Living in Harmony with Nature: Complication of Climate Change and Governance

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INTRODUCTION

Climate change, a coupled natural and human system, is perhaps the greatest challenge facing society as it is global, but it will affect regions and localities in different ways. Anthropogenic activities have altered the natural climate system. Changing climate alters human activities. This feedback loop is non-linear and effects are amplified in unknown ways that may lead to unexpected tipping points both in global climate and viability of society. We must find ways, and soon, to adapt to changing climate to sustain social systems. Human systems are coupled to, and indeed dependent upon, natural systems; we need to conduct climate change research that integrates studies of both systems. *And we need to apply what we learn about these systems to decisions that get made.*

Climate change is a wicked problem—a class of problems that cannot be solved by technology and science alone because they have a human dimension (Rittel and Weber, 1973; Brown et al., 2010). Coupled natural and human systems, by this definition, present wicked problems. Almost all environmental problems are wicked and climate change is the perfect storm of a wicked problem (Karl et al., 2011). Wicked problems are considered intractable. It is suggested they are only intractable if one expects a discrete and one-time

solution. The nature of a wicked problem is constantly changing through time, because both natural and human systems are dynamic. Thus, one cannot approach solving a wicked problem with a solution in mind. There is no solution and in this sense the problem is intractable. But that does not mean it cannot be dealt with. We might define "the solution" in a different way. The solution is one of altering and adjusting decisions in response to the changing problem. In other words we need to find ways to adapt to the ever-emerging properties of changing climate.

Whereas this paper focusses on the United States, it has implications for other societies and cultures striving to adapt to changing climate. During the last decade, societies have begun to embrace not only mitigation but also adaptation as strategies to cope with global warming. And now adaptation is considered by most to include mitigation measures.

International accords and national policies, although necessary, are insufficient for effective adaptation to climate change. Adaptation is local and requires community planning and grass roots movements. My premise is that collective action across and that integrates all scales and levels of governance and society is needed to address the impacts of climate change to achieve sustainable societies and ecosystems. An essential and critical part of this premise is the imperative of representing the wide range of interests, insights, knowledge, and experience that resides in a highly diverse society. Disadvantaged groups and communities are being disproportionately affected by the impacts of climate change (for example, submergence of the Sundarbans and Pacific island nations, the effects of Hurricane Katrina, etc.). These groups and communities must be included in developing adaptation strategies for society to survive changing climate. Many reports and guides on adaptation to climate change recommend public involvement. We must develop a truly participatory, collaborative process that combines deliberation with analysis in an inclusive process; it must become a way of thinking and doing that infuses our current governance and decision-making processes and helps to guide their evolution and foster new institutional arrangements, and it must grow from the grass roots up and be supported from the top down.

In modern western culture, the question of whether humans can live in harmony with nature has been debated since at least the contrasting philosophies of the 17th century English philosopher Thomas Hobbes and the 18th century French philosopher Jean-Jacques Rousseau. Essentially Hobbes viewed competitiveness and violence as the innate tendency of humans, whereas Rousseau saw human nature as largely benevolent and good. An extension of Hobbes' view is that humans are in competition with nature, whereas Rousseau believed humans could live in harmony with nature. The "cynical" and "idealistic" view of human nature may be considered end-members of the human relationship with the environment.

CONCEPTUAL MODELS OF ENVIRONMENTAL POLICY

These contrasting philosophies to this day influence and shape distinctly different approaches to environmental policy and climate change. In the late 1960s and early 1970s several environmental protection laws, including the Clean Air Act of 1970, the Clean Water Act of 1972, and Endangered Species Act of 1973, were enacted in the United States. These unprecedented laws were a response to the environmental crisis of the 1960s that was symbolized by Cleveland's contaminated Cuyahoga River catching fire. The National Environmental Policy Act (NEPA)—the foundation of modern American environmental policy—was enacted in 1969.

The purpose of NEPA is "to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."[1] In effect, NEPA aspires to achieve reconciliation or balance or harmony among three systems: natural (ecological) systems, social systems, and economic systems. Moreover, it mandates, among other directives, that all federal agencies should "utilize a systematic, interdisciplinary approach which will ensure the *integrated use* of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on man's environment" and "…insure that presently unquantified *environmental amenities and values* may be given appropriate consideration in decision-making along with economic and technical considerations"[2] (emphasis added).

Many subsequent reports and environmental initiatives have also aimed to achieve the aspirations set forth in NEPA. Yet, environmental policy continues to fall short of achieving productive harmony (Karl et al., 2012).

Contrasting Conceptual Models

The following discussion is excerpted from the first chapter of Karl et al. (2012).

> Productive harmony is most often interpreted to imply an equal status among the three systems. However, one worldview puts economic systems and societies they support on a higher plane than ecological systems, whereas another worldview elevates ecological systems. These opposing worldviews generate conflict, which often results in dysfunction, because the antagonists on one side presume robust economies are attained at the expense of ecosystem health (despoiling the environment) and those on the other side believe aggressive environmental protection and ecosystem restoration are not compatible with strong (profitable) economies. Some actions to reduce environmental impacts do carry costs, and most production and consumption activities have some

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[1] http://ceq.hss.doe.gov/nepa/regs/nepa/nepaeqia.htm; Section 101.
[2] http://ceq.hss.doe.gov/nepa/regs/nepa/nepaeqia.htm; Section 102.

environmental impacts. However, pursuit of economic and environmental benefits need not be a zero-sum contest. Such a framework presents an unnecessary dichotomy. Adherence to it causes polarization and stalemate. The potential tensions between economic actions and environmental protection, when managed well, can transform into a creative tension that can lead to breakthrough solutions—the harmony among ecological, economic, and social systems envisioned in the National Environmental Policy Act. ….

   … The conventional conception of productive harmony among the three systems is that each system occupies the corner of a triangle or some other trilogy analogy (Fig. 18.1). Productive harmony, or sustainability, is achieved at the centre of the triangle, which seldom occurs in practice. There are various paths and combinations to reach the harmonious centre, yet these paths often require trade-offs that can possibly (and often do) result in deadlock. Theoretically, productive harmony could be achieved at numerous points along these paths through compromise. But compromise is difficult to achieve, particularly where mistrust flourishes and, where decision making remains framed within the triangle of competing systems, there is no way to think outside the "box."

   .Figure 18.1 is a representation of the traditional way of thinking of harmony among ecological systems, social systems, and economic systems. The dots with crosses represent a few of the infinite combinations within the circle among the three systems. This is a static model, with movement only possible within the bounds of the triangle, with sustainability essentially conceived as a series of different tradeoffs.

   Another way to visualize productive harmony is to look at sustainability as a house (Fig. 18.2). In this conceptual model, Dynamic Productive Harmony, ecological systems are the foundation of the house and the heating, plumbing, electrical, and water systems (infrastructure) of the house; social systems are the
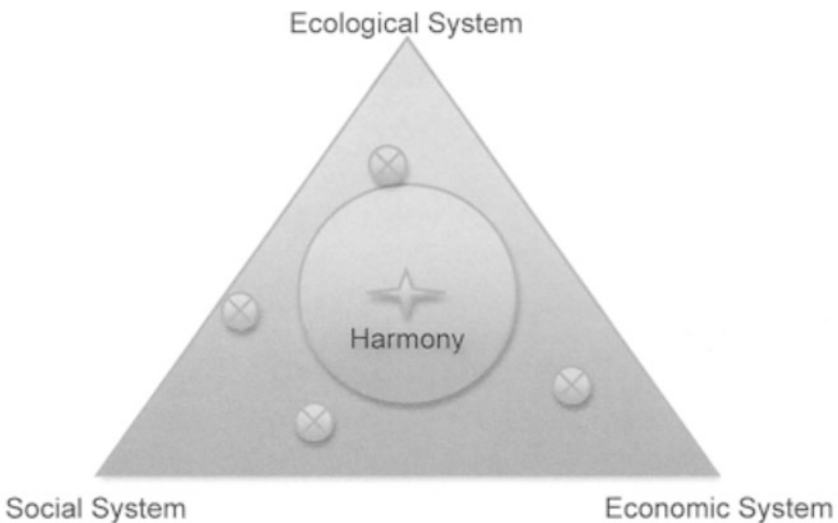

Fig. 18.1: Static productive harmony model.
Source: Karl et al. (2012), Springer.

living spaces (superstructure); and economic systems are the flows of goods and services such as food and fuel into the house to service the living spaces.[3] The engines (ecosystem services) for the infrastructure are housed in the basement, the structural foundation of the house. The environment is the overall framework of the house that shelters all. A deteriorating framework exposes everything within the house to the weather, with degradation or even, ruination resulting. Similarly, if the foundation is faulty or allowed to deteriorate, the superstructure and flow of goods and services will eventually deteriorate. Indeed, if the foundation has been neglected, a nicely painted house may provide a false sense of security. The house must be constantly maintained (a continuing process) to stay in good repair. Given a strong foundation, the house can be remodelled and enlarged—breaking out of the original "box." The architect (scientist/engineer), general contractor (policy maker/economic actors), subcontractors (natural resource managers/land use planners), and owner (citizen/community) together
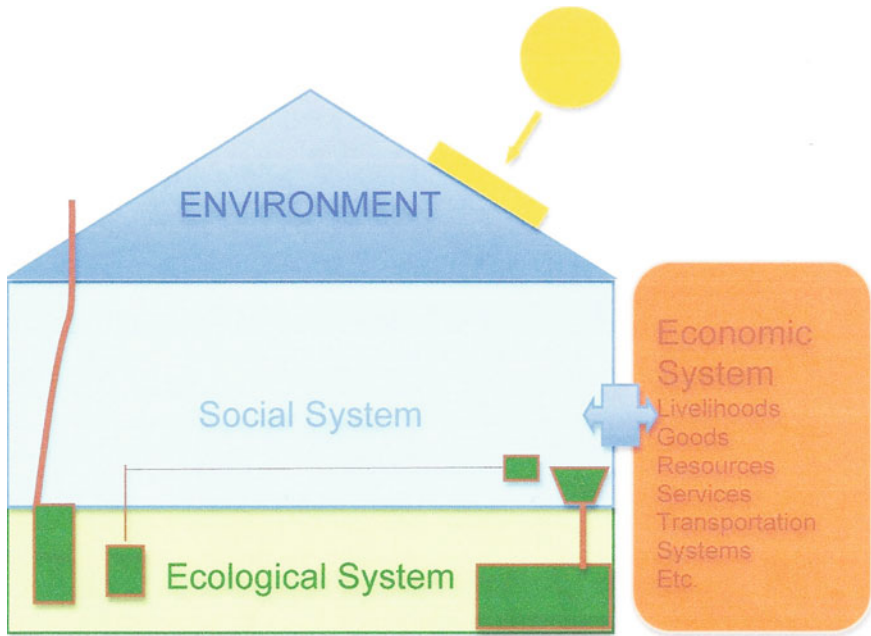

Fig. 18.2: Dynamic productive harmony model.

Source: Karl et al. (2012), Springer.

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[3] Ecological systems are both foundations and infrastructure. Using ecosystems in an ecosystem services framework is often about replacing "gray" infrastructure—levees, wastewater treatment plants, etc.—with "green" infrastructure i.e. coastal sea marshes, wetlands, etc. Economic systems are not really just matters of "static" infrastructure i.e. bridges, roads, airports, etc. As systems, economies are highly dynamic contexts through which people exchange goods and services, allocate scarce resources, etc.

can create something new to fit the growing needs of the family (society/ nation).[4]

Figure 18.2 is a conceptual model where the ecological system is the foundation and infrastructure for robust social systems and strong economic systems. Sustainability is not possible without a healthy ecosystem. This is a dynamic model reflecting the complex and complicated dynamics of coupled natural and human systems. The "house" needs constant upkeep and if the needs of the family (society) change it can be expanded and remodelled. It is a dynamic, process-oriented model. Sustainability is attainable as an outcome of continual decision-making processes.

The distinction between these conceptual models is critical as they represent two fundamentally different approaches to restoring and sustaining lands and setting environmental policy. Following the first conceptual model, policy tends to move toward compromise among the three systems by seeking the centre of the triangle, equating harmony as balance, but generally requiring tradeoffs among systems. Trade-offs are presumed at the expense of one system over another. In the second, policy focusses on sound construction and preservation of the foundation and the overall decision framework to sustain and preserve the superstructure, infrastructure and resource flows. Trade-offs may still be necessary in this model. However, value can be added by "remodelling" mitigating trade-offs. Others have described this intersection of environmental, economic and social values as achieving "triple bottom line" or win-win-win outcomes.

Fundamentally these models represent value dynamics at play; it is believed that decisions at their core are based on values. The set of values are essentially the same in both. However, individual values are weighted differently in the decision-making process under each conceptual model. For example, often under the Static Productive Harmony Model power and wealth seem to be the dominant values that influence the decision outcome; these are associated with politics and economics, respectively. Whereas in the Dynamic Productive Harmony Model, for instance, enlightenment and respect would be weighted more heavily in the decision-making process (ideally a participatory, collaborative process) and have a greater role in shaping the outcome. Note that no value judgement about the "goodness" or "badness" of different values is being made here. It is said that under the different conceptual models, the same values would be weighted differently and, consequently, the resultant outcome under each model given the same situation or issue could be different.

NEW INSTITUTIONS AND DECISION-MAKING PROCESSES

Will the existing institutional and governance arrangements give us the information we need to respond in a timely and effective manner to the risks

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[4] Anyone who has built a house knows that there is constant negotiation and tension among the architect, contractor, subcontractors and owner. When tension is managed well, a superior house is built.

associated with climate change, and more generally, formulate policy guided by the Dynamic Productive Harmony Model? A recent 2009 National Research Council (NRC) report (2009) "Informing Decisions in a Changing Climate" states explicitly that our current institutions and decision-making processes are not adequate to deal with changing climate. The report asserts, "Decision makers…need new kinds of information, as well as new ways of thinking, new decision processes, and sometimes new institutions to function effectively in the context of ongoing climate change." It discusses aspects of these elements that include that scientists should address user's needs, problems should be tackled by interdisciplinary and multidisciplinary workforces (that include social scientists and engineers), institutions should cooperate across boundaries, enhanced interdisciplinary programmes for graduate students, opportunities for graduate students and researchers to engage in applied research, and develop ongoing forums for collaborative problem solving with citizens. Many of the concepts and applications described in the report have been described in earlier reports, books, and papers. And consider the language in NEPA. Does it not presage that above?

The following is excerpted from an internal Massachusetts Institute of Technology proposal (Susskind and Karl, 2007) to the U.S. Geological Survey:

> In the 1995 report, *Science, Policy, and the Coast—Improving Decisionmaking,* the National Research Council (NRC) stated
>> more effort is needed in the interpretation of fundamental science results for use in policymaking. Perhaps the most effective means of such integration is by … scientists who are engaged in both fundamental research and policy-relevant scientific activities, although such individuals are a rarity. They are able to extend the results of more applied, and often more descriptive, research by bringing in the understanding of processes resulting from fundamental research.
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> Neal Lane in his 2006 *Science* editorial, "Alarm Bells Should Help Us Refocus," develops the NRC perspective further, stating that to meet the challenges of a rapidly changing world that we must engage "… the nation's top social scientists, including policy experts, to work in collaboration with scientists and engineers from many fields and diverse institutions on multidisciplinary research efforts that address large but well-defined national and global problems."
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> To increase the number of scientists with these capabilities, the NRC has encouraged institutions of higher learning to "improve the cross-disciplinary training of natural and social scientists … and [to create] "programs of training for 'science translators'." Science translator training programs "should include exposure to the natural and social sciences, policy development and implementation, and conflict management and communication skills." Recent experiences with collaborative research illustrates that science can be a "community-building tool" that brings together diverse individuals and organizations, creating credibility and agreement around policy outcomes.
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> To help ensure that good science is given its due in public policy making, appropriate forums and collaborative procedures, particularly at the local or

community level, are needed to bring experts, public officials, environmental advocates, business interests, and the general public together to take account of scientific input, local knowledge, as well as the relevant values and interests of the stakeholders involved. This is widely recognized to be the case; the NRC report, *Science, Policy, and the Coast* suggests that "the scientific community could help improve the application of appropriate scientific information to … management problems by developing consensus-forming processes that support credible analyses for use to policymaking."

More than a decade ago, in her Presidential Address to the Annual Meeting of the American Association for the Advancement of Science, Jane Lubchenco asserted, "Urgent and unprecedented environmental and social changes challenge scientists to define a new social contract." Under this contract, scientists are expected not only to do the best possible science but also to produce "something useful." She recognized that "new and unmet needs of society include more comprehensive information, understanding, and technologies for society to move toward a sustainable biosphere." She challenged scientists to meet these requirements. Lubchenco's challenge has been issued repeatedly over the past decade.

Why have not the recommendations made in the above reports and others been widely accepted and become routine practices? Researchers and practitioners should focus on answering this question to help foster substantive change.

Adaptation to Climate Change and Sustainability

There is great uncertainty regarding the risks associated with climate change, especially at local and regional (as opposed to continental and global) scales; hence, we must develop flexible and adaptive strategies to mitigate and manage their impacts.

Most reports on adaptation to climate change agree that adaptation is local. For example, "Because impacts of and vulnerabilities to climate change vary greatly across regions and sectors, adaptation decisions are fundamentally place-based…. Local governments should develop and implement climate change adaptation plans pursuant to national climate change adaptation strategy in consultation with the broad range of stakeholders in their communities" (National Research Council, 2010). A contradiction is seen in the above on two accounts.

First, if adaptation is place-based, why should local adaptation plans be developed and implemented "pursuant to national" policy? Consider what we know about the best practices of stakeholder participatory collaborative processes. Each place has different physical and cultural characteristics, which ought to be taken into account when developing and implementing a climate change adaptation strategy. National strategies cannot be that specific for place-based adaptation; they can, however, provide general guidelines. Consider three US coastal and port cities: New York City, Boston and Miami.

Let's consider only their physical location (and not cultural differences) and only one effect of climate change that of rising sea level and increasing storm surge. New York City and Boston are in the northeast and about 300 km apart. Yet, the impact of climate change will be different for each. With rising sea level, the lower elevations of both cities will be submerged and storm surges will cause frequent flooding of higher elevations. It is within the realm of possibility to build a sea wall completely around the island of Manhattan, which is the world's financial hub and the home to global organizations such as the United Nations, to protect these institutions and other highly valued infrastructure. Other adaptation strategies would likely be necessary for the other boroughs that might include abandonment and migration. Boston, on the other hand, is not an island. Although surge barriers might be constructed, it might not be possible to isolate and protect areas of Boston deemed critical and essential as it would Manhattan, one of five New York City boroughs. Engineering adaptations might not be effective for Miami at all. It is built on porous and permeable limestone and beach sand unlike New York City and Boston that, while portions of each are built on fill, are largely underlain by impermeable bedrock. For Miami adapting to climate change might require relocation of large parts of the city. The above scenarios are driven by economic and technical considerations. Recall, however, the language in NEPA to "…insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations."

So, second, let's consider the role of a place's culture, environmental amenities, and values—components of the social system—with respect to developing and implementing climate change adaptation strategies. Even if the scientific evidence shows that an area that has been severely impacted will very likely be impacted as severely or worse again, people who live in the area may decide to rebuild and continue living there; this was the case in certain districts in New Orleans after Hurricane Katrina. The NRC report (2010) above states that adaptation plans should be developed by local government "in consultation with the broad range of stakeholders in their communities." What does this mean? Often "consultation" means that a plan has already been developed by a government agency and is presented to citizens for comment at a public meeting. The public usually has a limited time to comment at the meeting often as short as two minutes per person. In the United States, Daniels and Walker (2001) characterized this form of consultation as the "Three-'I' Model: inform, invite, and ignore," because usually the public comments are not substantively included in the final plan. A more participatory consultation process is that of establishing a citizen committee that functions as an advisory committee in the government decision-making process. This approach was used by Boston in developing its climate change adaptation plan (Karl et al., 2012). However, this approach is still not a true participatory approach where citizens make decisions as equal partners with government, which will be addressed in the subsection *New Process*.

In the discussion above, two end members—economic and social systems—of the Static Productive Harmony Model (Fig. 18.1) have been briefly touched upon. For the sake of discussion let us say that in the United States "trajectories and solutions of harmony" are generally contained in the lower one-third of the triangle between social and economic systems and weighted toward the economic end member. Yet, if we strive to live in harmony with nature, it would seem that "trajectories and solutions" of harmony need to move toward the top of the triangle and the ecological systems end member, because "…healthy ecosystems are the foundation for thriving communities and dynamic economies" (Karl et al., 2012). This has not been achievable in the four decades since enactment of NEPA even though many sustainability and environmental initiatives have encouraged it as well. Perhaps it is not even possible if environmental policy continues to be influenced conceptually by the static model and is formulated within current institutions and governance regimes.

Whereas it may not be possible or desirable to relocate many existing cities and communities as they are impacted by the effects of changing climate, as part of strategic planning to adapt to changing climate, for people that will be forced to migrate and relocate, it might be possible and desirable to plan and develop new communities based on the conceptual principles of the Dynamic Productive Harmony Model (Fig. 18.2). Ecovillages might serve as one model. Avelino and Kunze[2] state:

> The ecovillage movement emerged in the 1980s/90s in response to ecological and social challenges in modern societies. The definition that ecovillages most often use to describe themselves is "a human-scale, full-featured settlement, in which human activities are harmlessly integrated into the natural world, in a way that is supportive of healthy human development and can be successfully continued into the indefinite future" (Gilman, 1991). A more recent definition of ecovillages is: "private citizens' initiatives in which the communitarian impulse is of central importance, that are seeking to win back some measure of control over community resources, that have strong shared values and that act as centres of research, demonstration and (in most cases) training" (Dawson, 2006).

Currently a type of ecovillage, called Khajuraho Eco Business City, is being planned in the Indian state of Madhya Pradesh. "The purpose of the Khajuraho Eco Business City is to be the motor for the multicultural and sustainable social, economic and ecological development of the city and the (regional) community" (de Rooij et al.). This experiment is a concept of co-learning between East and West and North and South and the outcome will not be known for several years. Ecocities may provide an alternative approach to sustainability. Planning for ecocities would require collaboration among a range of stakeholders that include citizens, planners, scientists and government officials.

New Process

There is a distinction between "consultation" and "collaboration" when considering community and citizen engagement in a process. Yet, the two are often conflated in usage. Similarly, there is a distinction between "involvement" and "participation." These also are often used interchangeably. Consultation does not imply that the recommendations of those consulted will be acted upon. Involvement does not necessarily mean full and equal participation. Collaboration and participation, on the other hand, imply a higher, more equal, and more active level of engagement among actors.

The consultative processes (public hearing and advisory committee) described above are two of a spectrum of participation processes. What is meant by an active, equal, and inclusive community participation process is a consensus-seeking decision process that includes a broad range of stakeholders each of whom has an equal role (Susskind et al., 1999). To be effective so that the decisions of the group are implemented, those agencies authorized by statue and law to make and implement the decision must be represented and meet regularly with the group. In this process, it is important to understand that the group does not usurp the authority of the decision-making agency or agencies. In a well-designed process, the agency agrees to implement the consensus decision of the group instead of making a unilateral decision. This is a critical distinction that is often misunderstood by agencies. There are well-defined best practices for developing and managing a consensus seeking process (Susskind et al., 1999). One critical factor is that the actors around the table must be self-selecting. This is done through an impartial stakeholder assessment. The stakeholder assessment will also determine if a collaborative process is even appropriate. The selection of a representative stakeholder group is not a trivial matter and there are a number of complicating factors that must be taken into account. In large metropolitan complexes, for example, one complicating factor is cultural differences between neighbourhoods (Karl et al., 2012) as well as social and environmental justice concerns.

Indeed, a consensus-seeking process seems to be among the new decision-making processes called for by the NRC (2009) and others. The report describes a decision support process that combines "participatory deliberation with expert analysis in an iterative process." In effect they have described a consensus-seeking process with a joint fact finding element (Ehrmann and Stinson, 1999; Andrews, 2002; Karl et al., 2007). This is not a new process, yet it is not tried and implemented as often as it could be. Many people are not aware of it and to them it is new.

New Information

Among the new information that the NRC report (2009) urges is developing "…the science of climate change *response*, as a complement to the science

of climate change *processes*. … Also, needed are contributions from a wide range of the disciplines including behavioral and social science disciplines….” Unless “…decision support processes … take priority over information products…” the products are unlikely to be used by decision makers. This is in accord with the discussion in the previous subsection.

As documented herein, this type of information and research is not new. That it continues to be the subject of new reports underscores the fact that multi-disciplinary research that includes the social and behavioural sciences is rare, and, rarer yet is the use of products of this research in collaborative or other decision-making processes.

Equally as rare is the integration of local, indigenous, or experiential knowledge with scientific knowledge. Collaborative, multidisciplinary and interdisciplinary processes should take into account these forms of information.

New Thinking

It should be apparent that to tackle the wicked problem of adapting to changing climate, a more holistic way of thinking is necessary. In the past very few graduate schools trained scientists to think broadly across disciplines. Scientists, for the most part, continue to be trained to focus narrowly on a discipline. To do so is necessary to make fundamental advances in a particular discipline or field. It is not being suggested abandoning reductionist science. It is suggested that a new class of professional be trained to think holistically and to learn how to synthesize diverse intelligence and information (Susskind and Karl, 2007). These professionals would have a strong grounding in a discipline or field, but would engage in an integrated, multi-disciplinary course of study.

There are many barriers to conducting integrated, multi-disciplinary research and training students to think holistically. Foremost among these is the strong disciplinary nature of academic departments. Others include the reward structure for research scientists and the tenure system for academic faculty (both of which emphasize achieving excellence in a discipline or field), the paucity of funding for interdisciplinary research, and the under-appreciation for such skills among decision makers.

New Institutions

Overcoming the barriers to support new information and new thinking will require bridging gaps and developing new institutions. Holling and Chambers (1973) stated this almost forty years ago: “Wherever we look there are gaps – gaps between methods, disciplines and institutions.”

A core question and area of action research: What will the new institutions look like to bridge these gaps?

As stated earlier, my premise is that collective action across and that integrates all scales and levels of governance and society is needed to address

the impacts of climate change to achieve sustainable societies and ecosystems. Therefore, the new institutions need to function cooperatively and support collaborative process approaches.

Because developing the professionals to staff these institutions is critical, universities and colleges should establish programmes to train students in interdisciplinary (Clark et al., 2011), transdisciplinary (Klein et al., 2001), and collaborative processes (Susskind et al., 1999) approaches so that they build the capacity to think critically, holistically, and collectively to solve problems. These programmes must have students working in collaborative teams on a problem (Susskind and Karl, 2009). The nature of the problem will shape the questions to be asked, the intelligence to be gathered, who will gather it, and what approach and process will be used. Universities and colleges that have such a programme should make it widely known and take care to distinguish it from typical environment studies programmes (Walton, 2007). The U.S. Geological Survey and the Massachusetts Institute of Technology developed such a programme—MIT-USGS Science Impact Collaborative (MUSIC)—housed in MIT's Department of Urban Studies and Planning.[5] The administrators of these programmes might reflect on whether the course content and structure is in accord with that recommended by the NRC for "science translators" and strategies for "integrating knowledge, education, and actions for a better world" as articulated by Clark et al. (2011). Course curricula should also evolve to meet the continual challenges brought about by emerging properties of coupled natural and human systems. In this regard, academic faculty should interact more with practitioners and citizens. Universities and colleges should be strongly integrated into their communities.

Owing to length restraints, it is not possible to discuss thoroughly the various forms of new institutions that are emerging during a period of transition and evolution in responding to the interactions between human and natural systems in a changing climate. For a synopsis and pertinent references, the reader is referred to Scarlett (2012) and Karl et al. (2012) and the social-ecological, political science, and social science literature.

What these new institutions and governance regimes have in common is a structure and operating principle based on coordination, cooperation and collaboration among institutional entities and individual actors. These institutional arrangements could include public-private partnerships, commissions consisting of several government agencies that cooperate to act as a single entity, and local stewardship groups that consist of diverse stakeholders using a consensus-seeking decision process. Also, these institutions ought to give more weight to values such as enlightenment, respect and well-being to balance better the often dominant values of power and wealth in typical decision-making processes.

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[5] http://web.mit.edu/dusp/epp/music/; USGS ended its participation in the programme in 2010. MUSIC is continued by MIT as Science Impact Collaborative.

Kania and Cramer (2011) describe a promising form of institutional arrangement, called collective impact. "Shifting from isolated impact to collective impact is not merely a matter of encouraging more collaboration or public-private partnerships. It requires a systematic approach to social impact that focusses on the relationship between organizations and the progress toward shared objectives. And it requires the *creation of a new set* (emphasis added) of nonprofit management organizations that have the skills and resources to assemble and coordinate the specific elements necessary for collective action to succeed."

We are in a period of transition globally and societies have the opportunity to shape the institutions that will enable more effective and durable decisions with respect to the environment and adaptation to climate change.

SCALE

The processes and institutions described above will need to take into account and operate over different spatial and temporal scales. The processes of climate change have global impacts and operate over long (hundreds of years to geologic) time scales. Yet, adaptation to climate change is local and policy is formulated and planning done on short time scales (months to years). The new institutions will need to reconcile these differences in scale between natural processes and decision-making processes.

Do we have the time to develop these institutions? Climate is changing rapidly as manifested by rising global temperature, rising global sea level, and increasing local extreme weather events that include flooding and drought. Not only will it take time to develop institutions that function collaboratively, it will take time *to build the trust* among individuals and between the institutions so that they can function at all. Trust takes years to build among those that have different points of view and it is a constant challenge to keep it. Yet, once developed, often impasses are broken and new ideas sprout that enable creative solutions to what before were unsolvable problems.

For the most part societies on a global scale have been sufficiently resilient to absorb the impacts of natural disturbances and human activity. However, as Holling and Chambers (1973) point out "resilience is not infinite" and "…three hundred years of ignoring these limits has left us with a baggage of approaches and solutions that are only admirable as instruments for resolving fragments of problems."

SUMMARY AND CONCLUSIONS

Environmental crises, exacerbated by climate change, are occurring worldwide with greater frequency and more intensity. International accords and national plans outlining strategies to mitigate the effects of and adapt to changing climate have been developed over the past decade. These are insufficient and

have had little effect in meeting the challenges of a rapidly changing climate. Climate adaptation is local and local planning is necessary to implement the recommendations of the international and national plans. Current institutions, legal frameworks, and decision processes were developed during a stable climate. These may not be adequate to deal with changing climate, which is now the new normal. New institutions will need to reconcile the difference in scale (spatial and temporal) between natural processes of climate change and governance processes.

Climate change is not a scientific problem—it is a political and social problem. Human behaviour and values are essential elements in developing policies and plans for adapting to climate change. Consequently, societies need new institutions and decision processes that integrate scientific, political, and social information to formulate more durable and equitable climate change policies and environmental policies in general. Whereas lawmakers like to claim that environmental decisions are based on the best science, with rare exception[6] this assertion is largely a myth (Karl et al., 2007). Decisions are based on values. Often lawmakers cannot agree on the science and it becomes a source of conflict and consequent inaction. And, even when there is agreement about the science, political, economic and social factors often take precedence in decisions that get made.

Because there is a diversity of worldviews and values held by individuals and societies, herein it is suggested that processes that enable collective action should be built into new institutions. Any form of coordination, cooperation and collaboration takes longer and is more difficult than unilateral decision-making, regulatory and law-making processes. And, in fact, it may not be appropriate for all situations. However, there are well known procedures to determine if some form of collaborative process is possible and best practices for managing such processes.

Conflict can be a creative force when managed well and trust is built; when not managed well, particularly in a context of mistrust, it is destructive. Societies need to harness, and concentrate through new institutions, the wisdom and power represented by a diverse citizenry to tackle the wicked problem of climate change.

ACKNOWLEDGEMENTS

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[6] One exception was the decision by the U.S. Department of the Interior to list the polar bear as a threatened species.

REFERENCES

Andrews, C.J. (2002). Humble analysis: The practice of joint fact finding. Praeger, London and Westport, CT.

Avelino, F. and Kunze, I. (In press). Ecovillages: Intentional communities on sustainable living. Beliefs and Values: Understanding the Global Implications of Human Nature. *In:* de Rooij, A. (ed.), Global knowledge cities: Twins of communities, one rich one poor, co-learning on practices and theories of connectivity and multiplicity. International Beliefs and Values Institute. http://www.springerpub.com/product/19420617#.TlZaKXNq1U0.

Brown, V.A., Harris, J.A. and Russell, J.Y. (2010). Tackling wicked problems through the interdisciplinary imagination. Earthscan, Washington, DC/London.

Clark, S.G., Rutherford, M.B., Auer, M., Cherney, D.N., Wallace, R.L., Mattson, D.J., Clark, D.A., Foote, L., Krogman, N., Wilshusen, P. and Steelman, T. (2011a). College and university environmental programs as a policy problem (Part 1): Integrating knowledge, education, and action for a better world? *Environmental Management*, **47:** 701-715.

Clark, S.G., Rutherford, M.B., Auer, M., Cherney, D.N., Wallace, R.L., Mattson, D.J., Clark, D.A., Foote, L., Krogman, N., Wilshusen, P. and Steelman, T. (2011b). College and university environmental programs as a policy problem (Part 2): Strategies for improvement. *Environmental Management*, **47:** 716-726.

Clark, S.G., Steen-Adams, M.M., Pfirman, S. and Wallace, R.L. (2011a). Professional development of interdisciplinary environmental scholars. *J. Environ. Stud. Sci.,* **6:** 99-113.

Curtin, Charles (2005). Complexity, conservation, and culture in Mexico/U.S. Borderlands. Natural Resources as Community Assets: Lessons from Two Continents. Chapter 9, pp. 237-258.

Daniels, S.E. and Walker, G.B. (2001). Working through environmental conflict. Praeger, Westport, Connecticut and London.

Dawson, Jonathan (2007). Ecovillages achieve lowest-ever Ecological Footprint results. *Global Ecovillage Network Europe News* (winter 2006/07).

de Rooij, A., Matta, C., van Rooizen, M. Karl, H.A. and Mishra, J. (2011). The Global Knowledge Cities Concept: Local-Global Solution to Social, Economic and Ecological Crises. *Beliefs and Values,* **3(1):** 147-162.

Ehrmann, J.R. and Stinson, B.L. (1999). Joint fact-finding and the use of technical experts. *In:* L. Susskind, S. McKearnan and Thomas-Larmer, J. (eds), The Consensus Building Handbook. Sage Publications, Thousand Oaks.

Gilman, R. (1991). The Ecovillage Challenge. *In:* In Context, No.1/1991.

Holling, C.S. and Chambers, A.D. (1973). Resource science: The nurture of an infant. *Bioscience*, **23:** 13-20.

http://www.context.org/ICLIB/IC29/Gilman1.htm 03.01.09

Kania, J. and Kramer, M. (2011). Collective impact. *Stanford Social Innovation Review*, Winter **2011:** 36-41.

Karl, H.A., Curtin, C., Scarlett, L. and Hopkins, W. (2011). Adapting to climate change—A wicked problem. *In:* I. Linkov and T.S. Bridges (eds), Climate: global change and local adaptation, NATO Science for Peace and Security Series C: Environmental Security, Springer Science+Business Media, B.V.

Karl, H.A., Scarlett, L., Vargas-Moreno, J.C. and Flaxman, M. (2012). Restoring Lands - Coordinating Science, Politics and Action: Complexities of Climate and Governance. Springer Science + Business Media, Dordrecht, The Netherlands.

Karl, H.A., Scarlett, P.L., Kirshen, P., Dell, R., Ibrahim, H., Kuhl, L., Mosher, T., Navarro, B., Rising, M. and Towery, N. (2012). Adapting to climate change: exploring the role of the neighborhood. *In:* Karl, H.A., Scarlett, L., Vargas-Moreno, J.C. and Flaxman, M. (eds). Springer Science + Business Media, Dordrecht, The Netherlands.

Karl, H.A., Susskind, L.E. and Wallace, K.H. (2007). A dialogue, not a diatribe— Effective integration of science and policy through joint fact finding. *Environment*, **49:** 20-34.

Klein, Julia Thomas, Grossenbacher-Mansuy, Walter, Haberti, Rudof, Scholz, Bill, Alain, Scholz, Roland W. and Welti, Mythra (eds) (2001). Transdisciplinarity— Joint problem solving among science, technology, and society: An effective way for managing complexity. Birhhauser Verlag, Basel, Boston, Berlin.

Lane, N. (2006). Alarm bells should help us refocus. *Science,* **312:** 1847.

Lubchenco, J. (1998). Entering the century of the environment: A new social contract for science. *Science*, **299:** 491-497.

National Research Council (2010). Adapting to the impacts of climate change. The National Academies Press, Washington, D.C.

National Research Council (2009). Informing decisions in a changing climate. The National Academies Press, Washington, D.C.

National Research Council (1995). Science, policy, and the coast: Improving decisionmaking. The National Academies Press, Washington, D.C.

Rittel, H. and Weber, M. (1973). Dilemmas in a general theory of planning. *Policy Sci.*, **4:** 155-169.

Scarlett, L. (2012). Transcending boundaries: The emergence of conservation networks. *In:* Karl, H.A., Scarlett, L., Vargas-Moreno, J.C. and Flaxman, M. (eds). Springer Science + Business Media, Dordrecht, The Netherlands.

Susskind, L. and Karl, H. (2007). Proposal: request for multi-year support for the MIT-USGS Science Impact Collaborative (MUSIC). A field-based internship program to train science impact coordinators. Working Paper Massachusetts Institute of Technology, submitted to U.S. Geological Survey.

Susskind, L. and Karl, H. (2009). The Best of MUSIC. MIT Working Paper, Environmental Policy and Planning Group, MIT-USGS Science Impact Collaborative (MUSIC), http://web.mit.edu/dusp/epp/music/pdf/Best-of-Music-2009.pdf; http://web.mit.edu/dusp/epp/music/

Susskind, L., McKearnan, S. and Thomas-Larmer, J. (eds) (1999). The Consensus Building Handbook. Sage Publications, Thousand Oaks.

Walton, Abigail Abrash (2007). Conservation through different lenses: Reflection, responsibility, and the politics of participation in conservation advocacy. *Environmental Management*, **45:** 19-25.