Innovations and Sustainability

Part 1

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This is the first of a six-part Discussion Paper Series of the SSHRC Research Project: *Environmental Governance for Sustainability and Resilience: Innovations in Canadian Biosphere Reserves and Model Forests*. This project involves researchers located at the University of Waterloo, Ontario and University of Saskatchewan, Saskatchewan, Canada.

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This Discussion Paper is intended to spark discussion and debate. Please use it but ensure that the ideas presented within are appropriately attributed to the author. Correspondence about the project as a whole can be directed to Dr. Robert Gibson at rbgibson@uwaterloo.ca or Dr. Maureen Reed at m.reed@usask.ca

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1. Prologue: Introduction to our approach and rationale. Three major approaches to generate innovations. Issues raised in international programs and literatures from different perspectives.

Prologue: Why "Innovations and Sustainability"?

The title of this SSHRC-funded study is "Environmental Governance for Sustainability and Resilience: Innovations in Canadian Biosphere Reserves and Model Forests". This places it in the growing tradition of community-based resource management and/or local socio-economic development. Much of the attention given to this is generally from people who are favorably disposed towards such programs and would like to see them succeed, but are also aware of the political and institutional difficulties that well-intentioned community activists might encounter. Academics who can function well as participant-observers might then be of help at certain phases along the way. There are a number of studies in Canada that relate to river basins and/or watersheds, agricultural communities, and coastal areas that are dependent in varying degrees on commercial fisheries or tourism. There were fewer studies that we were aware of that focused on different kinds of landscape units (other than watersheds) and especially biosphere reserves, the first several of which came into existence in the late 1970s and early 1980s in Canada, and the model forest program in Canada that appeared on the scene in 1992, with impressive funding from the federal government.

We also adopted a complex social-ecological systems set of perspectives for the systems of interest to us. "Complexity perspectives" raise a challenging set of unknowns and inherently unknowable features of system dynamics. These affect strategies to be adopted for steering towards desirable forms of sustainability within the governance systems through which this has to be done. The contextual and other changes that can occur in these (as well as other) community-based resource management systems require an ability to maintain some flexibility to adapt, sometimes rather suddenly, to altered circumstances. These latter can create new constraints or new opportunities, both of which require more than incremental adjustments. This is where "innovations" in some form may be necessary or opportune.

Complexity also characterizes the policies and programs promoting technology-based economic growth and development. Much that has been written about this tends to appear in different sets of mutually isolated literatures, each reflecting the particular disciplinary traditions and mono-scales for analyses that the contributors have adopted. We view these as “discursive domains”, i.e. self-referential communications among people who are busily engaged in the domain. The ‘dimensions’ of domains are defined by whoever is in them, and are bounded by their framing of the problems and issues of concern to them, the system boundaries they adopt in order to focus on what interests them the most, and the spatial and temporal extent they consider, i.e. always here & now, or also up and/or out occasionally? We encountered a number of discourse domains, and also note in passing domains that are quite relevant for certain issues being discussed, but are ignored. Thus, while at the community-based landscape scale notions about social innovation and environmental (or eco-) innovation may be more relevant, from the social-ecological systems and complexity perspectives we have adopted, the larger view of technology-driven economic and geopolitical changes across the country and around the world cannot realistically be ignored.

Other participants in this study have developed case studies of particular situations and incorporated results from interviews with key informants. This set of six Discussion Papers constitute literature reviews that document the local and broader contexts within which the local initiatives are set, and acknowledges that the largest context is clearly a world undergoing rapid change at the global through local scales. Following the prologue, this first paper constitutes an introductory overview based on a wide scan of the range and scope of the subject matter as it is being discussed in some influential international circles. It soon became apparent that there are three major themes unfolding about innovations, with limited cross-references across them:

- Creation of national innovation systems to build knowledge-intensive economies based on the many new high technology developments under way; this is widely viewed as the key to prosperity in a new post-industrial era;
- Eco-innovations, based on the sustainable development themes widely discussed since the 1980s; and
- Social innovations, based on social justice concerns at the same time that welfare states are being weakened or dismantled.

Each of these three themes has a long history of debates by earlier generations, most of in quite different discursive language than is used in these Discussion Papers. Decisions about when to pick up the story are necessarily arbitrary, but we generally assumed that using events from some 10-30 years ago generally sufficed, but occasionally brief mentions of earlier events seem called for (e.g. at what point and how did 'ecology' come to be acknowledged as a multi-disciplinary systems science given that it is still used mostly as a metaphor in a number of contexts today).

"Innovations and Sustainability" 2,3 and 4, review the Canadian situation with reference to what is being done under each of these themes. "Innovation and Sustainability – 5" examines the larger contexts in which the model forest and a successor forest communities program have functioned for the past 20 years. These overarching contexts are: 1) the economic crises in the forest industry itself, 2) the determination of the forest industry to reposition itself as the 'high tech' global leader for the 21st century, and 3) the considerable restructuring of the 'assets' of individual forest corporations caught up, and sometimes bankrupted by these changes. "Innovations and Sustainability – 6" returns to the community-based initiatives, noting that biosphere reserves and model forests are but two of 23 distinctive examples of local community-based initiatives in Canada, and comments on this situation from the complexity perspectives including wider notions of social innovations, some already well underway, that would make significant differences in institutional contexts.

Technologies and Innovations

On Technologies:

In recent decades there has been increasing and sustained attention devoted to the creation of a large variety of new knowledge-based business enterprises based on technological innovations. This is not only to replace the loss (or decline) of the industrial and manufacturing economies in the "developed" world to the newer and more competitive ones in the "developing" countries elsewhere. The policy imperative was also to grow many new businesses that can compete in the export markets and in domestic markets overseas in the new "globalization" world of competitive capitalisms. Altogether, these changes and events also become important drivers of more socio-

economic change and mould the contextual circumstances that can either force or facilitate adaptive changes at other scales within countries.

Arthur (2009) through historical and contemporary examples has documented clearly how technological innovations arise from discoveries converted into applications, both of which build on existing scientific knowledge and technologies. The latter are directly used or modified to become “sub-assemblies” for some newly combined system-of-systems. The construction of the new forms of technology is essentially one of “bricolage”, experimental assemblages that will also become refined over time.

There is also the phenomenon of “path dependencies” (i.e what happened before limits the options for what happens next resulting in a kind of “locked-in” situation). Nevertheless, one set of options for the present is sometimes to move “into the adjacent possible”. This notion is associated with Kauffman (2000; 2007) who as a medical biochemist has long been interested in evolutionary processes manifested at the molecular level within organisms, and now believes this to be a fundamental process for evolution and change in all systems. There seems to be an analogous view in Foucault’s notion of “governmentality” whereby governance structures discover a need to extend their range of control over new categories of people or things. This is also apparent in social-ecological systems (Lemke, 2001), but this question is not pursued further here.

Phases in the Innovation Processes:

There is broad agreement that innovation has quite distinct phases and there is also some lumping and splitting as to how many. The two basic phases are first an “ideation” phase characterized by a somewhat playful, open-ended exploration of ideas among diverse groups of ‘creative’ people in which various intuitions, hunches, and metaphorical reveries start coming together to the point that the participants are convinced that with some more exploration and clarifications they could be real possibilities. Johnson (2010) provides a number of examples of these processes from different periods of history, emphasizing the importance of notions such as the “adjacent possible”, slowly emerging similar hunches among a number of people (who are often unaware of each other), serendipity, “exaptation” (something that acquires a function for which it was not originally designed) and trial and error. They all play a role. The

organizational ambience in which this plays out (called “platforms”) is also important to energize and support these processes.

The second follow-up phase is one where the different possibilities need to be more clearly specified in terms of processes and possible prototypes to demonstrate how they might work in practice. At this stage, the focus has to be on “delivery”, including product launches, dissemination and scaling up to the point where they become more widely accepted as practical and useful for producing desirable outcomes in society. The knowledge and skills needed to achieve this are quite different. Entrepreneurship, technical or engineering skills, and organizational management practices all play a major role. The time necessary to achieve this can extend over decades and the processes can be somewhat chaotic. Much depends on an ability to identify opportunities that might suddenly open up from all the socio-economic and political events that happen in the larger governance situations in which the possible innovations are embedded. It is extremely rare for any one individual to play a leading role throughout all this. Instead, much seems to depend on the particular skills of individuals who are deeply involved at critical points along the way. Tales from the “Silicon Valley” region in California exemplify the strange dynamics that can arise from all this (e.g. Lewis 2000; Isaacson 2011).

“Innovation” has become somewhat a marketing mantra in recent decades, portrayed as something absolutely essential for continued prosperity or even survival in these times. It was not always thought of in these terms. Godin (2010), reviewed the history of innovation and reminds us that in England from the mid-16th to mid-17th century, innovation was depicted as evil, and anyone convicted of it was subject to the death penalty. The rationale was that the obligatory allegiance to Royalty and to the orthodoxy of the newly created Church of England over which the King presided (in place of the Pope) needed absolute conformity to rituals and ceremonies on the part of all subjects. Even the smallest deviations could begin to raise questions and doubts, leading to heresies, and then to large-scale unrest. The power structure in place at the time depended on this utter unquestioning conformity to authority. Now, the existing power structures are dependent upon a constant stream of technological and other innovations to retain their competitive positions of power and privilege. This should caution against assuming that “scaling up” of good ideas is always a good thing; it can also be the place where innovative ideas get strangled if they threaten the *status quo* establishments.

Recent International Reviews of Innovation:

There is a long history of technological innovations that have driven socio-economic change and development. With strong government support, new technologies have given some countries the military capacity to defeat adversaries as demonstrated in both the First and Second World Wars. Following the latter, the industrialized countries were locked into a very dangerous "cold war" contest between the US with allies in western Europe, and the USSR with its allies in eastern Europe.

In 1948, the US and western European countries formed an Organization for European Economic Coordination (OEEC), based in Paris. It initially was to coordinate US Marshall Plan funding for the reconstruction of western European cities and economies and secure the political and economic incorporation of a future European Free Trade Area into a US-led hegemony for the cold war politics. With the reconstruction effort well underway, in 1957 a Rome Treaty launched the European Economic Community to help consolidate this strategy. This in turn led to the creation in 1961 of the Organization for Economic Co-operation and Development (OECD) based in the former OEEC headquarters complex in Paris.

OECD was to serve as a major policy forum for countries committed to democracy and market economies to discuss issues of common concern based on collaborative background studies carried out by their Secretariat. They also considered policies that member countries might each adopt to further the general aims expressed through the OECD. The Council of all member countries represented at the ambassadorial level provides oversight and strategic direction for OECD programs. Substantive committees and subgroups for each of the major work sectors of OECD are formed by member countries and countries with official Observer status. They meet with members of the Secretariat to discuss issues and the implementation of the approved work plans. The Secretariat prepares analyses of issues, peer reviews of the current situations in member countries to serve as a kind of multilateral surveillance of the over-all situation, and publishes many reports in diverse formats for reference by national agencies. With the collapse of the former Soviet Union in 1989 and of the Council for Mutual Economic Assistance (1949-1991) in Moscow that was the OECD counterpart organization during

the ‘cold war’, OECD has been faced with its own dilemmas about its role and slowly changing membership, especially with the rise of other industrial powers elsewhere in the world (e.g. Clifton and Diaz-Fuentes 2011).

OECD and National/Regional Innovation Systems:

Godin (2006; 2009) and Sharif (2006) have traced the origins of the concept of national innovation systems in the post World War II era, and noted the critical role of OECD in pulling together key elements for it, going back to its own origins in the 1960s. A systems perspective was already widely used in policy discussions about mobilizing science and technology for development, and the concept of a knowledge-based economy was gaining favour as a key strategy for attaining a prosperous future. But there were still many problems about gaps and inconsistencies in the science and technology sectors and especially in linking these to economic development institutions at different levels from nation-states to individual business enterprises. There were also substantial debates about the proper role of governments, especially once the neo-liberal economic doctrines and “de-regulation” from government “intervention” gained ground from the 1970s on, and were widely and persistently promoted as the only strategies to follow. OECD documented some of these shortfalls, with case studies of how different countries were responding to them, and it also took up the questions of developing statistical indicators to track performance in both the science and economic sectors. The notion of innovation systems started to appear in the 1980s. Sharif (*op. cit*.) provides a particularly insightful account, based on interviews of key people who were involved, of the origins, and contexts within which the social construction of the concept of innovation systems developed in the late 1980s and through the decade of the 1990s.

OECD (1997) published a report on national innovation systems through its Committee for Science and Technology Policy. The context for it was noted to be OECD’s identification of best practices for both the knowledge-based economy and smooth operations of innovation systems that require “the fluidity of knowledge flows” among enterprises, universities and research institutes through joint industry research, public private partnerships, technology diffusion and movement of personnel. Further:

> “The concept of **national innovation systems** rests on the premise that understanding the linkages among the actors involved in innovation is key to improving technology performance. Innovation and technical progress are the

> result of a complex set of relationships among actors producing, distributing and applying various kinds of knowledge. The innovative performance of a country depends to a large extent on how these actors relate to each other as elements of a collective system of knowledge creation and use as well as the technologies they use. These actors are primarily private enterprises, universities and public research institutes and the people within them. The linkages can take the form of joint research, personnel exchanges, cross- patenting, purchase of equipment and a variety of other channels. There is no single accepted definition of a national system of innovation" OECD, 1997: 9).

Debates and Critiques of National and Regional Innovation Systems

For about the past three decades and continuing into the 21st century, voluminous literatures of academic and practical critiques have developed around themes such as the underlying concepts of "innovation systems", the assumptions that do, or appear to underlay them, empirical evidence brought forward to validate different hypotheses about how these systems do or should work, the many problems encountered in creating a smoothly operational innovation system under "real-world" circumstances, and the inherent contradictions that seem to cut across all of the above. This literature is not reviewed here. Instead, a brief overview of several recurring themes is noted, since these will also apply to Canadian initiatives to create such innovation systems.

The "Linear Model": In the lengthy discussion over many years that eventually led to the concept of an innovation system, the debates were about the main components that should be considered. Issues such as the role of "pure" or "basic" disciplinary research in academia *vs* applied research in technical schools were addressed. The entrenched higher status that was long claimed for the former animated this debate, especially when it was apparent that practical problem solving initiatives often had to do their own basic research to discover what could be used for the applied sectors each institution was engaged in. Still, technology does have to be based on some understanding of basic biophysical phenomena before going much further, so the sequence of discovery before application holds as a logical one. The problem was essentially that the European or other kinds of social class distinctions had to be dropped or ignored and the value of different kinds of knowledge and skills recognized.

The linkages to production systems in different socio-economic sectors are where the major gaps can occur. They are usually sector-specific and defined by the institutions of different countries, or regions within them (or supra-national regions e.g. European

Union). There can be links with the in-house research and development capabilities some larger corporations have developed to bring ideas to market through financing prototypes, full-scale production, marketing, and customer services. Much also depends on whether their goals are “radical product innovation”, “incremental product innovation” and diffusion, or low cost production based on “product imitation” with no new science required (e.g. Herrmann and Peine, 2011, based on detailed empirical studies of the pharmaceutical sectors in three European countries). Balconi and others (2010) provide an insightful commentary on the so-called linear model, and the validity or otherwise of many criticisms leveled against what often seem little more than the critics’ own false assumptions about what a sequence heuristic is actually pointing out.

Clusters and Related Issues of Proximity: It has long been known that from the earlier stages of industrial development, inter-related industries in major sectors of national economies became concentrated in different urban regions along with skilled labour employed by those industries. Some became known as “learning regions” because of innovations that were developed there.

Economic geographers have emphasized the advantages of spatial proximities and resulting co-location of activities associated with innovative processes. But there are other forms of proximities that are not so location bound. Boschma (2005) reviewed the pros and cons of four others – cognitive, organizational, social, and institutional proximities as well as geographical ones. Cognitive proximity refers to the scope and scale of the knowledge base that can support innovations, and it infers that networks of exchange for this purpose can extend well beyond any given geographic location.

But there are limits to what firms seek given their commitment to whatever their current base of operations require as well as their limited interest and capabilities to absorb completely new knowledge to what they have become dependent upon. While networks can facilitate communications, the “competency trap” of locked-in commitments to existing knowledge, or the dangers perceived in “involuntary spillovers” of the free flowing knowledge can severely restrict what businesses will do. Knowledge sharing that generates innovative ideas can pose threats to proprietary knowledge protected by various intellectual property rights (legal devices such as patents, copyrights, trade marks, product design, product licensing, and protection for trade secrets such as

codes, formulae, process databases) that established firms use to protect themselves from competitors, some of whom may be located nearby.

This general situation in turn leads to somewhat similar concerns arising from organizational proximity (at the firm level), social interaction proximities (at the employee or "micro-levels") and institutional proximities promoted by policy levels adopted by governmental and/or market promotion of regional cluster frameworks. At the other extreme, non-clusters, or much more widely distributed components of innovation may preclude sufficient learning for innovations to occur at all. Gustafsson and Autio (2011) noted that the sources of system failure can be from market failures in the form of systems level inertia and "inhibited emergence" of innovative structures. Market failures come from under-investment in major components of the system and from the failure of price mechanisms to recognize benefits from certain goods and services that provide social or other non-profit values ("merit goods").

Asheim and others (2011) have reviewed much of the same literature about national and regional innovation systems, and noted a lack of sufficient distinctions that should be made between clusters and networks. They also suggest "much of the empirical work on regional systems has been based on well-functioning, successful regional economies and on innovation in high-technology sectors" (*ibid*:180). Hence there is a need to analyze systems failure and dysfunctions in order to understand better the factors shaping regional innovation performance. The approach they suggest is to differentiate the knowledge base to distinguish more clearly between analytic, synthetic and symbolic knowledge. Analytic knowledge arises from scientific research and lends itself to being codified by the scientific process such that it can be quite widely shared among those who understand the codes. Synthetic knowledge is based much more on experiential and context-based tacit knowledge that in turn depends upon specific industries and their practices. Symbolic knowledge refers to cultural meanings of ideas, symbols and designs; it is grounded in the arts and used by cultural industries where the aesthetic and design component of goods and services is high. It tends also to be the most localized. Innovations therefore must recognize these three "ontological and generic categories" of knowledge. Policy platforms for developing innovation systems must differentiate among them to construct successful regional strategies, especially if the goal is to renew some districts facing secular declines.

Niosi (2002) noted that shortcomings in the ideals expressed about innovative systems can be viewed from two inter-related perspectives. “Efficiency” relates to gaps between the observed performance and existing best practices. “Effectiveness” is the degree to which organizations achieve their declared missions. He also noted that the notion of “optimality” under particular sets of circumstances is not considered in this kind of discussion. When particular innovative systems are viewed by these criteria, most of the inefficiencies and ineffectiveness are related to path-dependent development and institutional lock-ins of various kinds.

Schoales (2006) argued that understanding of clusters can be considerably advanced by studying “Alpha Cluster Industries”, defined as those that cluster because of an inherent transitory nature of their products and services. The performing arts and their suppliers are good examples. The fashion industries can also be included. They must have new goods or services several times a year if not more. These industries tend to be very spatially clustered in major urban regions, they have to be highly creative, and they help create urban environments that attract a wider range of creative people for other industries. Carlsson (2006) emphasizes the internationalization of innovation systems, not just in terms of the R&D work of multinational corporations, but also in the collaborative networks for research and education. This has implications for considering some differentiated roles for innovation policies across these different spatial scales.

Miller and Côté (2008) analyzed findings from questionnaire surveys of 1,000 firms worldwide ranging in size (large and small), age (old and new), and the kinds of innovations they sought to make. The authors also had 200 qualitative case studies of firms known to be innovative. This information revealed a variety of distinctive ‘logics’, strategies, and practices being used by various firms in different sectors that the authors called “games of innovation”. Each situation was characterized by the “competitive dynamics of the markets” the firms were in. There are important differences between firms that are entering new markets and ones in existing markets where improvements are being sought. It is also important if the “architecture” for the innovation is a singular new product or process, or a component of some much larger system. A first distinction then is between “market-creating innovations (MCI”) and “in-market innovations (IMI”). The latter is much more prevalent because that is where the majority of firms exist and

are in intense competition for productivity improvements. Over the years the latter result in large successful firms and failures in others along the way.

The “architectural” component of innovations distinguishes between i) stand alone products, ii) being part of a closed systems such as complicated technologies in which engineering improvements are being sought for components, or iii) they are “platforms” in open module systems (such as the ICT sector) that lead to “mass customization” of products and services. Miller and Côté (*op. cit*.) then identified six distinctive “games of innovation” based first on a distinction between the MCI and IMI and then on the three architectural types for either market. Most of their case examples were versions of the IMI. Their main conclusions were to challenge prevailing policy assumptions about the “almost mythical belief in the critical role of entrepreneurs and venture capital”, as well as the significance of the volume of expenditures for R&D in large firms, given the real nature of the ‘games’. They also query the rationale for having universities and government research centres at the core of public funding for clusters of organizations engaged in innovation strategies, again given how the real “games of innovation” are being played out.

Varieties of Capitalism: Institutional Descriptions and Comparisons: National and regional innovations systems are embedded in different nation-states each of which have had their own histories of institutional and economic development. This has led to many commentaries about which combination of components for a national innovation system are best, and to criteria for ranking countries with reference to external criteria from international agencies for judging each of the major components. Identified main components usually include educational and technical training programs; the basic national socio-economic structure, especially regarding the private sector and inter-firm relations; composition of the work force and roles of labour unions; the financial system including patterns of savings and investments; social welfare policies; and the key role of government(s) and corporate governance (for innovation systems). Clearly, there is ample room to lump and split such categories and assume different weightings for them. There is also considerable debate about different interpretations of these categories, as well as about criteria to “benchmark” statistical indexes for invidious rankings of different constellations of innovation systems for whatever purposes this is to serve.

In the early 1990s, a “two capitalisms” debate started (generally within the OECD member countries) with discussions about the relative performance of “coordinated market economies” exemplified by many European countries (where national governments maintained desirable degrees of balance among their socio-economic sub-systems in order to maintain social and political cohesion), as compared with the American (neo)-“liberal market driven capitalism” in which governments were the main facilitators. Their role was to provide subsidies, reduced taxation, and (de)regulated frameworks that were deemed to enhance business competitiveness in export markets and for overseas investments that enhance private sector hegemony in these areas. The economies of other English-speaking countries were seen as just variants of this US model.

After the collapse of the Soviet Union in 1989 and the liberation of Eastern Europe from Russian control, came the loud announcements from US and Britain in particular about the end of history and the triumph of capitalism. State run or dominated capitalism (“Communism or Socialism”) was gone and western capitalism was deemed to be the only alternative. But by the 1990s, with new forms of State dominated capitalisms becoming apparent, it was only the terms “socialism” and “communism” that had disappeared. Over the past decade or so it has been generally agreed that there are more than just two capitalisms, but there is still debate about how many. At least five have been proposed, still with reference to the two sets first distinguished. Another argument is that there is now just one generally “variegated capitalism”. But then come the new economic powers in Asia with others on their way in South America. For them, the State is back in or it never went away.

There is a very large literature underlying all of this (see for example, Jackson and Deeg 2006; Herrmann and Peine, 2011; Kang, 2006; Peek and Theodore, 2007). Critiques are also directed to the basic limitations of the national innovation systems literature. This is not so much because of the subject matter. Rather it is the somewhat narrow focus on descriptive categories of institutions within nation-states, the apparent accepted assumption that, with one massive if somewhat diffused “globalization” process well underway and with best practices on the innovation front, there will be a convergence on how best to relate to it productively by seizing the economic trade opportunities. There is

a somewhat parallel literature that contests the concept of one all-encompassing "globalization" phenomenon.

Otherwise, the focus is mainly at one scale, usually that of the business firm set within networks of other agents at the same scale ("holders", i.e. shareholders, stakeholders, but also problem holders, privilege holders etc). The disciplinary perspectives underlying much of the discussion seem to assume that innovative and constituent systems can be held in some kind of equilibrium within designated regions, that rational decision-making in the neoclassical economic tradition is both possible and necessary, and risks can be quantitatively assessed and managed. Social and environmental impacts arising from competitive national innovation systems, if noted at all, in the Schumpeterian "creative destruction" by new technologies destroying established orders, are ignored in much of these discussions. But there are also parallel discussions about eco-innovations and social innovations to deal with these 'side issues'.

Towards a Systems Dynamics Approach: There are also some perspectives on the development of national or regional innovation systems that examine how these evolve over time, and the factors that seem to direct this. Some of this is historical accounts dating back to various earlier times, or just to more recent decades when neo-liberal economic doctrines and neo-conservative political ideologies became dominant in the OECD countries in particular. The question of spatial and historical time scales also arises.

Within the concept of national innovation systems, elements of system dynamics have been introduced under headings such as the "Triple Helix" co-evolution of institutional systems, and the so-called "Globalization 2" of the knowledge based economy. The Triple Helix model was developed by 1997, and inferred a rapidly emerging knowledge economy where entrepreneurial universities would see growing demands for knowledge transfer to industry and through governments, to society at large. This in turn would stimulate funding from the latter and closer cooperation among all three institutions that would subsidize infrastructures such as science parks and associated "incubators" for possible new companies while also stimulating training of more academic-based entrepreneurs. This would provide positive feedback loops that eventually result in an effective local or regional cluster of technological innovations and the subsequent

expansions of knowledge-based economic growth in various sectors. As an ideal model, it was apparently inspired by the Massachusetts Institute of Technology (MIT), but overlooked a number of other contextual factors that would influence the growth of such systems anywhere, including MIT in Boston.

The new knowledge based economy was deemed to have started under “Globalization (or Mode) 1” that had been initiated by multinational corporations and trade organizations. This arose at a time when the knowledge was mainly generated from corporate research and development (R&D) units and kept confidential, while traditional disciplines in universities were conducting research on isolated topics within their individual disciplines, and peer-reviews by specialists were the means for quality control. Presumably under the influence of some collaborative processes such as a Triple Helix, a new mode of knowledge production emerged called “Globalization (or Mode) 2”.

Mode 2 is characterized as being trans-disciplinary, applications-oriented, and judged with a wider range of criteria by groups representing user groups as well as scientists. This is described as “contextualized science”, it is generated through collaborative networks, and its assessment includes “reflexivity” from a wider set of perspectives rather than conformity with disciplinary norms judged by specialists. (e.g. Cooke 2005). Other contextual characteristics of “Globalization 2” have been described by notions such as “post-academic science” referring to its mode of production; “academic capitalism” as larger proportions of universities and colleges engaged in competitive behaviours to become involved with all phases of the innovation processes including formation of new businesses; “post-normal science” referring to situations (such as the search for significant innovations) where uncertainty is high, the need for decisions is urgent, the consequences or stakes are high, but there is little usable science to rely upon (e.g. Ravetz 2004); and “strategic research/science” where the pressure for ‘relevance’ in the opinions of funders and users is immediate and constant, and quality is judged accordingly (e.g. Hessels and van Lente (2008).

Castellacci and Natura (2011) took up the subject of analyzing the dynamics of national innovation systems over time, noting that much of the existing literature provides limited insights on the drivers of national systems of innovation and of mechanisms that might explain their evolution over time. They conducted sophisticated econometric analyses of

a broad set of indicators measuring “national innovative capabilities” and “absorptive capacity” for a panel of 98 countries in the period 1980-2008. Their results indicated that innovative capability and absorptive capacity are linked by a set of long-term structural relationships. They are driven by the co-evolution of three capability variables (technological output such as patent and new products, scientific output in scientific and technical publications, and innovative output in terms of investments for R&D) and three absorptive capacity factors (income per capita as indicating the overall level of socio-economic development, infrastructure in the form of transportation, distribution systems and networks, and international trade to represent the openness of the national system and the ability to imitate foreign advanced knowledge). Human capital measured by tertiary education has often been assumed to be an important driver, but this study concluded it has mainly an indirect effect through effects on GDP per capita which in turn feeds back and sustains the innovative dynamics over time.

At the global scale there has been a disconnect between the globalization imperatives that are driving interest in national innovation systems, and the much more historically informed interpretations of the dynamics of the global political-economy itself. Sklair (2010) for example, sees the current situation as exemplifying an eclipse of the former dominant roles of nation-states (played out by the balance of power dynamics of “international relations”) and the emergence of various forms of transnational practices and new forms of cosmopolitanism where people of many different ethnic and other backgrounds live in the same general communities and strive to live in peace with one another. The capitalist globalization systematically blurs the difference between basic and false consumer needs, and spreads the industrial civilization over a planet that cannot cope with it as revealed by massive inequalities and environmental degradation. Steger (2009) sees the changes as “thickening of people’s awareness of the world as an interconnected whole” (p. 9). One result is the increasing lack of conviction in the old imaginary about globalization being about the liberalization and integration of world markets that is inevitable and irreversible, where nobody is in charge, yet it benefits everybody and promotes democracy in the world (p. 20). Some “new global imaginary” is replacing this old one.

It can be noted here in passing that well-grounded interpretations of the reality of ‘globalization’ are based upon comprehensive historical critiques, much of it under the

rubric of “world-systems analysis”. The critiques adopt various historical time spans, but most attention has been directed to the rise and development of capitalism and the nation-state system to encompass the entire world since the feudal era in Europe some 500 or so years ago. This literature is impressively large, and can be approached through the works of Arrighi (1995), Chase-Dunn and Grimes (1995); Chase-Dunn and Hall (1997); Harvey (2007); Hornborg (2009); Modelski (1996); Moore (2011); and Wallerstein (1999; 2005).

Eco-Innovation

The environmental impacts of strategies for economic development originating at different scales ranging from individual firms through to national and international policies and strategies have been a matter of growing concern since the mid-1960s. There has been a rough progression of responses to these concerns. Initially in the 1970s, the demands to stop pollution from entering the environment focused on “end-of-pipe” technologies to reduce the volumes of waste being generated and to provide waste treatment for wastes that were produced so that they would be less toxic. Limitations to this approach led to initiatives to lessen the use of all energy and raw materials inside industrial plants, and to the realization that with proper treatment, the wastes from one kind of industrial process could be used as recycled resources for another.

With this ecologically inspired insight, the concept of industrial ecology developed to become a linked network among industries each adopting a closed loop and life-cycle management approach to all materials used in each facility or company. Where feasible, there were also ‘symbiotic exchanges’ of remaining residuals, sometimes referred to as ‘by-product synergy’. Cluster concepts became realized in the form of industrial parks where mutual proximity lessened transaction costs for each company and the resulting efficiencies improved profitability for all concerned. “Industrial ecology” became an applied science and technology on its own, and the nearby environment quality was much improved. There is a huge literature about all this, including theoretical debates about the meaning and political implications of “ecological modernization”, that is not reviewed here, but see for example, del Rio and others (2010) for a discussion of a theoretical framework for eco-innovation policies.

By the mid-1980s, the concept of “sustainable development” had emerged in a form that seemed to promise guiding principles for ‘eco-design’ that did not assume a stark choice of economic development or destruction of already stressed environmental life-support systems. The principles could then be called upon for various kinds of innovations that could guide the way to a humane and sustainable future. Because much more attention was being given by ecologists and environmentalists to ecosystems and the kinds of ecological goods and services humans could draw from them without immediate cost, the need to sustain the integrity of the structure and function of both natural and managed ecosystems became more widely recognized as part of what had to be done. At about this time, the concept of “eco-innovation” came into use with much ambivalence about what it too meant (along with sustainable development).

The OECD was inclined to see “eco-innovation” as a variant of their interpretations of national innovation systems and social innovations, but something that requires more radical improvements than just incremental improvements in products and manufacturing processes. In their view, the urgent need was to find satisfactory indicators to accelerate corporate sustainability efforts and benchmark progress (OECD 2009).

The European Union defines eco-innovation as follows:

> Eco-innovation is innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole life-cycle. The understanding of eco-innovation has broadened from a traditional understanding of innovating to reduce environmental impacts towards innovating to minimize the use of natural resources in the design, production, use, re-use and recycling of products and materials. Technological innovation alone is not sufficient to enable the transition of Europe into a sustainable economy; the magnitude of the challenge also calls for systemic innovations in the way services are delivered and organizations are run. Public acceptance and social changes are key in this process. (EIO 2011: p. vii).

Studies on eco-innovation are being conducted under the EU’s Competitiveness and Innovation Framework (CIF) Programme that was initiated in 2007 and directed mainly towards small and medium enterprises (SMEs). This in turn is set in the context of a “Resource-Efficient Europe” goal in the Europe 2020 Strategy. An Eco-Innovation Observatory has been set up by CIF to provide a “platform for the structured collection and analysis of an extensive range of eco-innovation information” from the EU and elsewhere. This information is subsequently reported out in a number of ways, and in its

first annual report for 2010 compiled under major headings such as resource efficiency key trends and targets; eco-innovation performance of countries; eco-innovation in sectors and markets; drivers and barriers to eco-innovation; and future outlook in Europe and globally.

Rio+20

This is the short name for the 2012 United Nations Conference on Sustainable Development (UNCSD) held in Rio de Janeiro on the 20th anniversary of the UN Conference on Environment and Development (UNCED) held in Rio in 1992 (and the 40th anniversary of the UN Conference on the Human Environment held in Stockholm in 1972). UNCSD was meant to achieve three main outcomes. The first was to get a strong re-commitment of all countries to the Millennium Development Goals spelled out in 2000 (General Assembly Resolution 55/2, September 2000), but were lagging behind their proposed 2015 achievement date. The second was to reach some consensus about the adoption of strategies and measures for a "green economy" (at all scales) as the pathway to sustainable development and poverty eradication (UNEP 2011). The third was to agree on how best to strengthen "international environmental governance" (IEG) at the global as well as national scales to achieve the first two goals. The preparatory work for Rio+20 was officially started with General Assembly Resolution 64/236 in December 2009.

Rio+20 would also be the occasion to recognize a number of inter-governmental and non-governmental agreements for related programs. A major one is the creation of the "Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services" (IPBES) as a follow-up to the Millennium Ecosystem Assessment, but with features similar to the Intergovernmental Panel on Climate Change that emerged from the Rio conference in 1992. The background for this is described by Larigauderie and Mooney (2010); Perrings and others (2011).

In 2008, the International Council for Science (ICSU) approved a Program on Ecosystem Change and Society (PECS) as a 10-year initiative devoted to research on complex social-ecological systems across a range of space and time scales. Its guiding question is: "How do policies and practices affect resilience of the portfolio of ecosystem services that support human well-being and allow for adaptation to a changing environment?" Its

research is guided by the concept of complex social-ecological systems and its program office is in the Stockholm Resilience Centre and in cooperation with the University of Sains Malaysia. Recent research and commentary that helps direct PECS can be found in Scheffer and others 2009; Rockström and others 2009; Steffen and others 2011; and Westley and others 2011.

In addition to the above there is also the "Earth Systems Research for Global Sustainability: A New 10-Year Research Initiative" organized by an International Group of Funding Agencies for Global Change Research (IGFA). This group was established in the early 1990s to serve as a forum for national agencies that fund a set of somewhat independent multilateral research programs, each having their own program office, Secretariat, and advisory committees. The main programs are the World Climate Research Program, the International Geosphere Biosphere Program, DIVERSITAS (biodiversity) Program and the International Human Dimensions Program. There had been steps taken to combine these into an Earth Systems Science Partnership (ESSP) as they move towards follow-up from their earlier 10 year initiatives.

The IGFA, on behalf of ICSU, began an extensive consultative process in 2009 (under the general name of "The Belmont Forum") to examine options for "a single, holistic international strategy for integrated, policy relevant Earth System research". This gave rise to the new initiative in June 2011, and it is to transition into a permanent governance structure by the end of 2012.

Innovations and Sustainability – 3 describes the outcomes of Rio +20 and its outcome document "The Future We Want" in more detail. To some extent these developments can be seen as "innovations". Many more will be required to reach the lofty goals being presented.

Social Innovation

Issues of social-economic change and development that are created or stimulated by technological developments and their associated impacts have long been matters for analyses and debate. Much of it had been pursued as questions about social changes within different configurations of social economies. The phrase "social innovation",

distinguished from technological or business innovations, and “Eco-innovations” has been much more recent. It has become increasingly prominent over the past decade or so with the result there has been considerable semantic confusion over its precise meanings, scope, and contents (elaborated for example, by the reviews and clarifications of Pol and Villa 2009; Sharra and Myssens 2010).

Nevertheless, there are a number of similarities among operational definitions proposed by practitioners. For example, a widely used definition from the Centre for Social Innovation, Stanford Graduate School of Business (California) was put forward in comments to a San Diego Grant-makers Conference, May 2009.

> “The meaning of Social Innovation: Any novel and useful solution to a social need or problem, that is better than existing approaches (i.e. more effective, efficient, sustainable, or just) and for which the value created (benefits) accrues primarily to society as a whole rather than private individuals” Phills, 2009).

The Oxford Said Business School was partial to the phrase “new ideas that work” but given the wide range of situations that might cover suggested a somewhat narrower definition:

> “innovative activities and services that are motivated by the goal of meeting a social need and that are predominantly developed and diffused through organizations whose primary purposes are social” (Mulgan 2007: p. 8).

Another comes from the Bureau of European Policy Advisers in the European Commission, 2011.

> “Social innovation relates to the development of new forms of organization and interactions to respond to social issues (the process dimension). It aims at addressing the (outcome dimension);
>
> Social demands that are traditionally not addressed by the market or existing institutions and are directed towards vulnerable groups in society (Approach 1).
>
> Societal challenges in which the boundary between ‘social’ and ‘economic’ blurs, and which are directed towards society as a whole (Approach 2);
>
> The need to reform society in the direction of a more participative arena where empowerment and learning are sources and outcomes of well-being (Approach 3);
>
> These approaches are not mutually exclusive, but rather interdependent; the first approach is the foundation for the second which creates the conditions for the third – an innovation that addresses a social demand (e.g. care of the elderly) contributes to addressing a societal challenge (ageing society) and through its process dimension (e.g. the active engagement of the elderly), it contributes to reshape society in the direction of participation and empowerment” (European Union, 2010: p.43).

Much of the ambivalence about meanings of these terms (beyond disciplinary and professional competitions to incorporate these new and possibly lucrative policy fields into their own exclusive domain, e.g. “management science”, “knowledge management”) seems to arise from three different strands or foci incorporated into the main concept:

- the range of knowledge and skills required by people who are involved in the work required by different phases of the innovation processes;
- the different organizational ambiences that facilitate or otherwise support the processes that can result in significant outcomes from each of these phases; and
- the structures of some larger governance regime that will either enhance, selectively accept, or prevent incorporation of innovations that would result in (their) system changes.

Together with the different space and time scales required to bring social innovations to a successful conclusion as system change, the range of factors to be dealt with is impressive. For example, the scope of the numerous challenges was sketched out on the occasion of the 2011 inauguration of the European School of Social Innovation, based in Vienna. This School is to be a “flagship initiative” for the Europe 2020 Strategy with its 34 “action points” to address Europe’s “innovation emergency”. Just prior to that, the European Union (2010) sponsored a competition to identify ten best examples of social innovations underway in Europe, and received over 100 applications from 23 countries. This indicated that there were many initiatives underway that could be built upon in various ways. The European School will draw on social sciences and humanities to redraw boundaries in terms of differences and overlaps between business innovations and new technologies and social innovations. In part, this recognizes that innovation emerges where sectors, systems and concepts converge. The School has identified research topics related to concepts, definitions, theory construction, and methodologies to identify and measure results from innovations. It has also identified 14 prioritized issue-oriented research themes (Vienna Declaration 2011).

The European Commission has situated “The Innovation Imperative” in a very wide context, documented in its “State of the Innovation Union 2011” report. Social innovation

is but one aspect of a wide range of societal challenges as spelled out in the Europe 2020 Strategy and its 34 action points. The goal is to re-orient EU budgets for research and innovation to create a single strategic framework ("Horizon 2020") to fund the whole innovation cycle. This includes "… more focus on societal challenges, a strengthened approach to small and medium enterprises (SMEs), and stronger support to market uptake of innovation, including by means of procurements, standard-setting and loan and equity financing" (European Commission 2011: §2.3, p. 7).

The OECD has also played a role for social innovation similar to its role in national and regional innovation systems. It includes a series of publications on different aspects of the subject since about 1999. Based on extensive literature reviews it has compiled nine working definitions of "social innovation" (including the first two above) and some 29 definitions of "social entrepreneurship" from the period 2000-2009 (OECD 2010). In 2000, the OECD created a multi-national and multi-stakeholder Forum on Social Innovation (FSI) under its Local Economic and Employment Development (LEED) in the Committee for Science and Technological Policy. FSI has examined working examples of social innovation and social entrepreneurship from a number of different countries, including the "BRICs", i.e. Brazil, Russia, India, and China (OECD 2011).

Comments and Critiques of Social Innovation

Much of what is now heralded as 'social innovation' had in earlier times been considered as social change, industrialization, or features of modernity. There were many approaches to analyzing and interpreting social change, some of which were noted in the above discussion of national innovation systems. However there are several recurring themes about social innovation in recent international literature.

Social Entrepreneurship: A number of commentators identify this concept to be the key one that defines the field. Other aspects now included as social innovation are best treated as inventions or imitations, and the players as social activists or volunteers for charitable organizations (e.g. Martin and Osberg, 2007). The entrepreneurial roles have been addressed primarily in terms of key individuals, particular organizations, or social movements. Di Domenico and others (2010) view social entrepreneurship as the art of creating social values through a process of "bricolage". Thus the entrepreneurs are

the ”bricoleurs” or “tinkerers” who make do with whatever is at hand, improvise whenever possible, and always look for ways around some external limit imposed on them. The resulting process is a constant assembly of on-going transformations and reconfigurations that nonetheless serve a social purpose. Yet, the social value creation has to be evident to the beneficiaries. That in turn means it is important to engage as many stakeholder participations as possible among the beneficiaries, and be adroit in the arts of persuasion with people in different situations and/or institutions. These admonitions are also consistent with recognition of the era of “post-normal science” as the larger context within which this has to be done (e.g. Ravetz 2004).

Social Enterprises: This is a generic term that refers to all manner of organizations that have a business component as part of their operations, but rather than having profits siphoned away by their managers and shareholders, allocate the moneys instead to support various social, cultural or environmental activities that create societal benefits for different communities. There are a wide variety of entities that can do this, and they differ according to the legislative frameworks and cultural norms of different countries, and/or other jurisdictions within them. The variety of them can be situated along a continuum ranging from philanthropy to for-profit businesses that embrace social responsibility within their operations. Well-developed social movements might create some version to help finance their programs along with other grants and donor contributions. Conversely, small community-based organizations might try to develop a small business component from their start in some urban neighbourhood or small rural community.

There is much discussion about the problems and constraints that social enterprises often encounter. There are often weaknesses in the legal structures they incorporate under, the funding sources they can attract, and the management tensions that can arise from the constant need to match funds that have been raised with the demands and expectations of their beneficiaries. From a social entrepreneurship monitor program under way in England (and to be expanded more widely in the future) it was found that while social entrepreneurs form a distinct group with more positive attitudes than the general population, as they become more experienced they are likely to become more disillusioned with entrepreneurship and see fewer opportunities let alone good long-term career prospects (Harding 2006). This contrasts with new business-oriented technology

"start-ups" whose owners might seek buy-outs so that their new wealth opens up more opportunities for them.

Social Economy Context: Social enterprises have a number of earlier precedents especially during the industrial era of developed economies. Examples include the benevolent societies that banded together for self-help among their members, producer and consumer co-operatives that shared profits with their members, and local credit unions. Contemporary social enterprises might be able to re-invigorate some of these older organizations that have generally declined with the ascent of corporate capitalism in a globalization era. The ITC technologies would allow for enhanced networking among such organizations to form virtual clusters or interacting systems of them. But, they too may well suffer from inefficiencies and ineffectiveness related to their own path-dependent development and institutional lock-ins. Local and regional situations need to be examined before conclusions can be drawn.

Towards More Integrative Perspectives

A major challenge is to draw all of these insights together and see how best to apply them to particular issues facing a given country. In this connection, the experience of the Dutch Research Institute for Transitions (DRIFT), established in 2004 at the Faculty of Social Sciences, Erasmus University, Rotterdam, merits consideration. The "transitions" approach arose out of issues facing the Fourth National Environment Policy Plan (2001-2006) in the Netherlands. Many sector problems needed attention and competition among Ministries for priority setting with funding for implementation had to be addressed. As Loorbach (2007) noted:

> "to realize a sustainable society it is clear that we are in need of societal innovation: the creative powers of our society need to be utilized to create new societal systems based on innovations in technology, culture, economy, ecology, institutions and society. Such societal transitions are needed at all levels, from global to local, but they are obviously long-term, highly uncertain and disputed processes. Organizing and coordinating such transitions thus poses an enormous and inspiring challenge for our society in general and governance and policy in particular: how to develop sustainably so that we overcome global inequalities, degradation of ecosystems and social and cultural crises and do not end up in crises and conflict? What exactly is sustainable, how should sustainability be organized or managed and at what pace should we transform unsustainable societal systems – these are all issues for debate…" *ibid*: 11.

DRIFT brought together the development of transition typologies and an understanding of the role of agency in transitions (Grin and others 2011). It has developed conceptual models for a research component of its activities. They entail a sequence of problem structuring, envisioning and organization for specific transition arenas, and with a "strategic" emphasis on system culture. Then a "tactical" phase develops sustainability images, identifies and mobilizes coalitions, develops joint transition agendas with them, and develops experimental approaches for testing different practices. All of this entails:

- Adopting complex systems and transition thinking as an analytic base;
- Adopting long-term visioning (at least 25 years) as a framework for short-term actions;
- Taking multi-level (scale) dynamics into account with multi-actors;
- Recognizing that the processes are co-evolutionary ones involving institutional, cultural, demographic, economic, ecological and technological determinants;
- Creating small "niches" in governance for experimentation, and develop strategies to deal with regimes (institutions);
- Recognizing that transition involves building up new structures and allowing the decay of existing ones;
- Keeping options open and exploring multiple pathways;
- Learning by doing and doing-by-learning;
- Focusing on the "frontrunners" as the more significant participants;
- Monitoring and assessing results as an experiment from which to learn.

Generally this means that a number of initiatives at various stages of development and implementations are going on at any given time and engaging different groups throughout the Netherlands. Collectively, they may be viewed as building greater resilience for system change and adaptation, prompting some transition towards sustainability in a given sector, or setting up innovative transformations Rotman (2006); Rotman and others (2007). Kemp and van Lente (2011) describe two earlier hygienic and waste management transitions in the Netherlands. Loorbach and Rotman (2010) describe three current ones under way in the Netherlands and one in Belgium. International conferences on sustainability transitions have been held in Amsterdam (2009), Lund (2011), and Copenhagen (2012). A Sustainability Transitions Research Network (STRC) has also been created (Geels 2011).

Mention should also be made of the Social, Technological and Environmental Pathways to Sustainability (STEPS) Centre created in the University of Sussex, Brighton, UK in 2006. STEPS is linked with the Institute of Development Studies (IDS) and the Science and Technology Policy Research Unit (SPRU) at Sussex. “Innovation, Sustainability, Development: A New Manifesto” was produced in 2010 and widely circulated in print and multi-media formats. The most pressing challenges were seen to be linking environmental sustainability with poverty reduction and social justice and making science and technology work for the poor. Together with the two other units, STEPS will serve as an interdisciplinary global research and policy engagement hub working with partners in Africa, Asia and Latin America. The program brings together theoretical frameworks for systems dynamics, governance and design with three domains of on-going field applications, i.e. food and agriculture, health and disease, and water and sanitation. The STEPS Centre produces a range of publications and multi-media information materials about this work. (See Leach and others 2007a; b).

Leach and others (2012) have also agreed that the STEPS Centre and the Stockholm Resilience Centre should strive to (re)connect these two strands of sustainable development in order to find ways for humanity to navigate within safe operating spaces within multi-scale planetary boundaries to enhance sustainability for all, and do this ‘from the bottom up’.

Köhler (2012) noted the conceptual similarities between theorizing about sustainability transitions at one scale, and the ‘long wave Kondratiev cycles’ driven by major technological innovations that co-evolve into new techno-economic paradigms that create major institutional changes over multi-decades (~60 years or so), with overlaps between the end of one era and the beginning of the next, leading to sustainability for some components and the demise of others. It is generally recognized that there have been five of these cycles since the beginning of the industrial era in the late 18th century and that the 6th is on the horizon, as evidenced by the growing excitement about the new high tech knowledge-based economic future. Could there be some blending of these two sets of insights such that agency recognized as important by the STRN for example, could be introduced to guide global governance for the 6th K-cycle along the normative guidelines noted above?

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