

REFLECTIONS ON RECENT DEVELOPMENTS IN WATERSHED MANAGEMENT IN ONTARIO AND THE IMPLICATIONS FOR NATURAL AREAS MANAGEMENT

Dan Shrubsole
The University of Western Ontario

Abstract

This paper addresses three questions. First, it describes the concept of sustainable development and watershed management. Literature from the Earth Summit (1992), the World Summit on Sustainable Development (2002) and the 3rd World Water Forum (2003) are used to establish a foundation to examine the concept and practice of watershed planning. Second, it outlines the evolution of watershed planning in Ontario between 1993 and 2003. Three documents are used to frame the recent evolution of watershed planning in Ontario and to consider their implications, including those for natural area management in Ontario. Third, implications and future directions are described.

Introduction

The protection and management of natural areas continues to be an important concern, one often associated with conflict and controversy. The IUCN (1996: 2) defined protected areas as “an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity; and of natural and associated cultural resources, and managed through legal and other affective means.” In the past, planning approaches have often emphasized the need to manage natural areas for their biodiversity values. In 1992, concern for this issue was sufficient enough to warrant the signing of a U.N. *Convention on Biodiversity* at the 1992 *Earth Summit* (Grubb *et al.*, 1993). The means to manage natural areas has focused attention on a diversity of approaches including the creation of parks, conservation easements, stewardship approaches, debt for nature swaps, biodiversity prospecting, ecotourism, and paying for intellectual property rights (Patterson, 1991; Reid, 1997; Bondrup-Nielsen *et al.*, 2002; Deardon and Rollins, 2002). While this research has been valuable, it is also appropriate to consider how these types of mechanisms might be better implemented in light of the changing context and approaches for watershed management in the Province of Ontario.

The 1980s and 1990s has witnessed enormous changes in the conduct of watershed planning in Ontario and other jurisdictions. In May 2000, the water supply of the community of Walkerton, Ontario was contaminated by *Esherichia coli* 0157:H7 and *Campylobacter jejuni*. Following an intense rain event, these organisms entered the water supply via a livestock farm located adjacent to the municipal water well field. Seven people died, over 2,300 hundred became ill, and a subsequent public inquiry recommended significant changes to the practice of watershed and land use planning in Ontario (O’Connor, 2002). The need to better integrate water and related land-based resources has also been recognized in other jurisdictions such as New York State (NRC, 2000).

The primary goal of this article is to describe some of the recent and major changes to watershed planning that have occurred at international and Ontario levels, and to speculate on their implications, including those related to natural areas (or protected area) planning. Watershed planning influences natural area planning. The protection of natural features, such as wetlands and floodplains, can be supported through a variety of policy instruments — education and stewardship programs, grant programs, acquisition, and the regulation of development type and operations. Projects for natural area protection are often framed in the context of watershed-based plans. Thus, it is appropriate to consider the status of watershed planning in Ontario and note opportunities to further natural area protection.

According to Grigg (1996), the philosophical foundations for water resources management are closely associated with the principles of sustainable development. Integrating environmental, economic and social considerations into long term decision-making that serves human needs is fundamental to this philosophy. In order to provide a context for the discussion of water management activities in Ontario, the next section describes three major initiatives at the international level related to sustainable development. This is followed by a review of Ontario's recent efforts to reform watershed management. Implications for the future, with reference to natural areas are considered in the final section.

Recent Evolution of Sustainable Development at the International Scale

At the international level, *Agenda 21* and the *Rio Declaration*, which were developed at the 1992 *Earth Summit*, furthered the concept of sustainable development that was espoused by the Brundtland Commission (WCED, 1987) by encouraging better resource management through many avenues including:

- The adoption of realistic standards;
- The merging of environment and development;
- Integrated land management;
- Promoting sustainable agriculture and rural development;
- Conserving biodiversity;
- Changing consumption patterns;
- Applying a mix of policy instruments including pricing mechanisms;
- A participatory approach to decision making;
- The need to build institutional and individual capacity;
- The use of the precautionary approach; and,
- Promoting integrated water management (quality and quantity).

(Grubb *et al.*, 1993).

In 2002, obstacles to achieving sustainable development and what initiatives should be undertaken in order to achieve sustainable development were identified at the World Summit on Sustainable Development held in Johannesburg, South Africa. Its major accomplishments included:

- A reaffirmation of the commitment to *Agenda 21* and the Millennium Development goals — a set of eight targets aimed at reducing poverty and promoting sustainable development;
- Strengthening of the concept of sustainable development and the important linkages among poverty, the environment and the use of natural resources. It also made progress on issues not adequately addressed at the 1992 *Earth Summit*, such as patterns of production and consumption; and,
- The emergence of partnerships as a viable mechanism to pursue sustainable development in a way that complements government action (UN, 2002).

At the *3rd World Water Forum* in Kyoto, Japan, many themes, including the following were discussed at length: groundwater, water and cities, water and governance, and integrated water resources management and basin management. These themes reflect the interactions among environment, economy and society, which lies at the heart of the philosophy of sustainable development (Grubb *et al.*, 1993). Important action items included the need water decision makers to relate to the participatory process and the need to assess water availability and scarcity (Water Forum, 2003).

Since the 1980s, adaptive management and the precautionary principle are two approaches that have gained some prominence in the practice of sustainable development and water management. With the high level of uncertainty in our understanding of human-environment processes and in predicting future conditions and needs, the precautionary principle is being increasingly espoused at international and local scales as an essential element of sustainable development (Mitchell, 2004). The precautionary principle is defined as the following: where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. In practice, one or more of the following meanings can be interpreted as being precautionary:

- Thoughtful action in advance of scientific proof (i.e., taking action over inaction in the absence of absolute scientific proof);
- Leaving ecological space as room for ignorance (i.e., deciding not to develop available resources);
- Applying care in management (i.e., monitoring activities, outcomes and impacts in order that lessons can be learned and improvements made); and,
- Shifting the burden of proof from the government to the proponent (O’Riordan, 2000).

Implementing these approaches goes against the traditional practice of resource management. For instance, O’Riordan (2000: 24) suggested that the removal of significant biological resources should be “limited by punitive requirements on guaranteeing the protection of sizable amounts of these resources, possibly by payment into a global heritage fund, or via royalty payments for taxonomic research ...” These and other precautionary mechanisms can be instituted at national, provincial and/or local levels.

Adaptive environmental management was developed to deal explicitly with uncertainty in resource and environmental management and can be considered as one approach to

“apply care in management” (Mitchell, 2004). Adaptive management suggests that resource managers should explicitly treat the implementation of policy as a opportunity to learn (Lee, 1993). Developed over 30 years ago by Holling and Walters (and associates), adaptive management is a collection of “concepts, techniques and procedures intended for the design of creative management and policy alternatives” (Noble, 2004: 443). The need to monitor environmental processes has been an important principle of adaptive management. According to Noble (2004), challenges facing the implementation of adaptive management include:

- Inconsistency in definition and principles. There is a lack of direction concerning the operationalization of principles;
- The need to ensure that adaptive management is considered at the early stages of program and project development rather than a “last-minute add-on”;
- Ensuring the active participation of all relevant participants in order that a higher level of information and greater diversity of perspectives are provided.
- Recognizing that adaptive management often requires longer timeframes than laboratory experiments and political terms of office; and,
- The requirement that resource management agencies transform their procedures and corporate culture to one that accepts uncertainty and the possibility that mistakes will be made.

Collectively, these international statements and new planning concepts suggest that watershed planning is a diverse set of activities that seeks to address three key goals:

- Environmental processes sustain human and other forms of life;
- Economic activities are supported; and,
- Environment looks beautiful.

Watershed planning pursues multiple goals through multiple means, and relies on the effective participation of all stakeholders (Mitchell, 1986). In Canada, it must balance participatory approaches with the principles of representative government. Balancing these competing and conflicting goals has been an ongoing water management challenge for all jurisdictions on a worldwide basis. One frequent response has seen governments rely on watershed planning in order to guide the implementation of a wide range of programs. In this paper, watershed planning is grounded in the integration of environmental, economic and social perspectives (i.e., legal, cultural, administrative, financial, political, social-psychological) to make informed and effective decisions. The application of the precautionary principle and adaptive management, as well as traditional assessment techniques, such as benefit-cost analysis, public participation, impact assessment and risk assessment, can assist in this regard.

The Recent Evolution of Watershed Planning in Ontario

Three documents highlight the evolution of watershed planning in Ontario for the period 1993-2003. These are: 1) *Watershed Management on a Watershed Basis: Implementing an Ecosystem Approach* (1993); 2) *Evaluation of Watershed Management in Ontario*

(1997); and, 3) *Protecting Ontario's Drinking Water: Toward a Watershed-based Source Protection Framework* (2003). Each is described below.

Watershed Management on a Watershed Basis: Implementing an Ecosystem Approach (1993)

Subwatershed planning has been part of the environmental management tools used in Ontario since the late 1980s. This became more formalized in 1993 due, in part, to concerns about the impact that urban development was having on the environment. This prompted the provincial government to release a document entitled *Watershed Management on a Watershed Basis: Implementing an Ecosystem Approach*. At this time, it was believed that “*the province's steady economic, urban and industrial growth... has brought with it a wide range of water quality and quantity concerns, demands and conflicts, and these are more complex than ever*” (Ontario, 1993: 1). An ecosystem approach to land use planning was advocated as a solution to these challenges because “*it is based on the recognition that ecosystems have limits to the stress which can be accommodated before the ecosystems are irreversibly degraded or destroyed*” (Ontario, 1993: 4). Four principles characterized Ontario's ecosystem approach:

- *watershed based*: land use planning should incorporate watershed-based approaches in order that upstream-downstream conflicts and cumulative effects could be dealt with;
- *informed decision making*: with a particular emphasis on biophysical data in order that the form and function of natural systems could be identified. These would include land uses, natural features, linkages, and surface and groundwater systems;
- *public participation*: valuable ideas and the public's aspirations could be articulated through public participation. Mechanisms to achieve these goals included printed material, special events, field trips, public meetings, media and public opinion polling; and,
- *multiple and regionally oriented goals*: these included to maintain and enhance environmental quality, prevent problems and reduce costs.

An impact assessment approach was the means through which decisions would be informed. Two key functions of an impact assessment are to determine the magnitude and significance of impacts. Several means were identified to support implementation: the municipal planning process, stewardship activities, capital works, landowner assistance and state of the environment report cards. Public participation was also an important element that guided planning activities. More specific direction for implementation through the municipal planning process, which was the most important implementation mechanism, was provided through a set of Comprehensive Policy Statements. Introduced in 1995, the Comprehensive Policy Statements provided guidance on two key aspects of implementation: 1) the link between the watershed plan and the land use plan; and, 2) the nature of the provincial policies.

The *Comprehensive Policy Statements* supported subwatershed planning in several ways. They were intended to protect natural features through the revised provincial policies (to

be discussed in the next paragraph); to assess the environmental impacts of municipal plans; to map and describe environmental features; to monitor environmental indicators; and to plan on a watershed basis.

Part of the *Comprehensive Policy Statements* saw the introduction of a Natural Heritage Policy. It essentially combined the former policy statements on floodplains and wetlands. Previous research has indicated that relative to stated goals, the implementation of floodplain regulations has been successful (Shrubsole *et al.*, 1995; 1997). However, these goals are focused on economic and public safety aspects, and do not provide explicit recognition of other values — water resource, heritage and ecosystem. No buffers or setbacks are established to specifically protect natural areas. Floodplain regulations have been focused on managing urban development rather than on natural areas. The *Wetlands Policy Statement* was focused exclusively on urban development, and failed to embrace agricultural activities, which has caused 80% of Ontario's historical wetland losses. Other shortcomings included the lack of provisions for wetland restoration, the lack of monitoring, the establishment of 120m setbacks as opposed to scientifically-based buffers that would better protect the feature(s) of interest, and the lack of effective protection afforded to locally significant wetlands (Gonzalez, 1996; Bardecki, 1998; Penfold, 1998). Thus, the current institutional arrangements for wetland management have had limited success on protecting the ecological functions and areal extent of natural areas (Walters and Shrubsole, 2003).

In summary, interest in subwatershed planning emerged from concern over the deterioration of the natural environment, particularly through urban and industrial development. Essentially, natural features (e.g., floodplains, wetlands) would be mapped, impact assessments completed, and mitigative and protective measures identified and implemented through municipal official plans. Other initiatives (e.g., stewardship) would supplement these efforts. Local governments would determine to what extent they would regard the recommendations arising from subwatershed plans. In this way, there was to be a balance between participatory approaches (subwatershed planning) and representative democracy (decision making by municipal councils made within the context of the *Comprehensive Policy Statements*).

Evaluation of Watershed Management in Ontario (1997)

The previous section described the intent of watershed planning in Ontario. An interagency committee evaluated the practice of subwatershed planning in 1997 (Ontario, 1997). Between 1990 and 1995, 86 watershed studies had been started with 55 completed. The committee surveyed relevant government officials and provided comments on the strengths and areas requiring improvement.

Respondents identified several positive aspects. First, partnerships among government agencies were enhanced through technical committees, which usually comprised a “manageable number” of 6 to 10 members. Roles among government agencies were clarified. This is important since water and land resource management in Ontario is fragmented among many agencies. A third attribute was the sharing of information among agencies. The results of the subwatershed planning process were believed to be increased adminis-

trative efficiency, improved water quality, and improved quality of life for Ontario's residents.

There were also areas that required further attention. The high cost and long time period to complete studies were of concern. Costs ranged from \$160,000 to \$420,000. Goals and objectives were stated in a general manner, which caused a lack of certainty over if and when they were actually achieved. This problem may reflect the nature of many environmental dilemmas, which may be too complex and interrelated to be divided into a mutually exclusive set of individual problems. In addition, public agencies and stakeholders working from many different and relatively narrow perspectives may find it easier to achieve consensus on broadly stated goals and objectives rather than on well-defined problems. Public participation programs were viewed by respondents as labour intensive and time consuming. Respondents believed these could be improved through: 1) providing more complete information about the benefits of watershed management; 2) defining the scope of watershed management; and, 3) promoting more effective awareness, public education and communication programs on watershed functions and management. Implementation of programs could have been improved if financial compensation had been provided to those landowners who modified their land use practices to accommodate watershed management objectives. Third, financing for studies appeared inadequate. In 1995, only 18% of total requests could be financed, and cutbacks to conservation authorities after 1995 precluded future funding. Fourth, obtaining adequate inventory data was problematic and GIS technology was not used to its full capacity.

One of the cornerstones of Ontario's approach to subwatershed planning was to implement the required programs through the *Land Use Planning Process and the Comprehensive Policy Statements*. In 1995, this foundation was removed following the election of the Conservative Government. Thus, while the general principles of Ontario's approach to watershed planning — watershed based, multi-agency and public participation, multiple goals, informed decision making — were sound, implementation was made more difficult because the mechanism to promote implementation was removed.

Protecting Ontario's Drinking Water: Toward a Watershed-based Source Protection Framework (2003)

The Walkerton Inquiry has and will continue to dramatically change the context for water planning and implementation in Ontario. It advocated a multi-barrier approach to the protection of drinking water supplies, which would begin with source area protection (O'Connor, 2002). Source water protection refers to the management of watersheds used to supply water — both surface and groundwater — to people. Given the nature of Ontario's water supply sources, which includes the Great Lakes, all watersheds in the province can be considered as source areas.

Of the 93 recommendations made in the *Part Two Report* of the *Walkerton Inquiry*, 22 concerned the theme of source area protection (O'Connor, 2002). Central to this approach was a planning framework that would be enshrined in legislation. An Advisory Committee was established by the Minister of Environment in November 2002, and it released its report in March 2003 (Ontario, 2003). The following discussion highlights

the themes and some of the 55 recommendations in that report, which suggested that, at times, the protection of source areas should take precedence over other legislation when human health was a concern.

The water management principles advocated by the Advisory Committee were:

- *Sustainability*: water was recognized as essential for human health and ecosystem viability. The watershed-based source protection framework would apply to all watersheds, and should be promoted by the province when it negotiated future agreements with other Great Lakes jurisdictions. This principle extends the earlier principle of watershed-based approaches by explicitly considering human health as well as ecosystem values.
- *Continuous Improvement / Informed Decision Making*: will be promoted through a risk assessment approach. Previously, impact assessment was the fundamental tool to assess alternatives. Risk assessment is based on identifying outcomes and their probability of occurrence. Rather than focusing on the magnitude and significance of impacts, managers in Ontario will now be concerned with risk identification and assessment. The capacity of current water quality and quantity networks to support this approach will be assessed. Data from this network will be made available free of charge.
- *Comprehensive*: source area protection plans should take a precautionary approach and use the best available science. This extends the principle of informed decision making to embrace the precautionary approach.
- *Public Participation and Transparency*: open discussion and communication regarding source area protection is to occur among all stakeholders. This continues the principle of using public participation as a fundamental aspect of planning.
- *Cost Effectiveness and Fairness*: the implementation of feasible approaches is emphasized. Based on the nature of commentary in the document, these are likely defined on the basis of the costs and impacts on people and groups, and their economic sustainability.
- *Shared Responsibility and Stewardship*: reinforcing public participation and transparency, many agencies and groups — MOE, CAs, municipalities, First Nation - are responsible for aspects of the initiative. Explicit reference to First Nations is highlights the need for effective public consultation and transparency in decision making.

These principles will guide a source area protection process that has the following two key components. First, Source Protection Coordinating Committees, consisting of a maximum of 18 members, who are 1/3 municipal representatives, 1/3 provincial representatives, and 1/3 public health and other stakeholders, will be formed. There will be 24 committees, 16 in southern Ontario and 8 in the north, which will be instrumental in all aspects of source area protection. Second, source area protection plans will be developed and will address the following items:

- Objectives and targets;
- Technical information, including a water budget, fate of contaminants model,

maximum contaminant loads to meet water quality objectives, maps identifying vulnerable and high-risk areas, existing land uses and natural features;

- Identification of where source protection issues exist;
- An implementation plan;
- A monitoring and reporting plan;
- A description of how the plan will be updated; and
- A description of outstanding and unresolved issues and how these will be dealt with.

To be successful, stakeholders must be involved in all stages — formulation, implementation and monitoring — of a source water protection program.

Observations

A number of ongoing and emerging issues can be identified. Ongoing challenges include the long time and high cost required to complete plans, the establishment of realistic goals and objectives, the mixed level of commitment to establish effective public participation and partnerships, and ensuring that plans are adequately informed and financed.

Based on the initial experience of subwatershed planning in Ontario, source area protection plans will likely be relatively costly and lengthy. Governments and their agencies will have to become accustomed to their new roles as facilitators of a planning process focused on human health as well as environmental protection, and consultants and relevant government officials will have to become familiar with new data sets and methods of analysis. It will take time to firmly (re)establish partnerships among stakeholders. It will also take time to shift from an impact assessment to a risk management orientation. Ideally, these risk assessments will be conducted from a “whole of watershed” perspective rather than the traditional pollutant-by-pollutant approach (Serveiss, 2002). At the same time, the emerging source area protection initiative embraces risks to human health to a greater extent than the earlier subwatershed planning approach. Thus, the next generation of watershed studies will have to cope with the need to link environmental impacts to risks to human health. The challenge for natural area protection will be to effectively demonstrate environmental consequences with human health outcomes.

Meeting the new demands for informed decision making has been and will continue to be a challenge. Information that supports watershed planning has tended to be dominated by biophysical data on water and related land resources. It would also be appropriate to incorporate socioeconomic information in order that existing and future resource demands can be considered. In addition, the new focus on human health risks suggests that it would also be appropriate to consider active disease surveillance as part of the public health component and that these should be linked to the GIS. Since effective public health monitoring has often been problematic, the desirability and feasibility of using surrogate measures for gastrointestinal illnesses, such as monitoring the sales of antidiarrheal medications, health of nursing home patients and monitoring labs for the number of stool samples submitted, should be considered (NRC, 2000). This type of monitoring would better embrace the concept of adaptive management. Traditionally, resource managers have

tended to rely on 'trial and error'-based learning without an explicit and systematic consideration of how we can best learn from our management practices (Lee, 1993). More time is required to fairly comment on the extent to which adaptive management in Ontario acquires an effective set of operational definitions; incorporates effective participatory approaches; allows for the development of long-term monitoring networks (i.e., biophysical, human activities and health); and supports an institutional culture that adopts a mind-set learning when policy is implemented.

Establishing data bases, and developing models and monitoring protocols will be of little use if they are not implemented. In the past, Ontario and many other jurisdictions have used set backs as opposed to site-specific buffers in lands use planning (Burke and Gibbons, 1995). Buffers will vary according to circumstances, while set backs are applied universally. Although the former are easy to administer, they may not adequately protect sources of drinking water or natural features. Setbacks that are too generous will be inefficient and perceived as unfair. Moving to water quality objectives based on a mix of total and relative loads will also be appropriate to better protect human health and ecosystem values.

Adequately financing studies has been another ongoing challenge. Some attention has been devoted to this topic, although no definitive answers have yet been given (Ontario, 2003). This is a question requiring a clear response by governments. The source of funds will likely come from a mix of general tax revenues and user (e.g., water) fees. A key issue will be to ensure that the level of funding meets the proposed requirements and public expectations.

A new challenge concerns the application of the precautionary approach. There is no single view of what this means, although there is some guidance regarding its application (Canada, 2001). At present, it appears that there is a lack of clarity between prevention (i.e., regulation aimed at an established threat) and precautionary (i.e., requiring prudence and a duty of care by governments, proponents and users) approaches.

A new way of balancing between participatory approaches and representative democracy is proposed through the establishment of Source Area Protection Committees. Municipal councils will not have the final decision-making authority for implementation of source area plans. Instead, the Source Area Protection Committees, consisting of members appointed by provincial and municipal governments, will have a fundamental role. Since source area protection plans will have the support of legislation and could result in some people being required to curtail their land use activities, recommendations from the committees can be appealed. The responsibilities delegated to the Source Area Protection Committees and the proposed appeal process represent a new political approach to watershed management in Ontario.

In the context of protecting natural areas, it would be prudent to have relevant and appropriate individuals appointed as members of Source Area Protection Committees. In this way, smaller wetlands that have been afforded limited protection through the Natural Heritage Policy might be considered important for source area protection. Floodplain values might be extended to include water resource and ecological aspects that are excluded

from current the policy. As noted earlier, linking how changes to these areas can impact human health will be important in enhancing their protection and management in the emerging watershed planning environment.

The watershed-based source protection framework will be one important element on Ontario's new water resource management landscape. It embraces many of the recent concepts identified in the international field of sustainable development and water management — promoting integrated land and water management, supporting participatory approaches to decision making, using the precautionary principle and adaptive management, and applying a mix of policy instruments.

What remains to be seen is if the government, private interests and the general public are able to adapt to these changes, and effectively meet these challenges. It will also be important for government to promote other initiatives, such as technological innovation and applying economic and other instruments, in order that our resource consumption patterns can be reduced. That is the other half of the coin and one of the emerging issues arising from the 2002 World Summit on Sustainable Development that has yet to effectively addressed in Ontario.

Acknowledgments

The constructive comments provided by an anonymous reviewer and Prof. Gordon Nelson are appreciated.

References

- Bardecki, M.J. 1998. Advances and Retreat: A Policy Report and Analysis for Wetlands in Ontario. Pp. 529-539. In: S.K. Majumdar, E.W. Miller and F.J. Brenner (eds.). *Ecology of Wetlands and Associated Systems*. The Pennsylvania Academy of Science: Philadelphia.
- Bondrup-Nielsen, S., N.W.P. Munro, G. Nelson, J.H.M. Willison, T.B. Herman and P.Eagles. (eds.). 2002. *Managing Protected Areas in a Changing World: Proceedings of the fourth International Conference on Science and Management of Protected Areas*. Acadia University; SAMPAA: Wolfville, NS.
- Burke, V.J. and J.W. Gibbons. 1995. Terrestrial buffer zones and wetland conservation: A case study of freshwater turtles in a Carolina Bay. *Conservation Biology*, 9(6): 1365-1369.
- Canada. 2001. *A Canadian Perspective on the Precautionary Approach/Principle Proposed Guiding Principles*. Privy Council Office: Ottawa, ON.
- Deardon, P. and R. Rollins. (eds.). 2002. *Parks and Protected Areas in Canada: Planning and Management (2nd Edition)*. Oxford University Press: Toronto.
- Gonzalez, N. 1996. Bill 20 soft on protecting environment. *Seasons Spring*, 12-13.
- Grigg, N.S. 1996. *Water Resources Management: Principles, Regulations, and Cases*. McGraw-Hill: New York.
- IUCN (The World Conservation Union). 1996. *CNPPA in Action*. CNPPA/IUCN:

- Gland, Switzerland.
- Grubb, M., M. Koch, A. Munson, F. Sullivan and K. Thomson. 1993. *The Earth Summit Agreements*. Earthscan Publications Ltd.: London.
- Lee, K. 1993. *Compass and Gyroscope: Integrating Science and Politics for the Environment*. Island Press: Washington, D.C.
- Mitchell, B. 1986. The evolution of integrated resource management. Integrated approaches to resource planning and management. Pp. 13-26. In: R. Lang (ed.). The Banff Centre: Banff. *School of Management*.
- Mitchell, B. (ed.). 2004. *Resource and Environmental Management in Canada*. Oxford: Toronto, ON.
- National Research Council (NRC). 2000. *Watershed Management for Potable Water Supply: Assessing the New York City Strategy*. National Academy Press: Washington.
- Noble, B.F. 2004. Applying Adaptive Environmental Management. Pp. 442-466. In: B. Mitchell (ed.). *Resource and Environmental Management in Canada*. Oxford: Toronto, ON.
- O'Conner, D.R. 2002. *Part Two: Report of the Walkerton Inquiry — A Strategy for Safe Drinking Water*. Queen's Printer: Toronto, ON.
- O'Riordan, T. 2000. Environmental Science on the Move. *Environmental Science for Environmental Management (2nd Edition)*. Essex, U.K. Prentice Hall.
- Ontario. 1993. *Watershed Management on a Watershed Basis: Implementing an Ecosystem Approach*. Ontario Ministry of Natural Resources (OMNR): Toronto, ON.
- Ontario. 1997. *Evaluation of Watershed Management in Ontario*. Ontario Ministry of the Environment: Toronto, ON.
- Ontario. 2003. *Protecting Ontario's Drinking Water: Toward a Watershed-based Source Protection Framework*. Ontario Ministry of the Environment: Toronto, ON.
- Patterson, A. 1991. Debt for nature swaps and the need for alternatives. *Environment*, 32(10): 4-13, 31-32.
- Penfold, G. 1998. Planning Act reforms and initiatives in Ontario, Canada. Pp. 149-173. In: J. Schnurr and S. Holtz (eds.). *The Cornerstone of Development: Integrating Environmental, Social and Economic Policies*. Lewis Publishers.
- Reid, W. 1997. Strategies for conserving biodiversity. *Environment*, 39(7): 16-43.
- Serveiss, V.B. 2002. Applying Ecological Risk Principles to Watershed Management and Assessment. *Environmental Management*, 29(2): 145-154.
- Shrubsole, D., V.J. Hammond and M. Green. 1995. Floodplain Regulation in London, Ontario, Canada: assessing the implementation of Section 28 of the Conservation Authorities Act. *Environmental Management*, 19: 703-717.
- Shrubsole, D., V.J. Hammond, R. Kreutzwiser and I. Woodley. 1997. Assessing floodplain regulation in Glen Williams, Ontario, Canada. *Journal of Environmental Management*, (50): 301-320.
- United Nations (UN). 2002. *The Road from Johannesburg: World Summit on Sustainable Development, What was achieved and The Way Forward*. UN: NY.
- Walters, D. and D. Shrubsole. 2003. Agricultural Drainage and Wetland Management in Ontario. *Journal of Environmental Management*, 69: 369-379.
- Water Forum. 2003. *The 3rd World Water Forum: List of Recommendations*. Available: www.world.water-forum3.com/2003/eng/dipm/list_of_recommendations.html.
- WCED. 1987. *Our Common Future*. Oxford University Press: London.