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Development of the DPSIR+C Framework for Measuring the Social Capacity of Environmental Management

Junyi Zhang
Hiroshima University

Phone: +81-824-24-6919
Fax: +81-824-24-6919
email: zjy@hiroshima-u.ac.jp

Akimasa Fujiwara
Hiroshima University

Phone:
Fax:
email:

Abstract

Environmental management in various sectors, including transport sector, is becoming more and more important. Successful environmental management should be supported by a better capacity of the whole society (called social capacity). This paper defines the social capacity for environmental management as the total capacity wherein the whole society-composed of three social actors: government, firms, and civil society-tackles environmental problems to achieve sustainable states through the learning process, taking into consideration inter-actor interactions and future uncertainty. This paper further proposes a new framework, DPSIR+C (Driving forces, Pressures, States, Impacts, Response + Capacity), to support the next generation of environmental management. The DPSIR+C framework was proposed as the core framework for the 21st Century Center Of Excellence (COE) Program, "Social Capacity Development for Environmental Management and International Cooperation" at the Graduate School for International Development and Cooperation (IDEC), Hiroshima University, Japan (2003-2007). In theory, the DPSIR+C framework could be applied to any public policy decisions.

Keywords

Social Capacity, Environmental Management, DPSIR+C framework, Actors, Sustainable Development

Note:

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Discussion Paper

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Junyi Zhang and Akimasa Fujiwara

Graduate School for International Development and Cooperation
Hiroshima University, Japan
Email: zjy@hiroshima-u.ac.jp

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Junyi Zhang and Akimasa Fujiwara
Graduate School for International Development and Cooperation, Hiroshima University,
1-5-1 Kagamiyama, Higashi-Hiroshima, Hiroshima 739-8529, Japan
Phone & Fax: +81-824-24-6919
E-mail: zjy@hiroshima-u.ac.jp

1. Introduction

The progress of global warming, the unbalanced development of human society, and the ceaseless desire for economic growth have been causing increasingly serious problems that hinder human society from realizing its long-term sustainable development. Solving these problems requires time; however, the passage of time cannot automatically solve these problems. Various efforts are needed at different stages of development. There is no doubt that market-based technological innovation has been playing, and will continue to play, an important role. However, it should be noted that the effective use of technological innovation relies heavily upon the attitude and behavior of human society. Both successful and unsuccessful experiences in developed countries have proved the aforementioned arguments. Therefore, developing countries should learn from the experiences of developed countries, while developed countries should provide various opportunities to support sustainable development in developing countries. On the other hand, in Japan, official development assistance (ODA) is experiencing dramatic changes under domestic economic recessions and large financial deficits. It is necessary to create new approaches for future international cooperation that could be well received by people in both types of countries.

It is a known fact that various actors (stakeholders) are usually involved in environmental management (EM), including the central government, state or provincial government (where applicable), local authorities, non-governmental organizations (NGO), community-based organizations, and private sectors (TUGI, 2003). The capacity of each actor is expected to influence the quality and performance of the EM and the total capacity of all the actors is not the simple summation of the capacity of each actor. In both academic fields and professional practices, there is growing interest in the capacities of people, communities, and institutions (Ivey *et al*, 2004; de Loe *et al*, 2002). There is a significant amount of literature that addresses capacity in public sector agencies and institutions (e.g., Hartvelt and Okun, 1991; Grindle and Hilderbrand, 1995), local governments (e.g., Gargan, 1981; Collinge and Leach, 1995), and more broadly, communities (e.g., McGuire *et al*, 1994; Murray and Dunn, 1995; Litke and Day, 1998). All these studies recognize that capacity is a function of several interrelated dimensions, and that the relative importance of these dimensions varies between organizations and between communities.

Debates on capacity development at the international level are based substantially upon the capability theory proposed by Sen (1985, 1992, and 1997). For example, the human development index (HDI) proposed by the United Nations is based upon Sen's capability theory, and it argues that the basic elements of human development include productivity, equity, sustainability, and empowerment. The capability approach emphasizes functional capabilities ("substantial freedoms," such as the ability to live until old age, engage in economic transactions, or participate in political activities) that are construed in terms of the substantive freedoms that people have reason to value, instead of utility (happiness or choice) or access to resources (income, commodities, assets). Ten capabilities are proposed: (1) life; (2) bodily health; (3) bodily integrity; (4) senses, imagination, and

thought; (5) emotions; (6) practical reason; (7) affiliation; (8) other species; (9) play; and (10) control over one's environment. It is believed that through such capability development, individuals can discover their own path of development. It might be appropriate to use the term "capability"; however, this paper adopts the term "capacity," considering its wide usage in various disciplines and at the international level. In the context of capacity development, capacity refers to the aim-oriented, problem-solving ability of the actors involved in development aid. The concept of capacity has had a huge impact on the direction of development aid and argues that development aid should be directed toward capacity development based upon residents' self-directed participation and preference. In other words, capacity development should be based upon equity ownership and empowerment.

Studies on the capacity of each actor involved in EM have dominated literature and practices. Little research has been conducted that comprehensively deals with the total capacity of all the actors involved in EM. Under such circumstances, this paper attempts to conceptually describe social capacity for environmental management (SCEM), which is a core concept of the twenty-first century center of excellence (COE) program, "Social Capacity Development for Environmental Management and International Cooperation" at the Graduate School for International Development and Cooperation (IDEC), Hiroshima University. This paper attempts to pose a sophisticated definition of SCEM and proposes a new framework to measure SCEM as well as other relevant indicators.

2. Capacity

To effectively develop and implement EM plans/policies, it is necessary to properly take into account the interests of various actors (Sampford, 2002). On the other hand, individual actors have specific roles in EM, which vary from issue to issue and context to context. Here, we first clarify the roles of these actors and then review existing definitions of their capacities. For this purpose, we group all the actors into the following three major categories: government, firm, and civil society.

2.1 Roles of Actors

Government

Throughout society, governmental agencies take on greater responsibility for complex policy choices and are frequently the only body that can effectively bring together various parties. The government creates a conducive political and legal environment by building and maintaining the rule of law, regulating socioeconomic standards, developing social and physical infrastructure, and ensuring social safety nets and citizen protection (TUGI, 2003; Sampford, 2002). The role of the government is to maximize the social welfare of the entire society.

Firm

There is a role to be played by ethical firms—those who acknowledge that businesses will have to act to enhance environmental sustainability and social justice by looking to the long-term value of their investments and appealing to their shareholders that they are more than just investors. At the same time, employees are not only businesspeople, but also parents and friends with self-esteem and the desire to sleep comfortably at night. An ethical firm finds new ways to do business and to structure businesses to serve the broader interests and values of its shareholders (Sampford, 2002).

Civil Society

Civil society facilitates social and political interaction through organizing and educating communities, mobilizing groups, supporting solidarity actions and watchdog functions, fostering culture, and so on (TUGI, 2003). This is a very general and broad concept and includes citizens (residents), communities, NGOs and NPOs, scientists, the media, and international agencies. Citizen participation in shaping bureaucratic activities can be viewed as a vital link between governing and being governed (Kweit and Kweit, 1981; Koontz, 1999; Tonglet *et al*, 2004). On the other hand, such citizen participation may be

time-consuming and costly, and it may reduce the ability of technical experts to base decisions on their professional judgment. If top-down programs to protect resources have failed because of the government's inability to exercise authority at a distance, then decentralization of authority to those communities that are located near the resource might be a better option (Agrawal and Gibson, 1999). NGOs and NPOs are mostly concerned with the differential environmental impact of various activities. Once solutions have been suggested, they can produce public pressure to take up solutions and put pressure on those businesses that do not act (Koontz, 1999; Sampford, 2002). Scientists can provide a clear understanding of the basic dimensions of environmental problems, describe and identify options for the appropriate solutions to those problems, and contribute to the resolution of environmental problems by estimating the economic, social, environmental, and political consequences of proposed solutions through time and space and across population groups (Levien, 1979; Steel *et al*, 2004). The media can popularize problems, encourage debate on solutions and popularize options, provide legitimacy to the result, publicly praise those who are worthy of it, and monitor the governance regime to detect cheaters, free-riders, and obstructionists (Sampford, 2002). Finally, international agencies can provide appropriate funding as aid, alternative forums for negotiation, and negotiation skills to those interests and groups who lack them (Sampford, 2002).

2.2 Government Capacity

To define the capacity of government, the research on state capacity in political science seems relevant. The state capacity is defined as (1) the ability to make decisions that are unconstrained by special interests, (2) the ability to make decisions on the basis of a knowledgeable assessment and through a process involving various agencies of government, and (3) the implementation authority to penetrate society (e.g., Mann, 1984; Weiss and Hobson, 1995). Focusing on developing countries, Migdal (1988) defines state capacity as the state's freedom and ability to make informed decisions and to have those decisions implemented. Polidano (2000) defines capacity of government as the ability of the permanent administrative machinery of government to implement policies, deliver services, and provide policy advice to decision-makers. It includes policy capacity, implementation capacity, and operational efficiency. On the other hand, local government capacity research has a long history in the public administration field (see Cohen, 1995). Gargan (1981) defines local government capacity as the ability of the local government to do what it wants to do. Grindle and Hilderbrand (1995) identify five dimensions of public sector capacity: action environment (social, political, and economic milieu), institutional context (government policies, procedures, rules and regulations; roles and responsibilities; financial support), task network (communication and interactions among all organizations involved in a particular task), organizations (resources, goals, activities, leadership), and human resources (training, recruitment, utilization, retention).

2.3 Firm Capacity

The primary criterion for designing an appropriate EM approach is the company's ability to manage its environmental risks; political institutions play an especially important role in the management of such risks (Vastag *et al*, 1996). Research on organizational capability argues that it is dynamic and consists of a set of specific and identifiable processes that allow the organization to generate new, value-creating strategies (Grant, 1995; Floyd and Wooldridge, 1996; Eisenhardt and Martin, 2000; Oxtoby *et al*, 2002). Judge and Elenkov (2004) conceptually describe a new organizational capability, known as organizational capacity for change, which allows the firm to adapt old capabilities to new threats and opportunities as well as create new capabilities. Organizational capacity for change has eight distinct dimensions: trustworthy leadership, trusting followers, capable champions, involved mid-management, innovative culture, accountable culture, systems communications, and systems thinking. Finally, an organization's ability to learn (e.g., Verona and Ravasi, 2003) is also relevant. Another stream of research is on Ashby's law (Ashby, 1956). An implication of Ashby's law for business organizations is that they must develop sufficient information management and decision-

making capacity to cope with the complexity and variety in the environment in which they operate (Beer, 1981; Janis, 1989; Waelchli, 1989; Lewis and Stewart, 2003).

2.4 Capacity of Civil Society

A careful review would suggest that there is little research on the capacity of civil society. Therefore, here, we attempt to define the capacity of civil society based on the discussion on citizen participation or public involvement in EM. The need for citizen participation in the decision-making of EM is well established in both theoretical and applied assessment literature (e.g., Parenteau, 1988; Webler, 1995). Fitzpatrick and Sinclair (2003) summarize the following roles of citizen participation: (1) accentuates the effectiveness of the EM process (Mitchell, 1997); (2) actualizes the principles of democracy (Gelhorn, 1971; Fox, 1979; Zimmerman, 1986; Shepard and Bowler, 1997); (3) ensures that the project meets the needs of the public, in terms of both purpose and design (Pearce *et al*, 1979; Forester, 1989; Tauxe, 1995; Shepard and Bowler, 1997); (4) assigns legitimacy to a project because the assessment process appears to be transparent (Chapin and Deneau, 1978; Susskind and Cruikshank, 1987); (5) provides avenues for conflict resolution for stakeholders (Mitchell, 1997; Shepard and Bowler, 1997; Diduck, 1999); (6) provides a forum for the submission and inclusion of local knowledge in the EA decision (Usher, 2000); and (7) provides for a more comprehensive consideration of factors on which decisions are based (Parenteau, 1988; Webler *et al*, 1995; Shepard and Bowler, 1997). Fitzpatrick and Sinclair (2003) argue that education is important in public involvement because education creates an awareness of the process and facilitates an understanding of substantive environmental, economic, and social issues (Diduck and Sinclair, 1997). Providing members of the public with an opportunity to participate in the management process enriches the outcomes of the process through the incorporation of varied knowledge and opinions into the information base. If public participation practitioners orient processes to promote social learning, then public participation will become more effective at strengthening democracy and overcoming the tendency of people to be rational egotists (Webler *et al*, 1995).

2.5 Social Capacity

Based on a systematic review of extensive literature that describes public policies and their implementation in the United States, Bengston *et al* (2003) concluded that (1) administrative efficiency and other details of policy implementation are critical in determining their effectiveness, (2) vertical and horizontal coordination are critical for successful growth management but are often inadequate or lacking, and (3) meaningful stakeholder participation throughout the planning process and implementation is a cornerstone of effective growth management. This emphasizes the importance of studying social capacity. Several research streams are relevant to the concept of social capacity.

Community or local capacity

The first type of research is related to community or local capacity. Such research acknowledges the importance of the interrelated characteristics of the larger social, political, economic, and institutional environment; community-related factors; and the nature and resources of particular organizations (Biswas, 1996; Hamdy *et al*, 1998). McGuire *et al* (1994) suggest that community capacity for economic development can be conceptualized in terms of citizen participation, community structure, and development instruments. De Leo *et al* (2002) conceptualize local capacity in terms of five interrelated factors: technical capacity (Jaffe and Di Novo, 1987; Witten *et al*, 1995; Neufeld, 1998); financial capacity (Brown, 1980; Gargan, 1981); and institutional, social, and political capacity (Koudstaal *et al*, 1992; Koonce *et al*, 1996; Watson *et al*, 1996). Together, these factors capture many of the major themes evident in the literature (i.e., capabilities of staff, financial resources, leadership, organizational culture, relationships with other organizations, and institutional arrangements). The participation and commitment of members in the community can enhance a municipality's capacity by increasing the knowledge, skills, credibility, and financial resources available to the municipality

(McGuire *et al*, 1994; World Bank, 1995; Poole, 1997; van den Berg *et al*, 1997; Neufeld, 1998; Litke and Day, 1998).

Capacity building
Capacity building is another important aspect in defining social capacity. Capacity building can be defined as the enhancement of people's skills and the capacity of institutions in resource management through education and training (Cicin-Sain and Knecht, 1998). Capacity building pertains to building the capacity of institutions as well as individuals. The emphasis on capacity building in the Rio Declaration on Environment and Development is on endogenous capacity building and the transfer of technological knowledge and scientific understanding for sustainable development. Capacity building in developing countries is discussed with the overall objective of "endogenous capacity building," which is stated to be "to develop and improve national and related sub-regional and regional capacities and capabilities for sustainable development, with the involvement of the nongovernmental sectors" (Wescott, 2002). Cicin-Sain and Knecht (1998) argue that capacity needs to include four realms: legal and administrative capacity, financial capacity, technical capacity, and human resources capacity.

Governance
Governance is another relevant area of research. Governance is the process through which diverse elements in a society wield power and authority, thereby influencing and enacting policies and decisions concerning public life and economic and social development. Governance is implemented by the state as well as the private sector and civil society (Ehler, 2003). Over the past decade, the concept of "good governance" has become a fashionable term in development discussions (TUGI, 2003). First, governance is conceptually broader than government. It recognizes that power exists inside and outside the formal authority and institutions of government and that the interactions among actors create a cumulative impact on the lifestyles and living standards of its citizens. Second, governance is broader than management, which tends to focus on the implementation and administrative functions of government. It is not only concerned with the management function performed by a local government but also with the environment in which managerial decisions are made and implemented. Third, governance emphasizes process and recognizes that decisions are made on the basis of complex relationships between numerous actors with different priorities. Finally, governance is a neutral concept. The actors, mechanisms, processes, and institutions can produce positive or negative results.

3. Social Capacity for Environmental Management

Based on the abovementioned reviews, we can summarize the important elements related to the definition of social capacity in Figure 1. Here, "government" refers to all the public sectors, and "firm" refers to all the private sectors. Civil society includes all other actors such as citizens, communities/neighborhoods, the media, scientists (experts), and international agencies. All these actors interact and such interactions might differ over time, context and country (city). It is obvious that many types of interactions can be observed in Figure 1. This makes it difficult to define and measure social capacity. Matsuoka *et al* (2004) define SCEM as the capacity to manage environmental problems in a social system composed of three social actors—government, firms, and citizens—and their interrelationships. Each actor's capacity depends upon three fundamental factors: (1) policies and measures; (2) human and organizational resources; and (3) knowledge, technology, and information. Capacity is correlated with institutions, and SCEM is understood in the dynamism of the capacity development process and institutional change. Each episode in institutional change defines unique stages of SCEM, which consequently affects relations between social actors.

However, the reviews given at previous sections suggest that this definition is insufficient. It should be refined from the following five aspects.

1) Capacity is a relative concept and does not have an absolute value. In this sense, the evaluation of capacity is meaningful only relative to certain reference point(s) or benchmark(s).
2) In order to provide policy makers with useful advice/recommendations, capacity should be goal-oriented. Without information about the relationship between the capacity indicators and the goals, capacity indicators cannot tell policy makers to what extent the proposed policies would contribute to the goals. Consequently, it would be difficult to use capacity indicators to support policy decisions.
3) The classification of actors could make it easier to assign responsibility, conditional on their interrelationships. However, one needs to keep in mind that some of these interrelationships may not be formal, and therefore could become unstable over time. They might also be also influenced by the individual interest of each actor in the issues under study. In addition, the concept of "citizens" is too narrow. Civil society is much more general and extensive than the citizens; they are only a part of civil society.
4) Capacity should be defined in a holistic manner; otherwise, it cannot be used to properly measure the genuine effects of policies.

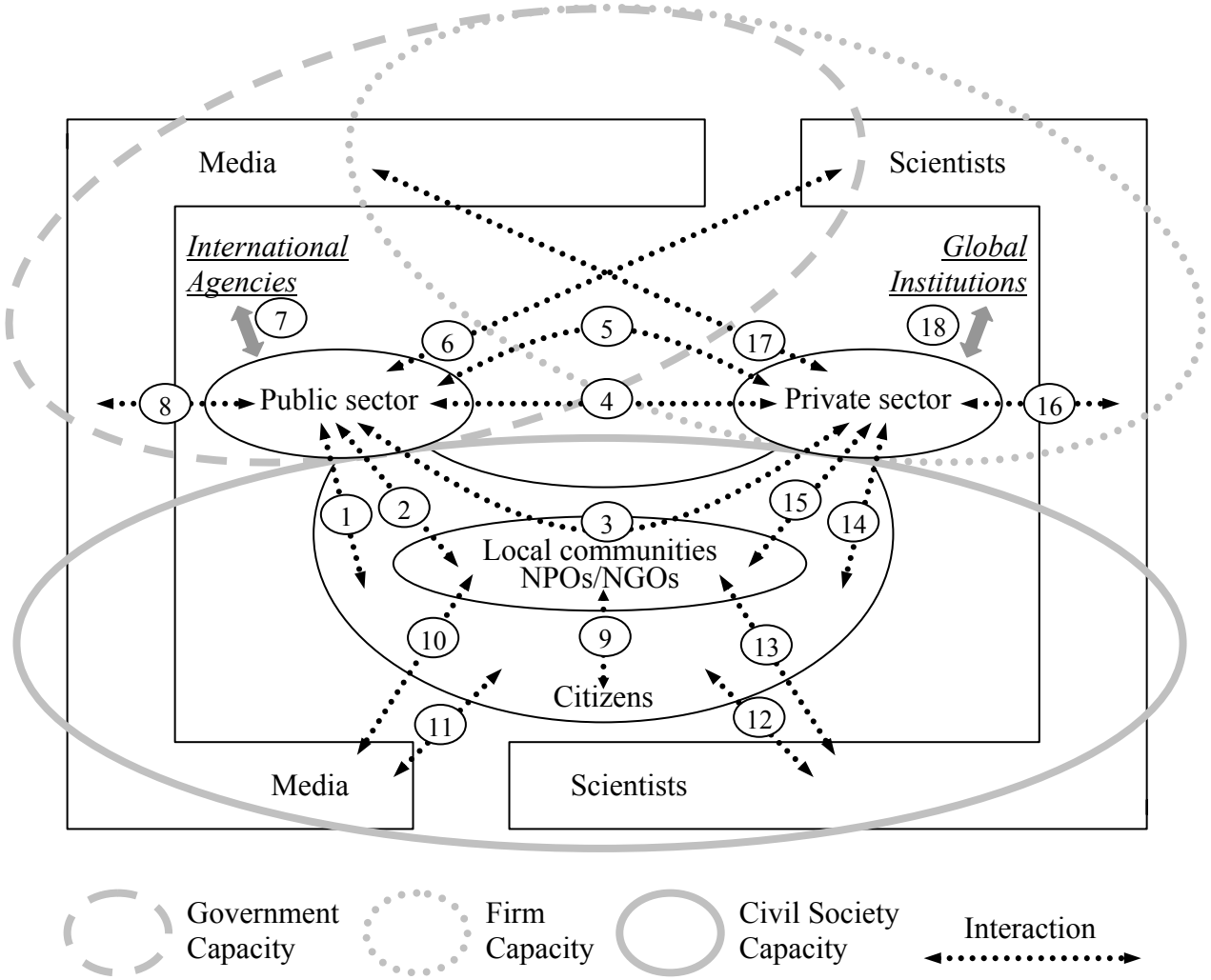


Figure 1. Conceptual framework of social capacity

5) Government, firm, and civil society functionally overlap in the sense that they have some common sub-actors such as the media and scientists, who are an important part of civil society,

but sometimes they also work together with either the government or firms. This has not been elucidated in the original definition of SCEM.

To overcome the first shortcoming of the original definition, we propose to define capacity by explicitly incorporating the influence of temporal and spatial aspects. With respect to the temporal aspect, capacity indicators should be able to inform policy makers about the extent to which the capacity would be improved in a new situation compared with previous situations. Concerning the spatial aspect (e.g., national level, regional level, city level, or neighborhood level), capacity should also provide the policy makers with some guidelines that will be helpful in setting their goals, such as considering the existence of current "best practices" at other places (e.g., other countries or cities). Proper selection of temporal/spatial reference point(s) would help the policy makers to make more effective decisions. However, an incorrect selection might lead to completely different conclusions. To deal with the second shortcoming, we propose to define capacity by linking it to policy goals. In this study, since we are dealing with EM, capacity should be defined to incorporate the relationship between capacity indicators and environmental emissions. Thus, once the capacity is determined, environmental states will be automatically known or measured. With regard to the third shortcoming, we propose the use of the concept of civil society instead of citizens. Civil society is a complex aggregate that is composed of various temporally changing sub-actors. All these sub-actors have considerably different roles in enhancing the capacity of civil society. Successful EM largely depends on how these actors are involved in the process. Even though we identify the media and scientists as a part of civil society, they sometimes work together with either the government or firms. For example, the media could play an important role in propaganda for government policies. Firms often rely on the media in the form of advertisements for their products. On the other hand, the scientists could provide advice to both government and firms. Therefore, to define the capacities of the government and firms, we cannot ignore the roles of either the media or scientists. With respect to the fourth shortcoming, we argue that capacity indicators should be defined on the basis of certain systematic approaches. The last shortcoming implies that each actor's capacity indicator shares the same type of data. Based on the abovementioned criticisms of the original definition of social capacity, we redefined the SCEM as follows:

> *Total capacity wherein the whole society—composed of three social actors: government, firms, and civil society—tackles environmental problems to achieve sustainable states through the learning process, taking into consideration inter-actor interactions and future uncertainty.*

The above SCEM definition is similar to existing definitions proffered by major international organizations such as United Nations Development Programme (UNDP), OECD, and JICA, in the sense that all these definitions emphasize the meaning of total capacity as constructed by the capacity of each actor. Different from existing definitions, ours argues that the definition of capacity should guide analysts on how to measure capacity. Such a consideration makes the SCEM definition operational. In this definition, "sustainable states" are policy goals. Three actors cover all the stakeholders involved in EM. "Learning process" and "future uncertainty" are introduced, considering that capacity is relative in value and dynamic over time. This consideration argues the importance of reference point(s) or benchmark(s). SCEM seems similar to the concept of social capital, a key concept in sociology. As described by Pretty and Ward (2001), social capital captures the ideas that in turn capture the idea that social bonds and social norms are an important part of the basis for sustainable livelihoods. Its value was identified by Jacobs (1961) and Bourdieu (1986), later given a clear theoretical framework by Coleman (1988, 1990), and brought to wide attention by Putnam *et al* (1993) and Putnam (1995). Bubolz (2001) argues that social capital is nothing but a resource (i.e., matter, energy, or information converted into specific forms for attaining goals) embedded in relationships among people, which they can draw upon to provide information or other resources or to facilitate activities for social or personal benefit. Social capital is one part of capital assets, which also includes human capital, financial capital, physical (or man-made) capital, and natural capital (Bubolz,

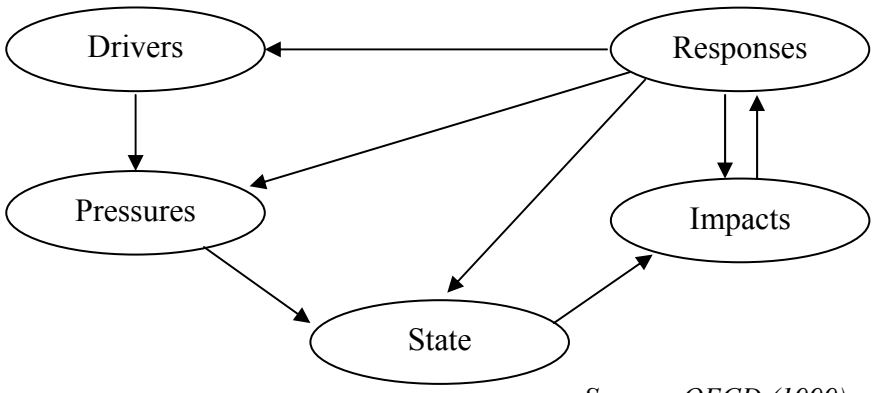
2001; Rudd, 2004). In this sense, SCEM is different from the concept of social capital. Social capital can be regarded as one of the tools that support the decisions of environmental policies.

4. Existing Measurement Framework

To assist effective EM based on effective cooperation and collaboration among various actors, it is necessary to develop some appropriate indicators for social capacity. Indicators have been used for a long time as a tool with which more information can be obtained about issues as varied as people's health, the weather, and economic welfare (e.g., Segnestam, 2002; Nicholson and Fryer, 2002). Segnestam (2002) summarizes the most important lessons learned from the existing studies and suggests that the following aspects are important when developing a set of indicators: (1) development and harmonization of a framework to organize the information; (2) definition of selection criteria, indicator sets, and analytical methods/tools; (3) establishment of a participatory/consultative network; (4) data search and development of databases for the indicator sets and analytical tools; (5) development of capacities and tools to visualize information and analyze cause-effect relationships; (6) development of test studies for the validation of project results; (7) dissemination of information and tools; and (8) design of actions and implementation. Based on a review of existing studies, we found that the following three major measurement frameworks are relevant to the context of EM.

4.1 DPSIR Framework

The drivers-pressure-state-impacts-response (DPSIR) framework (see Figure 2) was proposed by OECD (OECD, 1999; VRDC, 2001). According to this framework, social and economic developments exert pressure (P) on the environment and, as a consequence, the state (S) of the environment changes, as in the provision of adequate conditions for health, resource availability, and biodiversity. Finally, this leads to impacts (I) on human health, ecosystems, and materials that may elicit a societal response (R), which directly feeds back to the driving forces (D), or on the state (S), or impacts (I), through adaptation or curative action. Concretely speaking, indicators for driving forces describe the social, demographic, and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption, and production patterns. The primary driving forces are population growth and developments in the needs and activities of individuals. These primary driving forces provoke changes in the overall levels of production and consumption. Through these changes in production and consumption, the driving forces exert pressure on the environment.



Source: OECD (1999) and VRDC (2001)

Figure 2. The DPSIR framework for EM

Pressure indicators describe developments in the release of substances (emissions), physical and biological agents, the use of resources, and the use of land. The pressures exerted by society are transported and transformed in a variety of natural processes to manifest in changes in environmental

conditions. Examples of pressure indicators are CO_2 emissions per sector; the use of rock, gravel, and sand for construction; and the amount of land used for roads. State indicators provide a description of the quantity and quality of physical phenomena (such as temperature), biological phenomena (such as fish stocks), and chemical phenomena (such as atmospheric CO_2 concentrations) in a certain area. State indicators may, for instance, describe the forest and wildlife resources present, the concentration of phosphorus and sulfur in lakes, or the level of noise in the neighborhood of airports. Due to environmental pressure, the state of the environment changes. These changes then impact the social and economic functions on the environment, such as the provision of adequate conditions for health, resources availability, and biodiversity. Impact indicators are used to describe these impacts. Impacts occur in a certain sequence: air pollution may cause global warming (primary effect), which may, in turn, cause an increase in temperature (secondary effect), which may provoke a rise in sea level (tertiary impact), which could result in the loss of biodiversity. Response indicators refer to responses by groups (and individuals) in society as well as government attempts to prevent, compensate for, ameliorate, or adapt to changes in the state of the environment. Some societal responses may be regarded as negative driving forces since they aim to redirect prevailing trends in consumption and production patterns. Other responses aim to raise the efficiency of products and processes through stimulating the development and penetration of clean technologies. Examples of response indicators are the relative number of cars with catalytic converters and the recycling rates of domestic waste. An often-used, overall response indicator is one that describes environmental expenditure.

In order to meet this information requirement, environmental indicators should reflect all elements of the causal chain that links human activities to their ultimate environmental impacts and the societal responses to these impacts. The DPSIR framework is useful in describing the relationships between the origins and consequences of environmental problems; however, in order to understand their dynamics, it is also useful to focus on the links between DPSIR elements. For instance, the relationship between the driving forces and the pressure from economic activities is a function of the eco-efficiency of the technology and related systems in use, with less pressure coming from more driving forces if eco-efficiency is improving. Similarly, the relationship between the impacts on humans or ecosystems and the state depends upon the carrying capacities and thresholds of these systems. The results of the response on the driving forces depend upon the effectiveness of the response.

4.2 IAD Framework

The institutional analysis and development (IAD) framework (Ostrom, 1990, 1999) is a robust framework that has been used extensively to design policy experiments and empirically test theories and models linking institutions and the sustainability of common pool resource systems (Ostrom *et al*, 1994). The strength of the IAD framework is derived from its systematic theoretical focus on the impact of rules and norms on individual incentives in complex ecological-economic systems, its empirically oriented focus on outcomes (including the transaction costs of management) and by its accounting for dynamic system interactions at multiple tiers of analysis (Ostrom, 1999). To date, however, the IAD framework has not been used to organize indicators of sustainability.

In the context of ecosystem-based fisheries management, Rudd (2004) modified the IAD framework in order to encourage analysts to organize indicators to take full account of the ecological, social, and institutional variables influencing and shaping the incentives and behavior of individuals and organizations. Societal responses to threats to capital assets are clearly differentiated through the investment choices that various sectors of society (private, public, and civil society organizations) make in response to those threats. Investments can be made in the capital assets themselves or in institutions that influence human behavior. The institutions (rules-in-use) that influence actor incentives and behavior include both formal and informal rules. Formal rules specify actions or outcomes that are permitted, prohibited, or required and prescribe formal sanctions for rule violation (Crawford and Ostrom, 1999). Norms similarly prescribe acceptable and unacceptable behaviors, but do not impose formal, legal sanctions on violators. The IAD framework recognizes three main situations in which institutions operate: operational, collective choice, and constitutional (Rudd, 2004).

4.3 System Approach

EM involves a complex decision-making process. In order to identify the vital aspects of SCEM and derive relevant indicators, a system approach is preferred. As described by Bossel (1999), a system is anything that is composed of system elements connected in a characteristic system structure. This configuration of system elements allows it to perform specific system functions within its system environment. These functions can be interpreted as serving a distinct system purpose. The system boundary is permeable for inputs from and outputs to the environment. It defines the system's identity and autonomy. Bossel (1999) proposed to apply orientation theory, which was developed in the 1970s, in an effort to understand and analyze the diverging visions of the future and normative interests of different societal actors (political parties, industry, environmental NGOs), and to define criteria and indicators for sustainable development (Bossel, 1987). Six fundamental properties of relevance to systems are found: normal environmental state (the actual environmental state can vary around this state within a certain range), resource scarcity (resources—energy, matter, and information—required for a system's survival are not immediately available when and where needed), variety (many qualitatively different processes and patterns of environmental variables occur and appear in the environment constantly or intermittently), variability (the state of the environment fluctuates around the norm in a random manner, and the fluctuations may occasionally divert the environment far from the normal state), change (in the course of time, the normal environmental state may gradually or abruptly change to a permanently different normal environmental state), and other systems (the environment contains other actor systems whose behaviors may have system-specific (subjective) significance for a given actor system).

Systems must be compatible with their system environment and their characteristic properties in order to be viable and to exist sustainably. Therefore, the environmental properties can, therefore, be viewed as imposing certain requirements and restrictions on systems, which orient their functions, development, and behavior. Basic orientors of systems include the environment-determined and system-determined orientors. The environment-determined orientors include existence, effectiveness, freedom of action, security, adaptability, and coexistence. Existence means that the system must be compatible with and able to exist in the normal environmental state. The information, energy, and material inputs necessary to sustain the system must be available. Effectiveness implies that the system should on balance (over the long term) be effective (not necessarily efficient) in its efforts to secure scarce resources (information, matter, energy) and to exert influence on its environment. Freedom of action suggests that the system must have the ability to cope in various ways with the challenges posed by environmental variety. Security means that the system must be able to protect itself from the detrimental effects of environmental variability, that is, variable, fluctuating, and unpredictable conditions outside the normal environmental state. Adaptability argues that the system should be able to learn, adapt, and self-organize to generate more appropriate responses to challenges posed by environmental change. Coexistence implies that the system should be able to modify its behavior to account for the behavior and interests (orientors) of other (actor) systems in its environment. On the other hand, the system-determined orientors include reproduction (self-reproducing systems must be able to reproduce, either as individuals and/or as populations), psychological needs (sentient beings have psychological needs that must be satisfied), and responsibility (conscious actors are responsible for their actions and must comply with a normative reference).

5. Existing Indicator Systems

Having determined the framework for measuring SCEM, it is necessary to first find some sets of candidate indicators. Indicators have been used for a long time as a tool with which more information can be obtained on issues as varied as people's health, the weather, and economic welfare (Segnestam, 2002). Here, we provide a brief review of existing relevant indicator systems that have been widely

applied in various fields. Existing indicator systems can be classified into two major categories: One is developed at the national level; the other, the city level.

5.1 Indicator Systems at the National Level

Human Development Index (HDI)
HDI—including life expectancy at birth, educational attainment, and GDP per capita—was proposed to monitor the progress of nations and global societies and constructed to reflect the most important dimensions of human development (UNDP, 1995). The index was developed in 1990 and has been used since 1993 by the UNDP in its annual Human Development Report. HDI is a measure of empowerment. In this sense, HDI could be used as an indicator to measure the social capacity level.

Genuine Progress Indicator (GPI)
GDP is badly flawed as a measure of economic health because it counts only monetary transactions as economic activity. To address the inadequacies of the GDP, the GPI was developed in 1994 by Redefining Progress, a nonprofit public policy institute. The latter has been measured for each nation from 1950 up to the present. Relevant contents include volunteer work, income distribution, change in leisure time, lifespan of consumer durables and public infrastructure, and dependence on foreign assets (Redefining Progress, 1999).

Millennium Development Goals (MDG)
In 2000, the UN Millennium Declaration, adopted at the largest-ever gathering of heads of state, committed countries—rich and poor—to doing all they can to eradicate poverty; promote human dignity and equality; and achieve peace, democracy, and environmental sustainability (UNDP, 2003). The indicators related to social capacity include literacy rate, ODA, telephone lines and cellular subscribers, personal computers in use, and Internet users.

Indicators for Sustainable Development (ISD)
In 1995, the Commission on Sustainable Development (CSD) of the United Nations initiated the development of indicators for the measurement of sustainable development. The major aspects covered were social, environmental, economic, and institutional (UNDSD, 2000). Indicators related to institutional aspects (i.e., strategic implementation of sustainable development, international cooperation, information access, communication infrastructure, science and technology, disaster preparedness, and response) can be used to measure the social capacity.

Dashboard
Dashboard was proposed by the International Institute of Sustainable Development (IISD) and consists of the four categories of society, environment, economy, and institutions (IISD, 2002). The institutional category has eight indicators: SD strategy, SD membership, Internet, telephones, R&D expenditure, disasters (human cost and economic damage), and SD indicator coverage. Institutional aspects are relevant to the measurement of social capacity.

Environmental Sustainability Index (ESI)
ESI is designed to provide national level figures on environmental sustainability for, at present, 122 nations across the globe (World Economic Forum, 2001). The ESI is an initiative of the Global Leaders of Tomorrow Environment Task Force of the World Economic Forum, in collaboration with the Yale Center for Environmental Law and Policy (YCELP) of Yale University and the Center for International Earth Science Information Network (CIESIN) of Columbia University. ESI consists of five dimensions or components: environmental systems, reducing environmental stresses, reducing human vulnerability, social and institutional capacity, and global stewardship. ESI is developed partly based on the pressure-state-response (PSR) or driving force-state-response (DSR) frameworks, which have their origin in work conducted by the OECD, Canadian government, and UNEP (Hammond *et al*, 1995; OECD, 1999). The social and institutional capacity and global stewardship reflect different

aspects of the response component of the PSR framework and can be used to measure the social capacity. The relevant indicators could be selected from those related to social and institutional capacity (i.e., science/technology, capacity for debate, regulation and management, private sector responsiveness, environmental information, eco-efficiency, and reducing public choice distortions) and global stewardship (i.e., international commitment, global-scale funding/participation, and protection of international commons).

Wellbeing of Nations (WN)
The Wellbeing of Nations (Prescott-Allen, 2001) surveys 180 countries and is the first global assessment of sustainability. This assessment can be used at any level from the municipality to the international. It differs from other approaches to assessing sustainability in its dual focus on human and ecosystem wellbeing. The Human Wellbeing Index was proposed to cover health and population, wealth, knowledge and culture, community (rights and freedoms, governance, institutions, law, peace, crime, and civil order), and equity (distribution of benefits and burdens between males and females, among households, ethnic groups, and other social divisions). Most of the indicators related to human wellbeing could be used to measure social capacity.

Global Environmental Monitoring System (GEMS)
UNEP/WHO (1996) issued a GEMS report about air quality management, which assumes that the capacity for air quality management is composed of the following four elements: (1) capacity to measure air quality, (2) capacity to assess and create available data, (3) capacity to estimate emissions and trace their sources, and (4) capacity to devise and implement policies. The adopted capacity indicators include the number of monitoring stations and measurement frequency of certain pollutants, making an attempt to quantitatively evaluate the capacity for air quality management and so on.

5.2 Indicator Systems at the City Level

As shown above, indicator systems have been widely developed at the national level. In recent years, an increasing number of cities and municipalities are undertaking community sustainability studies, encouraged by the Local Agenda 21 initiative (see Besleme and Mullin, 1997; Farrell and Hart, 1998), to monitor issues such as economic security, ecological integrity, and quality of life, and to raise public awareness, identify achievable goals, make trends visible, and help individuals, communities, and their governments establish priorities (see OECD, 1997). Here, two major indicator systems are briefly described as follows:

Indicators of Sustainable Community: Sustainable Seattle Indicators
A famous and often-replicated example is the set of indicators of sustainable development for the city of Seattle, Washington. This set is the result of a long process of discussion and development involving intensive citizen participation (AtKisson, 1996). Since the inception of Sustainable Seattle, the indicators report has been updated and published every two to three years, covering environment, population and resources, economy, youth and education, and health and community (Sustainable Seattle, 1998). Some of the indicators that represent economic status, education, and community could be used to measure social capacity. The progress of such indicator development around the world could contribute to the improvement of urban governance.

Good Urban Governance
A famous practical indicator framework for good governance was proposed by Kaufmann *et al* (2003). The framework explicitly recognizes the roles of each actor (government, firms, and citizens) and calculates the indicators for some 199 nations. Another famous indicator framework for urban governance was developed by TUGI (2003). Five types of indicators are commonly used to measure the governance level. (1) Input indicators include budget allocations, human resources, time required to produce output, institutional constraints, and so on. (2) Process indicators include the quality of administrative systems, procedures, policies, and plans. (3) Output indicators show the externally

visible results of the inputs and processes, including goods and services that satisfy citizen needs. (4) Outcome indicators measure the long-term goals or benefits derived from a process, usually in the form of satisfied needs or changes in behavior. (5) Impact indicators measure the impact of service delivery on the quality of life and on economic and environmental conditions. The core characteristics of the TUGI framework are participation, rule of law, transparency, responsiveness, consensus orientation, equity, effectiveness and efficiency, accountability, and strategic vision. This framework is comprehensive and systematic. However, since it requires an extensive set of data, it is still difficult to use when comparing the governance levels of different cities worldwide.

In addition, the Asian Development Bank has developed another data source about urban indicators (de Villa and Westfall, 2001), which include social capacity indicators such as local government employees, local government wages as a percentage of a recurring budget, and sources of local government revenues (a proportion from taxes and transfers). However, this data source only includes 17 Asian cities, of which most are developing cities.

6. Development of the DPSIR+C Framework

Japan's ODA is experiencing dramatic changes under domestic economic recessions and large financial deficits. At the same time, through economic globalization, the role of ODA is gradually, but steadily, changing because of substantial contributions from the private sector, communities, and universities (see http://home.hiroshima-u.ac.jp/hicec/en/about/page3.html). To effectively promote international cooperation based on Japan's ODA experiences, some innovative approaches are required. In the Hiroshima University COE program mentioned at the beginning of this paper, we proposed a new approach focusing on the development of SCEM. The above review argues its importance and supports the rationality of introducing the concept of social capacity. This new approach argues that Japan's ODA should be geared toward giving full play to the roles of various actors and constructive inter-actor interactions.

6.1 An Improved Framework

As reviewed in Section 4, there are three major frameworks used to carry out EM. Without sophisticated comparisons of these frameworks, it is difficult to conclude which framework is better than the others. Considering its popularity in EM at the international level, we propose to introduce the concept of capacity into the DPSIR framework (called DPSIR+C). Figure 3 shows the manner in which the DPSIR+C framework can be applied in the context of urban air quality management. In the figure, the green arrows indicate how the capacity influences the D-P-S-I-R elements, while the blue arrows indicate how the capacity should be built, taking into consideration the cause-effect relationships among the D-P-S-I-R elements. We argue that capacity is the basis of having good responses to the D-P-S-I elements. Without such capacity, it is difficult to expect good responses. One can see that there is a two-way relationship between capacity and responses. The arrow from responses to capacity means that lessons/experiences at previous points in time could help each actor improve its capacity. The D-P-S-I elements could also contribute to capacity building, but in a different manner.

For example, in the case of urban air quality management, population and economic growth, lifestyle, and the distances traveled might be major driving forces that exert pressures on the environment through the increase of environmental loads from car traffic. Such pressure could inversely influence the driving forces in a positive or negative way. Negative influence refers to the situation where the non-controlled or ill-controlled increase in environmental loads could induce people to travel longer, while positive influence indicates that, for example, a proportion of the population might voluntarily reduce their distances traveled in response to the increase in environmental loads. States can be represented by the term of urban air quality, which results from the influence of the pressure. Impact has been defined in various ways. However, we argue that the

extreme impacts of environmental issues are on human (e.g., health and quality of life) and natural systems (or ecosystems, e.g., biodiversity). Impacts on human society and the natural system may give rise to concerns over environmental issues. Such concerns lead to a response, e.g., policy decisions about the enforcement of laws and institutions, economic measures (e.g., road pricing), the support and promotion of technological innovation, and enlightenment. Responses could occur to tackle any of the D-P-S-I elements. In the case of driving forces, reconstructing our social system on the basis of an environmentally-friendly lifestyle could effectively control traffic generation. Policies to reduce environmental loads include the enforcement of laws and institutions by government, compliance and public involvement by citizens and firms, and technological development by firms. On the other hand, for example, increasing areas for green spaces and voluntary plantation could contribute to the absorption of air pollution. All responses rely heavily on the level of social capacity.

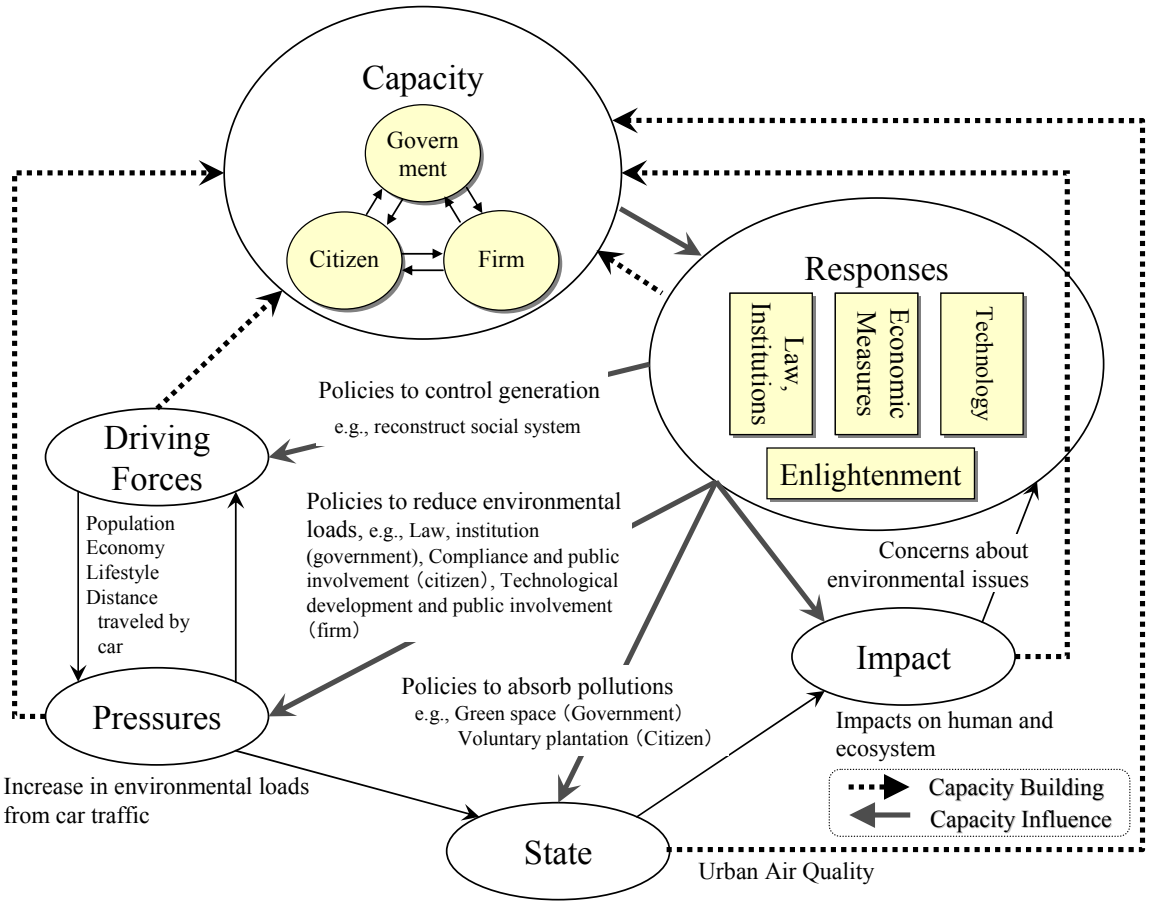


Figure 3. DPSIR+C framework: An example of urban air quality management

Although we proposed the improved DPSIR+C framework in the context of EM, it can be applicable to other types of sustainable development issues. Needless to say, such applicability should be examined in the future.

6.2 Measurement Based on Structural Equation Models

In order to capture the complex cause-effect relationships in the measurement of SCEM, a structural equation modeling approach can be applied. A structural equation model is a set of simultaneous equations that can be used to specify the phenomenon under study in terms of putative cause-effect variables and their indicators (Jöreskog and Sörbom, 1989); the full model structure can be summarized below.

Structural equation model:

$$\eta = B\eta + \Gamma\xi + \zeta \quad (1)$$

Measurement model for y:

$$y = \Lambda_y \eta + \varepsilon \quad (2)$$

Measurement model for x:

$$x = \Lambda_x \xi + \delta \quad (3)$$

Here, $\eta' = (\eta_1, \eta_2, ..., \eta_m)$ and $\xi' = (\xi_1, \xi_2, ..., \xi_m)$ are the latent dependent and independent variables, respectively. Vectors η and ξ are not observed, but instead, $y' = (y_1, y_2, ..., y_p)$ and $x' = (x_1, x_2, ..., x_q)$ are the observed dependent and independent variables, respectively. $\zeta, \varepsilon, \delta$ are the vectors of error terms, and $B, \Gamma, \Lambda_x, \Lambda_y$ are the unknown parameters.

Structural equation models have proven useful in solving many substantive research problems in social and behavioral sciences. Such models have also been used in the study of macroeconomic policy formation; intergenerational occupational mobility; racial discrimination in employment, housing, and earnings; studies on the antecedents and consequences of drug use; scholastic achievement; evaluation of social action programs; voting behavior; studies on genetic and cultural effects; factors in cognitive test performance; consumer behavior; and many other phenomena including transportation. Methodologically, the models play many roles including simultaneous equation systems, linear causal analysis, path analysis, structural equation models, dependence analysis, and cross-legged panel correlation techniques (Jöreskog and Sörbom, 1989).

In particular, since a latent variable is usually defined as one which represents the common characteristic behind a group of observed factors, the development of the indicators of SCEM are expected to be useful. For example, in the case of the DPSIR+C framework, indicators of driving forces, pressure, state, impact, response, and capacity could be defined by using the latent variables, and consequently, the structural equation models could be used to explore the cause-effect relationships in the DPSIR+C framework.

Existing studies have primarily specified the weights of indicators and their interactions exogenously and deterministically, based upon either experts' experiences/opinions or some ad-hoc approaches. In contrast, the structural equation model endogenously estimates the weights of indicators and their interactions based on the statistical cause-effect relationships. In other words, the estimation is made by minimizing the difference of the observed and the assumed correlations between the given (dependent and independent) variables. Such estimation reflects the stochastic features of the assumed cause-effect relationships.

6.3 Indicator System for SCEM

In order to measure the level of each actor's capacity based on the literature review, two major categories of indicators could be identified, i.e., objective indicators (tangible) and subjective indicators (intangible). The actor-factor approach (Murakami and Matsuoka, 2006) could be used to capture the influences of various objective indicators. These indicators can cover organizations, human resources, financial resources, infrastructure, information, knowledge, technology, and so on. With regard to the subjective indicators, those adopted in Good Urban Governance (TUGI, 2003) could be applicable. These indicators can be regrouped into tool-related indicators (strategy and rule of law), performance-related indicators (transparency, responsiveness, equity, effectiveness, efficiency), and process-related indicators (accountability, consensus building, participation). Throughout the

recognition and learning process, the three major actors dynamically form the social capacity. These are illustrated in Figure 4, as shown below.

The actor-factor approach should be positioned as an expert system. It is operational and easily applied in the real world. However, the selection and grouping of factors relies heavily upon data availability and the subjective judgment of analysts. Some statistical approaches such as factor analyses and principal component analyses could be applied to logically group these factors. Since this approach usually uses existing statistical data, the factors used in one city/country may not be observed in another city/country. In other words, depending on data availability, comparisons between cities/countries may not be possible or the comparison may be biased. In many cases, best practices in some cities/countries are often used as a benchmark; thus, comparisons between cities/countries are critical. To make up for such shortcomings, subjective indicators are introduced. These subjective indicators can be obtained by implementing questionnaire surveys with respect to all three major actors. The questionnaire surveys can be designed to have each actor report its subjective evaluations on current situations and future expectations related to each indicator. The systematic development of such subjective indicators could provide an important and informative guide to collect those missing data that were lost in the objective indicators. The shortcoming of subjective evaluation can be observed in its reliability.

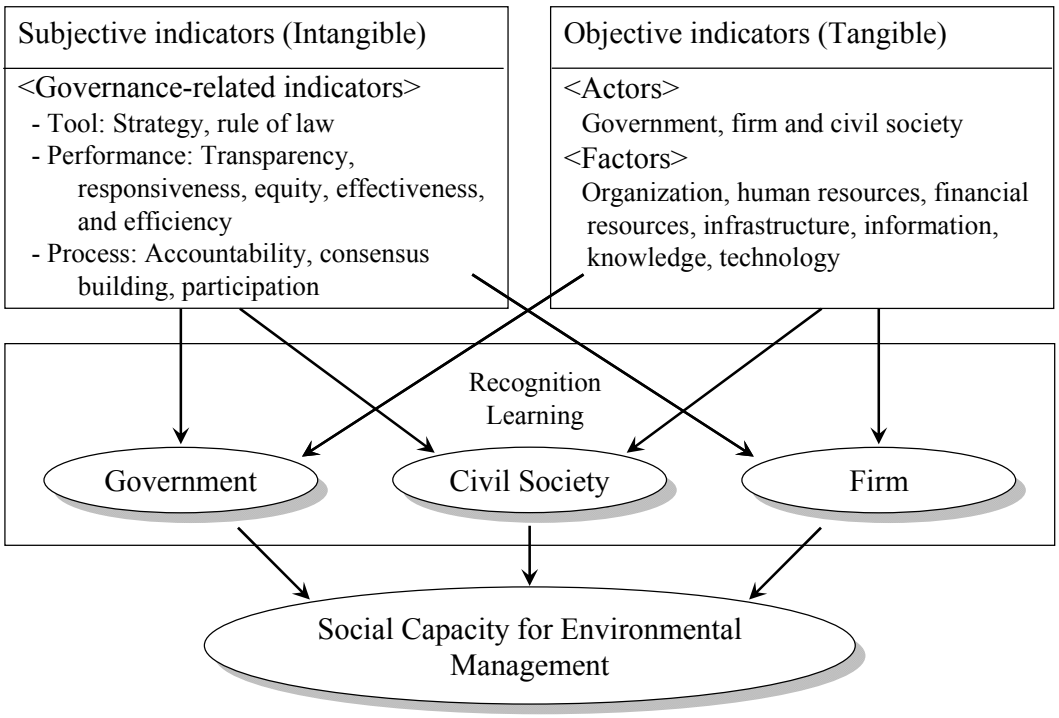


Figure 4. Structure of the indicator system for measuring SCEM

Based on the above discussion, it is obvious that both objective and subjective indicators have their advantages and disadvantages. These two types of indicators should be simultaneously incorporated into the SCEM indicator system. All the relevant indicators described in Section 5 can be used as candidate indicators for measuring SCEM. Among these, the ESI indicator system (World Economic Forum, 2001) provides a better set of capacity indicators (see Table 1). We have to point out that the ESI indicator system confuses the terms of responses and capacity, and incorrectly regards the capacity as a part of the responses. In addition, objective indicators cannot properly measure the quality of EM, because such data can tell analysts, for example, how many budgets were invested on EM but cannot show how effectively these budgets were spent. Even though reliability is one of their major shortcomings, subjective indicators can be used to measure the quality of EM; however, it is difficult to do this using objective indicators. One of the examples of such subjective indicators can be collected based on the Good Urban Governance indicator system (TUGI, 2003), of which the core

elements are described below. One could design questionnaires that have the three major actors evaluate these elements in the context of interest.

Table 1. Structure of the Environmental Sustainability Index (ESI)

Component	Indicator	Indicator type	Number of indicators
Environmental systems	Air quality	State	3
	Water quantity	State	2
	Water quality	State	4
	Biodiversity	State	2
	Terrestrial systems	State	2
Reducing stresses	Reducing air pollution	Pressure	5
	Reducing water stress	Pressure	4
	Reducing ecosystem stress	Pressure	2
	Reducing waste and consumption pressures	Pressure	2
	Reducing population pressure	Pressure	2
Reducing human vulnerability	Basic human sustenance	State	2
	Environmental health	State	3
Social and institutional capacity	Science/technology	Response	3
	Capacity for debate	Response	2
	Regulation and management	Response	4
	Private sector responsiveness	Response	5
	Environmental information	Response	3
	Eco-efficiency	Response	2
	Reducing public choice distortions	Response	3
Global stewardship	International commitment	Response	4
	Global-scale funding/participation	Response	2
	Protecting international commons	Response/pressure	5

Source: World Economic Forum (2001)

(1) Participation

- Existing policies and programs of the institution that encourages the participation of the civil society in the development of a particular process
- Relationship between the institution and stakeholders in the development of programs/policies
- Level of stakeholders' engagement in the development process
- Level of awareness among the institutions' staff on the importance of civil society participation in the development process
- Gender sensitiveness in the participation process
- Policies and programs of the institution that encourage the participation of all stakeholders, irrespective of their age, sex, language, economic condition, and religion
- Sensitivity of the institution toward the importance of participation in general and from within a gender perspective, in particular

(2) Rule of law

- Existence and adequacy of the rules and regulations related to partnership with stakeholders
- Fair and impartial enforcement of the existing rules and regulations in dealing with the stakeholders
- The extent to which the concerned parties (governments, stakeholders, and institutions) adhere to the rules and regulations
- Concern shown by the institution in taking action against parties for violating rules and regulations

(3) Transparency

- Level of transparency of the allocated budget and procedures for partnership with stakeholders
- Access to information and processes for stakeholders to participate in the development process
- Transparency in selecting stakeholders for partnerships
- Transparency in assigning contracts/work to stakeholders

(4) Responsiveness

- Mechanism to ascertain the capacities of the various stakeholders and enter into partnerships or involve them accordingly
- Ease of access for stakeholders involved in a program or policy decision to work with the institution
- Opportunities for stakeholders to take active part in the development process
- Accommodating various categories and sizes of stakeholders
- Gender sensitiveness of the institution in dealing with stakeholders

(5) Consensus orientation

- Practice in reaching stakeholder consensus in major, important, and strategic decisions
- Institutional mechanisms to consult stakeholders
- Gender sensitiveness in consensus orientation
- Involvement of the key stakeholders in decision-making processes
- Execution of joint decisions

(6) Equity

- Institutional priority of resource investment to mobilize stakeholders and work in partnership and collaboration with them
- Opportunity for stakeholders of all categories to contribute and work freely
- Concern shown by stakeholders to show respect and network amongst each other irrespective of their size and capacity
- Extent of gender sensitiveness in mobilizing and working in partnership with stakeholders
- Manner in which the institution deals with stakeholders of various categories including CBOs

(7) Effectiveness and efficiency

- Extent of mobilization of the involvement of stakeholders for the development of a program or policy
- Situation of the partnership and collaboration between the institution and the stakeholders
- Networking and collaboration among stakeholders
- Extent of mobilization of the resources from the stakeholders
- Cost-effectiveness in the activities undertaken by stakeholders

(8) Accountability

- The extent to which the institution realizes that they are accountable for their actions
- The extent to which the stakeholders realize that they are accountable for their actions
- The extent to which the grievances and complaints are entertained by the institution or overarching authority
- The legal provisions that exist to compensate for negligent conduct
- Examples of demonstrating accountability by the institution

(9) Strategic vision

- Availability of long-term or mid-term programs and policies to mobilize and work in collaboration with stakeholders
- Reflection of the partnership program with the stakeholders in the annual development program and budget of the institution
- Availability of statistical information or profiles of stakeholders involved
- Regular updating of information on stakeholders
- Evaluation of the stakeholders' performance

For example, Zhang *et al* (2005) applied a structural equation model to evaluate the SCEM at the city level in the transport sector. The Millennium Cities Database is used to measure environmental sustainability. Since it is difficult to collect capacity-related data at the city level, and it is also expected that capacity at the national level might influence that at the city level, the ESI capacity indicators at the national level are used to measure the influence of SCEM on environmental sustainability. They confirm that enhancing the capacity of the government could effectively contribute to the reduction of environmental load. To properly incorporate the quality of EM into the measurement of SCEM, Zhang and Fujiwara (2006) conducted a questionnaire survey in Beijing, with respect to the three major actors, by applying the concepts of the Good Urban Governance framework based on this DPSIR+C concept. They found that there exist strong correlations among the three

actors' capacities, and the capacity of civil society has the largest influence on the impact of people's health, livability, and ecosystems. The citizens also perceive that enhancing the capacity of civil society is the most effective way to improve the current situations of the transport system, air pollution, and ecosystems.

7. Conclusions and Implications

There is a broad array of literature related to both EM and social capacity. It is difficult to provide a comprehensive review of all existing studies. This working paper first discussed the roles of various actors involved in EM and reviewed the definitions of each actor's capacity and social capacity based on the studies conducted in various research fields. It is found that in principle, existing literature supports the definition of SCEM. However, the reality is much more complex than expected. To that effect, the original definition of SCEM was further refined to reflect the essence of social capacity (e.g., relativity, complexity, and dynamic and policy-oriented characteristics).

Implementing international cooperation based on the concept of capacity aims to create new types of development aid policies. Experiences in Japan and other developed countries reveal that traditional development aids deployed over the past half of the century were the development of donor countries (i.e., the tied aid) based on the donors' criteria. Such aids were not always effective in meeting development purposes in developing countries. The COE program aims to clarify the feasibility of applying the concept of social capacity to explore some new ways to further promote international cooperation from the theoretical and policy perspectives. The SCEM is a concept based on the theory of capability, and it is an extension of the capability and capacity that has been contributing to a paradigm shift in ODA policy and development theory. This paper proposes a new framework, that is, the DPSIR+C, which can work as a conceptual framework to support the next generation of development aids. Based on this new framework, it is possible to propose some new policies that emphasize the autonomy of recipient countries during the process of sustainable development. We further propose the application of structural equation models to measure the level of social capacity.

With regard to indicator development, it is confirmed that there are various data sources available and accessible at the national level; however, data at the city level are very limited. Considering the importance of "Think Globally and Act Locally," more research efforts are required to explore capacity development at the city level.

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REFERENCES

Agrawal, A. and Gibson, C.C. (1999) Enchantment and Disenchantment: The Role of Community in Natural Resource Conservation, *World Development*, 27(4), 629-649.

Ashby, WR. (1956) *An Introduction to Cybernetics*, Chapman & Hall: London.

AtKisson, A. (1996) Developing indicators of sustainable community: Lessons from Sustainable Seattle, *Environmental Impact Assessment Review*, 16, 337-350.
Beer, S. (1981) *Brain of the Firm* (2nd Edition). Wiley: Chichester.
Besleme, K. and Mullin, M. (1997) Community indicators and healthy communities, *National Civic Review*, Vol.86, No.1, 43-53.
Bengston, D.N., Fletcher, J.O. and Nelson, K.C. (2003) Public policies for managing urban growth and protecting open space: Policy instruments and lessons learned in the United States, *Landscape and Urban Planning* (in press).
Biswas, A.K. (1996) Capacity building for water management: Some personal thoughts, *Water Resources Development*, 12, 399-405.
Bossel, H. (1987) Viability and sustainability: Matching development goals to resource constraints, *Futures*, 19(2), 114-128.
Bossel, H. (1999) *Indicators for Sustainable Development: Theory, Method, Applications*, A Report to the Balaton Group. International Institute for Sustainable Development.
Bourdieu, P. (1986) The forms of capital. In J. Richardson (Ed.), *Handbook of Theory and Research for the Sociology of Education*. Westport CT: Greenwood Press.
Brown, A. (1980) Technical assistance to rural communities: Stop gap or capacity building? *Public Administration Review*, 40(1), 18-23.
Bubolz, M.M. (2001) Family as source, user, and builder of social capital, *Journal of Socio-Economics*, 30, 129-131.
Chapin, H. and Deneau, D. (1978) *Access and the Policy-Making Process*, Ottawa Council on Social Development, Ottawa, Canada.
Cicin-Sain, B. and Knecht R. (1998) *Integrated Coastal and Ocean Management: Concepts and Practises*. Washington: Island Press.
Cohen, J. M. (1995) Capacity building in the public sector: A focused framework for analysis and action, *International Review of Administrative Sciences*, 61, 407-422.
Collinge, C. and Leach, S. (1995) Building the capacity for strategy formation in local government, *Local Government Studies*, 21(3), 343-352.
Coleman, J. (1988) Social capital and the creation of human capital, *American Journal of Sociology*, 94, 95-120.
Coleman, J. (1990) *Foundations of Social Theory*. Boston, MA: Harvard University Press.
Crawford, S.E.S. and Ostrom, E. (1999) A grammar of institutions, *American Political Science Review*, 89, 582-600.
De Loe, R.C., Di Giantomasso, S.E. and Kreutzwiser, R.D. (2002) Local capacity for groundwater protection in Ontario, *Environmental Management*, 29, 217-233.
De Villa, V. and Westfall, M.S. (2001) Urban Indicators for Managing Cities: Cities Data Book. Asian Development Bank.
Diduck, A. and Sinclair, A.J. (1997) The concept of critical environmental assessment education, *The Canadian Geographer*, 41(3), 294-307.
Ehler, C.N. (2003) Indicators to measure governance performance in integrated coastal management, *Ocean and Coastal Management*, 46, 335-345.
Eisenhardt, K. and Martin, J. (2000) Dynamic capabilities: what are they? *Strategic Management Journal*, 21(10/11), 1105-1122.
Farrell, A. and Hart, M. (1998) What Does Sustainability Really Mean? The Search for Useful Indicators, *Environment*, Vol.40, No.9, 4-12.
Fitzpatrick, P., and Sinclair, A.J. (2003) Learning through public involvement in environmental assessment hearings, *Journal of Environmental Management*, 67, 161-174.
Floyd, S. and Wooldridge, B. (1996) *The strategic middle manager*. San Francisco: Jossey-Bass.
Forester, J. (1989) *Planning in the Face of Power*, University of California Press, Berkley.
Fox, D. (1979) *Public Participation in Administrative Proceedings*, Law Reform Commission of Canada, Ottawa.
Gargan, J. J. (1981) Consideration of local government capacity, *Public Administration Review*, 41, 649-658.

Gelhorn, E. (1971) Public participation in administrative proceedings, *Yale Law Journal*, 81, 359-387.
Grant, RM. (1995) *Contemporary strategy analysis*. Oxford (UK): Blackwell.
Grindle, M. S. and Hilderbrand, M. E. (1995) Building sustainable capacity in the public sector: what can be done? *Public Administration and Development*, 15, 441-463.
Hamdy, A., Abu-Zeid, M. and Lacirignola, C. (1998) Institutional capacity building for water sector development, *Water International*, 23, 126-133.
Hammond, A., Adriaanse, A., Rodenburg, E., Bryant, D. and Woodward, R. (1995) *Environmental indicators: A systematic approach to measuring and reporting on environmental policy performance in the context of sustainable development*. World Resources Institute, Washington, DC.
Hartvelt, F. and Okun, D.A. (1991) Capacity building for water resources management, *Water International*, 16, 176-183.
International Institute for Sustainable Development (2002): http://www.iisd.org/efault.asp, (December 12, 2002).
Ivey, J.L., Smithers, J., Loe, R.C.D, and Kreutzwiser, R.D. (2004) Community Capacity for Adaptation to Climate-Induced Water Shortages: Linking Institutional Complexity and Local Actors, *Environmental Management*, 33(1), 36-47.
Jaffe, M. and Di Novo, F. (1987) *Local groundwater protection*, American Planning Association, Washington.
Janis, I.L. (1989) *Crucial Decisions: Leadership in Policymaking and Crisis Management*. Collier Macmillan: London.
Jacobs, J. (1961) *The Life and Death of Great American Cities*. Random House, London.
Jöreskog, K.G. and Sörbom, D. (1989) *LISREL7, A Guide to the Program and Application*, 2nd Edition. SPSS Inc., Chicago.
Judge, W.Q. and Elenkov, D. (2004) Organizational capacity for change and environmental performance: an empirical assessment of Bulgarian firms, *Journal of Business Research* (in press).
Kaufmann, D., Kraay, A. and Mastruzzi, M. (2003) *Governance Matters III – Governance Indicators for 1996-2002*, The World Bank Working Paper.
Koonce, J.F., Cairns, V., Christie, A., Dodge, D.P., Hamilton, A., Lickers, H., McHattie, B., Roseboom, D. and Wooley, C. (1996) A commentary on the role of institutional arrangements in the protection and restoration of habitat in the Great Lakes, *Canadian Journal of Fisheries and Aquatic Sciences*, 53, 458-465.
Koontz, T.M. (1999) Citizen participation: Conflicting interests in state and national agency policy making, *The Social Science Journal*, 36(3), 441-458.
Koudstaal, R., Rijsberman, F.R. and Savenije, H. (1992) Water and sustainable development, *Natural Resources Forum*, 16(4), 277-290.
Kweit, M., and Kweit, R. (1981) *Implementing Citizen Participation in a Bureaucratic Society: A Contingency Approach*. New York: Praeger.
Levien, R., (1979) Global problems: the role of international science and technology organizations. In: Gvishiani, J. (ed.), *Science, Technology and Global Problems*. Pergamon Press, Oxford.
Lewis, G.L. and Stewart, N. (2003) The measurement of environmental performance: An application of Ashby's law, *Systems Research and Behavioral Science*, 20, 31-52.
Litke, S. and Day, J.C. (1998) Building local capacity for stewardship and sustainability: the role of community-based watershed management in Chilliwack, British Columbia, *Environments*, 25(2-3), 91-109.
Mann, M. (1984). The autonomous power of the state: its origins, mechanisms and results, *Archives Europeennes de Sociologie*, 25(2), 185-213.
Matsuoka, S., Okada, S., Kido, K. and Honda, N. (2004) Development of social capacity for environmental management and institutional change, *Proceedings of the Second International Symposium "Social Capacity Development for Environmental Management and International Cooperation in Developing Countries"*, Hiroshima University, January 13.
McGuire, M., Rubin, B., Agranoff, R. and Richards C. (1994) Building development capacity in nonmetropolitan communities, *Public Administration Review*, 54(5), 426-432.

Migdal, J. S. (1988). *Strong societies and weak states: state-society relations and state capabilities in the Third World*. Princeton: Princeton University Press.
Mitchell, B. (1997) *Resource and Environmental Management*, Longman, Waterloo, Ont.
Murray, M. and Dunn, L. (1995) Capacity building for rural development in the United States, *Journal of Rural Studies*, 11(1), 89-97.
Murakami, K. and Matsuoka, S. (2006) Evaluation of Social Capacity for Urban Air Quality Management, *The Japanese Journal of Evaluation Studies*, 6(1), 55-69.
Neufeld, D. (1998) Planning for groundwater: municipal implementation tools. In *Groundwater in a watershed context, Symposium Proceedings*. Burlington, Ontario. Canadian Water Resources Association: Cambridge, Ontario, December 2-4, 1998, 147-157.
Nicholson, M. and Fryer, R. (2002) Developing effective environmental indicators –does a new dog need old tricks? *Marine Pollution Bulletin*, 45, 53–61.
OECD (1999) *Environmental Indicators for Agriculture: Concepts and Frameworks*, Vol. 1. Organisation for Economic Co-operation and Development, Paris.
OECD (1997) *Better Understanding our Cities*, The Role of Urban Indicators. Paris.
Ostrom, E. (1990) *Governing the Commons: The Evolution of Collective Action*. Cambridge Univ. Press, Cambridge, U.K.
Ostrom, E. (1999) Institutional rational choice: an assessment of the IAD framework. In: Sabatier, P. (ed.), *Theories of the Policy Process*. Westview Press, Boulder, Colorado, 35-71.
Ostrom, E., Gardner, R., and Walker, J. (1994) *Rules, Games, and Common-Pool Resources*. University of Michigan Press, Ann Arbor.
Oxtoby, B., McGuinness, T. and Morgan, R. (2002) Developing organizational change capability, *European Management Review*, 20(3), 310-320.
Parenteau, R. (1988) *Public Participation in Environmental Decision-Making*, Federal Environmental Assessment Review Office, Ottawa, Canada.
Pearce, D.W., Edwards, L. and Beuret, G. (1979) *Decision-Making for Energy Futures: A Case of the Windscale Inquiry*, Macmillan, London, in association with SSRC.
Polidano, C. (2000) Measuring public sector capacity, *World Development*, 28(5), 805-822.
Poole, D.L. (1997) Building community capacity to promote social and public health: challenges for universities, *Health and Social Work*, 22(3), 163-170.
Putnam, R.D., Leonardi, R., and Nanetti, R.Y. (1993) *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton University Press, Princeton, NJ.
Putnam, R.D. (1995) Bowling alone: America's declining social capital, *Journal of Democracy*, 6(1), 65-78.
Prescott-Allen, R. (2001) *The Wellbeing of Nations*, Island Press: London.
Pretty, J. and Ward, H. (2001) Social capital and the environment, *World Development*, 29(2), 209-227.
Redefining Progress (1999) *The Genuine Progress Indicator*. http://www.redefiningprogress.org/projects/gpi/updates/gpi1999.html#S2.
Rudd, M.A. (2004) An institutional framework for designing and monitoring ecosystem-based fisheries management policy experiments, *Ecological Economics*, 48, 109-124.
Sampford, C. (2002) Environmental governance for biodiversity, *Environmental Science and Policy*, 5, 79-90.
Segnestam, L. (2002) *Indicators of Environment and Sustainable Development: Theories and Practical Experience*, Environmental Economics Series, Paper No.89, The World Bank Environment Department.
Sen, A.K. (1985) *Commodities and Capabilities*. Amsterdam: Elsevier Science.
Sen, A.K. (1992) *Inequility Reexamined*. Oxford: Oxford University Press.
Sen, A.K. (1997) Quality of life and economic evaluation, *Academia Economic Papers*, 25(3), 269-316.
Shepard, A. and Bowler, C. (1997) Beyond the requirements: Improving public participation, *Journal of Environmental Planning and Management*, 40(6), 725.

Steel, B.S., List, P., Lach, D. and Shindler, B. (2004) The role of scientists in the environmental policy process: A case study from the American west, *Environmental Science and Policy*, 7, 1-13.
Susskind, L. and Cruikshank, J. (1987) *Breaking the Impasse: Consensual Approaches to Resolving Public Disputes*, Basic Books, New York.
Sustainable Seattle (1998) *Indicators of Sustainable Community 1998*. A Status Report on Long-Term Cultural, Economic, and Environmental Health for Seattle/King County.
Tauxe, C.S. (1995) Marginalizing public participation in local planning: an ethnographic account, *Journal of American Planning Association*, 61(4), 471-481.
Tonglet, M., Phillips, P.S. and Bates, M.P. (2004) Determining the drivers for householder pro-environmental behaviour: waste minimization compared to recycling, *Resources, Conservation and Recycling*, 42, 27-48.
TUGI (The Urban Governance Initiative) (2003) *Manual for the Use of the TUGI Report Cards*, The Institute for Housing and Urban Development Studies (HIS), Rotterdam, the Netherlands.
UNEP/WHO (1996) *Air Quality Management and Assessment Capabilties in 20 Major Cities*. London: MARC.
United Nations Development Programme (1995) *Human Development Report 1995*.
United Nations Development Programme (2003) *Human Development Report 2003*.
UNDSD (2000) *Report of the Consultative Group to Identify Themes and Core Indicators of Sustainable Development*. New York, 6-9 March 2000. UN: New York, USA.
Usher, P.J. (2000) Traditional ecological knowledge in environmental assessment and management, *Arctic*, 53(2), 183-193.
van den Berg, L., Braun, E. and van der Meer, J. (1997) The organizing capacity of metropolitan regions, *Environment and Planning C: Government and Policy*, 15, 253-272.
Vastag, G., Kerekes, S. and Rondinelli, D.A. (1996) Evaluation of corporate environmental management approaches: A framework and application, *International Journal of Production Economics*, 43, 193-211.
Verona, G. and Ravasi, D. (2003) Unbundling dynamic capabilities: An exploratory study of continuous product innovation, *Industrial and Corporate Change*, 12(3), 577-607.
VRDC (Virtual Research and Development Centre) (2001) *Livestock and Environment Toolbox* (http://lead.virtualcentre.org/en/dec/toolbox/homepage.htm).
Waelchli, F. (1989) The VSM and Ashby's Law as illuminants of historical management thought. In *The Viable System Model: Interpretations and Applications of Stafford Beer's VSM*, Espejo R, Harnden R (eds). Wiley: New York; 51-75.
Watson, N., Mitchell, B. and Mulamoottil, G. (1996) Integrated resource management: institutional arrangements regarding nitrate pollution in England, *Journal of Environmental Planning and Management*, 39(1), 45-64.
Webler, T. (1995) Right discourse in citizen participation: an evaluative yardstick. In: Renn, O., Webler, T., Wiedemann, P. (eds.), *Fairness and Competence in Citizen Participation: Evaluating Models for Environmental Discourse*, Kluwer, Dordrecht, 35-86.
Webler, T., Kastenholz, H. and Renn, O. (1995) Public participation in impact assessment: A social learning perspective, *Environmental Impact Assessment Review*, 15, 443-463.
Weiss, L. and Hobson, J. M. (1995). *States and economic development: A comparative historical analysis*. Cambridge: Polity Press.
Wescott G. (2002) Partnerships for capacity building: Community, governments and universities working together, *Ocean and Coastal Management*, 45, 549-571.
Witten, J., Horsley, S., Jeer, S. and Flanagan, E. (1995) *A guide to wellhead protection*. American Planning Association, Michigan.
World Bank (1995) *Local government capacity in Colombia: beyond technical assistance*. The World Bank, Washington, D.C.
World Economic Forum (2001) *Environmental sustainability index*. Global Leaders for Tomorrow Environment Task Force, World Economic Forum and Yale Center for Environmental Law and Policy and Center for International Earth Science Information Network, Davos (http://www.ciesin.columbia.edu/indicators/ESI/ESI 01 tot.pdf).

Zimmerman, J.F. (1986) *Participatory Democracy: Populism Revived*, Praeger, New York.
Zhang, J. and Fujiwara, A. (2006) Measuring social capacity for environmental management in transport sector in Beijing based on an attitudinal survey from the perspective of civil society, *Proceedings of the 12th Annual International Sustainable Development Research Conference*, Hong Kong, April 6-8 (CD-ROM).
Zhang, J., Fujiwara, A., and Da Cruz, M.R.M. (2005) Social capacity indicators for environmental management: A case study in transport sector using macro-level data, *Journal of International Development and Cooperation*, 11(2), 51-65.