadership. The Regional Municipality of Niagara was perceived as having demonstrated leadership by their recently initiated efforts on climate change or else was perceived as being 'best-positioned' to provide leadership due to resource availability. Interviewees from municipalities in particular considered adaptation as a 'natural-fit' for the regional government. However, interviewees with municipal affiliations constituted the largest proportion of stakeholders in the SEI and when the responses to this question were re-analyzed without their inclusion, the dominant perception was that no current leadership is present in Niagara regarding climate change adaptation. Reasons given for this absence of leadership included a lack of knowledge to facilitate leadership and an absence of collaborative action in adaptation-related efforts. The Niagara Peninsula Conservation Authority (NPCA) was identified by some interviewees (particularly environmental managers) as an organization with potential to provide leadership in the future.

Climate change activities and efforts

A major focus of the SEI was to identify current practices through which stakeholders interact with the ecosystem, manage environmental features, and address environmental risks. Consistent with the SES perspective, these practices are important mechanisms to connect stakeholders to the landscape and provide a base from which actions to address climate change more specifically can be derived. Interviewees were thus asked to identify key practices within their organization regarding environmental management, protection, and risk management. Key practices identified by interviewees were coded and grouped into similar categories. Table 1 conveys the categories of practices presented in descending order of the number of interviewees who reported the

practice. Sustainability planning and public education emerged as the practice categories reported most often. Sustainability planning was often reported by municipal stakeholders while public education practices were reported by interviewees in the emergency management, environmental non-governmental organizations, and education and media. The categories of adaptation to environmental change and planning for risk management were reported by few interviewees.

In an effort to probe current actions in response to climate change in Niagara, interviewees were asked to share their knowledge of any efforts related to climate change within their organization. The activities revealed by the interviewees were then coded according the intent of their efforts. Four themes emerged from the analysis. The first theme was labeled 'adaptation' and encompasses efforts such as planning for extreme weather-related emergencies and changing environmental conditions. Adaptation activities were undertaken to some extent by all stakeholder groups except education and media. The second theme was labeled 'mitigation' and most of the activities reported by stakeholder groups fit within this theme. It encompassed efforts to manage or reduce corporate carbon emissions, sequester carbon, and develop / implement 'green' energy practices. 'Research on the impacts of climate change' emerged as a third theme. Municipal stakeholders and environmental managers in particular explained that efforts to research impacts are an important precursor to action. The final theme was labeled 'education and consultation with the public'. Responses from stakeholders in the education and media sector highlighted the information on mitigation practices that was delivered through their respective organizations.

Actor networks and relationships related to climate change

Revealing existing collaborative relationships and networks among stakeholders is a key aspect of the SEI. Interviewees were asked to identify other organizations with whom they collaborate concerning environmental management, protection, or risk management. Collaborations within each respective sector were most commonly reported. The amount of inter-sector collaborations varied considerably. The environmental management sector reported the greatest number of collaborations and was connected to each of the other sectors except emergency management. Conversely, the business and agriculture sector reported the fewest number of collaborations and was connected only with municipalities. The municipal, non-governmental organization and education sectors each reported numerous inter-sector collaborations. Municipalities were identified as the most common partner when collaborating.

In an effort to unpack the nature of these collaborations, interviewees were asked about the frequency and nature of these collaborations. Responses were coded into categories of 'ongoing relationships' and 'occasional partnerships'. Interviewees indicated that more than half of all collaborations were ongoing and the remaining collaborations were occasional partnerships, often for the purposes of a specific project. The education and media sector as well as the municipal sector reported mostly ongoing collaborations whereas collaborations reported by the emergency management and environmental management sectors tended to be more occasional. Three themes emerged from coding the responses from interviewees and the labels affixed ('working relationship', 'information sharing', and 'resource coordination') convey the nature of the collaboration as expressed by the interviewees. It is important to recognize that these codes

are not mutually exclusive and collaborations may be coded into one or more theme. The majority of collaborations were categorized as working relationships. Working relationships were present in all sectors but was most common for municipal stakeholders and education and media. Information sharing occurred in all sectors except business and agriculture. Resource coordination collaborations were not reported often, but were identified by environmental non-governmental organizations, education and media, and environmental management groups.

Bridging organizations are of particular interest in a SEI because they play an essential role in connecting actors within diverse networks across levels and coordinating information, perceptions, and resources. These organizations serve as key points to access existing networks. Interviewees were asked to identify a bridging organization in the Niagara Region concerning environmental management, protection, or risk management. The Regional Municipality of Niagara was the organization most often identified as a bridging organization; interviewees with a municipal affiliation in particular perceived the Region as 'best-positioned' to act as a bridging organization. Several interviewees also identified the NPCA as a bridging organization. Interviewees considered the NPCA to be a bridging organization because of its understanding of ecosystem functions, management of numerous environmentally sensitive areas, critical input into land use planning, and considerable linkages with government agencies as well as to the non-governmental sector. It is important to note that the second most common theme when coding responses to this question was the lack of a bridging organization within the Region. This perception was identified within all stakeholder groups.

Discussion

This paper explores the SEI as a tool for priming adaptive governance concerning climate change adaptation. In this section, we discuss several of the insights gained through the Niagara case study about how the SEI tool appears to have catalyzed initiating an ACM process.

Collaboration is one pillar of ACM and relationships are an essential ingredient in the process as they build trust, help to resolve conflicts, and assist with sharing power (Berkes, 2007; Armitage et al., 2009). The SEI made us aware of existing conflicts between and among stakeholders and revealed information about past collaborative efforts that had not ended well. Actors reacted positively to Brock University initiating and facilitating the ACM process and expressed that it provided an unbiased organization without ulterior motives. Power sharing is often a particularly difficult issue in collaboration and through the SEI we were able gain insights to the concerns of participants in this regard. Specifically, most of the actors considered the Regional Municipality of Niagara to hold the most power in making decisions about climate change and expressed concern that this power was not shared with other groups. Although it is certainly not always the case, the process of ACM is documented to build trust, resolve conflicts and mediate power differences (Folke et al., 2005; Plummer and FitzGibbon, 2007; Armitage et al., 2009). Insights about conflicts and power differentials gained through the SEI assisted with facilitating these challenges in the early stages of the ACM process. For example, actors were able to express their concerns that the Region was 'in charge' of climate change, and conversely, the Region was able to enter into dialogue about its desire to engage with stakeholders and together pursue an integrative approach to community-based adaptation. Trust appeared to have increased among the core group of actors whom have interacted on a regular basis for over a year.

The role of social networks is emphasized in adaptive governance (Folke et al., 2005; Olsson et al., 2006) and in ACM these networks connect actors horizontally and vertically to build trust and enable social learning (Plummer and FitzGibbon, 2007; Armitage et al., 2009). In drawing upon experiences in Kristianstands Vattenrike, Olsson et al. (2007: 274) observe how "these networks facilitate information flows, identify knowledge gaps, and create nodes of expertise that are of significance for ecosystem management". The SEI provided key insights into the frequency and number of collaborative connections within and between sectors. It also helped to understand the nature of exchanges (i.e., working relationships, information sharing, and resource coordination) taking place through these collaborative networks. The SEI in the Niagara case was especially valuable in illuminating potential bridging organizations (e.g., the Regional Municipality of Niagara and the NPCA) as well as their perceived absence. The research team was thus able to pay particular attention to fulfilling this bridging function during the early stages of the process. Insuring the presence and function of social networks is critical as these networks are identified as sources of resilience in SES (Hahn et al., 2008). Bridging organizations in particular offer lessons for nurturing resilience and may mobilized when required (Schultz, 2009).

Scientific and local knowledge are both recognized as playing important roles in climate change adaptation (Berkes, 2009b; Nilsson and Gerger Swartling, 2009). In undertaking the SEI in Niagara local knowledge held by stakeholders was revealed. While the depth of this knowledge varied, many sources of advanced local knowledge were identified. For example, one stakeholder was extremely knowledgeable about tree canopies while another had considerable insights about community gardens. The SEI also highlighted gaps in scientific and/or local knowledge and permitted actors an opportunity to identify information they would like to acquire. For example, many actors expressed that "we know the global or national predictions for climate change, but what does this mean for us in Niagara?" and "how do we adapt when we're not sure what we should be adapting to?".

Adaptive co-management provides a process by which different types of knowledge can be combined, co-generated, and used (Berkes, 2009b; Armitage et al., 2011). Developing an understanding of stakeholders' knowledge before undertaking ACM was immensely beneficial in the Niagara case because it allowed us to stream and tailor the process in several ways. For example, information gained about activities and efforts of stakeholders through the SEI facilitated introductions among actors. The expressed interest in gaining information through climate models about changes and impacts specific to Niagara Region allowed an entry point to engage actors in the ACM process through an information workshop. The SEI also helped to illuminate potential differences that could act as barriers in the early stages of ACM. In particular, it made us aware of value differences held by actors.

Learning is an adaptive behavior (Pelling et al., 2008; Woodhill, 2002) and in this way the ACM arrangement emerging in the Niagara case is itself an adaptive response. Learning is a hallmark of ACM. Adaptive co-management is frequently associated with the concept of social learning, understood as the "collective action and reflection that occurs among different individuals and groups as they work to improve the management of human and environmental interrelations" (Keen et al. 2005: 4). Conceptualizations of social learning (also referred to as group learning) in

relation to ACM emphasize the potential for multiple loops of learning to occur as the interactive and deliberative process develops (e.g., Plummer and FitzGibbon, 2007; Armitage et al., 2008; Berkes, 2009). Single loop learning occurs as actors endeavor to fix errors from routines, often by trying alternative strategies and actions in response to specific problems. Double loop learning takes place as worldviews and values are challenged and reconsidered, often manifest as shifts in management direction or policy changes. Triple loop learning involves deep questioning of the norms and protocols upon which the previous loops of learning are predicated and through this reflection change to the governance system may come about. While it is unrealistic to expect evidence of multiple loop learning in such a relatively short time frame and premature to consider the case as a robust adaptive governance network for climate change adaptation, the SEI appears to have accelerated the speed at which it is developing.

Conclusions

Adapting to climate change is imperative. Governance has a critical role to play in adapting to climate change. Adaptive co-management offers a way to make adaptive governance operational and does so by engaging actors in a collaborative and learning oriented process. In this way it coincides with emerging directions in climate adaptation. For example, Nilsson and Gerger Swartling (2009: 3) write that "in order to affect underlying values, the literature emphasizes social learning as an on-going social process focused on dialogue and exchange that can incorporate knowledge from various perspectives and different social levels". However, experiences with ACM suggest that it can take a substantial amount of time to evolve (Berkes, 2009a; Armitage et al., 2009). Tools to accelerate such processes have great value.

This paper explored the SEI as a tool for priming the governance system for climate change adaptation. The six step process was applied in the Niagara Region of Canada over a six month period as a precursor to undertaking an ACM. The SEI appeared to have catalyzed ACM in a myriad of ways. Insights gained about networks and relationships permitted identification of key actors and bridging organizations. Local sources of knowledge were revealed and gaps in knowledge were illuminated. Tailoring the ACM process was possible with an awareness of existing actions, desired information, and differences of values.

Three key future avenues for SEIs in relation to climate change adaptation emerge from this exploratory work. The SEI has been applied in only two contexts (Sweden and Canada) which are similar in respect to their development. An opportunity thus exists to apply the SEI tool in a variety of other contexts and to consider its performance. The SEI tool was designed to be used by several audiences, including researchers, resource managements, and citizens. Experiences with the SEI tool thus far come from the research community. It is anticipated that valuable insights and feedback on the SEI tool would stem from its uptake by resource managers, resources users and others. Possibilities also exist to design and conduct future research on the SEI tool. For example, comparative studies would be required to precisely ascertain the extent to which conducting an SEI catalyzes the process of ACM. Incorporating insights gained from pursuing these opportunities into the SEI tool will enhance the breadth of its applicability and its effectiveness.

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Figure 1. The SEI Process (source Schultz et al., 2011: 8)

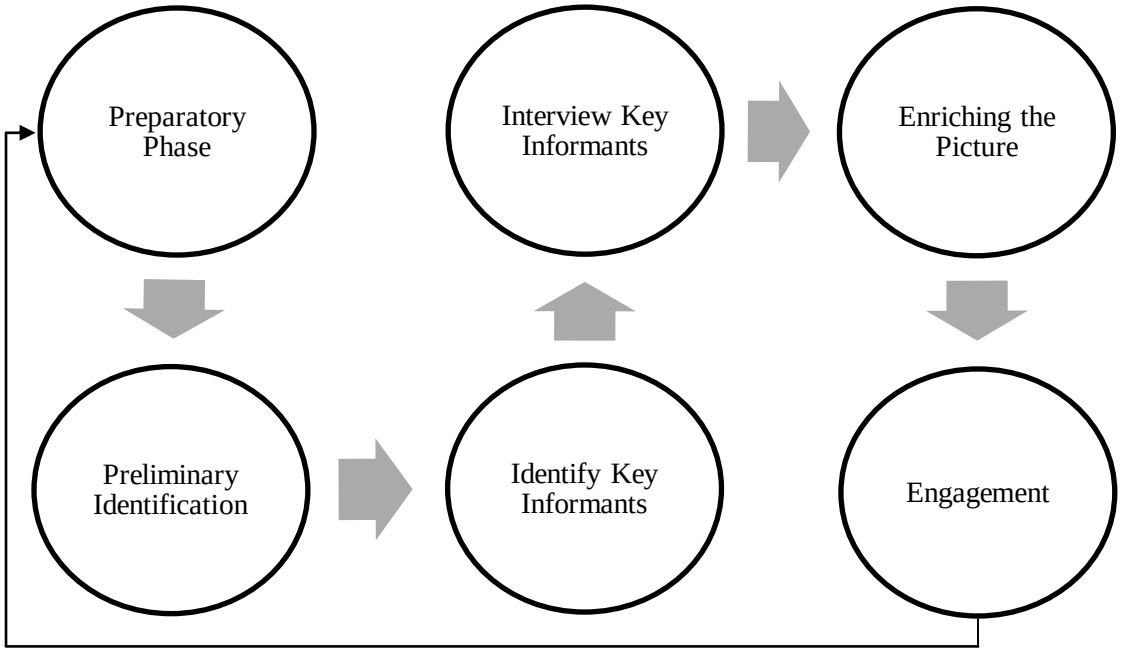

Table 1. Environmental and risk-management practices in Niagara (source Velaniškis, 2011).

Category of Practice	Description of Category of Practice (in order of frequency of reporting by interviewees)
Policy development & sustainability planning	Policy development based on the general principles of sustainability and environmental best management practices
Education	Education of the public about ecosystem functions, vulnerabilities, weather related risks, and carbon reduction practices
Water protection	Protection of surface water and groundwater resources and areas of recharge
Carbon management	Efforts to reduce carbon emissions internally and externally
Environmental regeneration	Restoration of land, water quality, wildlife habitat, wetland and forest functions, and other ecosystem functions
Resource conservation	Protection and conservation of natural resources, wildlife habitat, and ecosystem functions
Emergency response	Responding to weather related/and environmental emergencies such as heat wave, storm, fire, flood, spill, and air pollution
Shoreline protection	Protection of shorelines along lakes and rivers from erosion, bacteria and contamination
Oversight and enforcement	Environmental oversight, practices, and guidelines provided by other agencies / organizations
Natural systems/corridors planning	Planning to foster and protect natural heritage systems such as wildlife and forest corridors
Public health & weather monitoring	Monitoring of environmental conditions and responding to environmental threats to public health (i.e. heat wave alerts)
Adaptation to environmental change	Environmental management practices that take into account and anticipate changing environmental and climatic conditions
Planning for risk management	Planning for risks associated with environmental hazards and extreme events (i.e. identifying and analyzing risks, spill preparedness, evacuation planning, fire prevention)
Agriculture planning	Predominantly related to irrigation system planning