Web-GIS Technologies and their Potential as Decision Support Tools for Sustainable Development

Michael SUTHERLAND and Dr. Susan NICHOLS, Canada

Key words: Worldwide Web, Web-GIS, GIS, Technology, Sustainable Development.

ABSTRACT

There is evidence that global warming, resource depletion, and other negative human impacts on the environment are apparently affecting the Earth's capacity to meet human needs [Manning et al, 1998]. Industrialization and growth is economically desirable, but without attention to sustainability may be problematic for some ill-fated groups of society, and may seriously limit any region's aspiration for prosperity, as the dynamic and negative repercussions of unsustainability upon society may be significant [Bohlin, 1999].

To strike this balance between economic, social, cultural, and environmental concerns is essentially a challenge for governance. This is especially true considering the realities of the information age and globalization which are forcing jurisdictions to deal with ever-faster rates of change along with increasingly short-term profit-orientation and increased deregulation which (in some cases) make sustainability harder to achieve [vanDijk, 1999]. However to achieve sustainability, allowing equitable allocation of benefits from the exploitation of resources, while avoiding (or minimizing) irreversible effects caused by such exploitation, requires that stakeholders in governance have access to up-to-date, complete, accurate and useful information. This will include information on what resources exist, the spatial extent of the resources, and who has rights, responsibilities, and restrictions in relation to the spatial extents and resources [Nichols, Monahan and Sutherland, 2000].

Web-GIS technologies, though in their infancy, show great promise in the sharing of spatial information among governance stakeholders. With the use of examples, this paper will look at web-GIS technologies and their potential as decision support tools in support of sustainable development.

CONTACT

Michael Sutherland
Department of Geodesy and Geomatics Engineering
University of New Brunswick
Fredericton, NB
CANADA E3B 5A3
Tel. + 1 506 451 6812
Fax + 1 506 453 4943
E-mail: msutherl@unb.ca ;
http://www.unb.ca/web/GGE/Research/LandStudies/Sutherland.htm

Dr. Susan Nichols
Department of Geodesy and Geomatics Engineering
University of New Brunswick
Fredericton, NB
CANADA E3B 5A3
Tel. + 1 506 453 5141
Fax +1 506 453 4943
E-mail: nichols@unb.ca
http://www.unb.ca/GGE/Personnel/Nichols/Nichols.html

Web-GIS Technologies and their Potential as Decision Support Tools for Sustainable Development

Michael SUTHERLAND and Dr. Susan NICHOLS, Canada

1. INTRODUCTION

There is evidence that global warming, resource depletion, and other negative human impacts on the environment are apparently affecting the Earth's capacity to meet human needs [Manning et al, 1998]. Industrialization and growth is economically desirable, but without attention to sustainability may be problematic for some ill-fated groups of society, and may seriously limit any region's aspiration for prosperity, as the dynamic and negative repercussions of unsustainability upon society may be significant [Bohlin, 1999].

To strike this balance between economic, social, cultural, and environmental concerns is essentially a challenge for governance. In other words, the authors perceive sustainable development as a governance issue. This is especially true considering the realities of the information age and globalization which are forcing jurisdictions to deal with ever-faster rates of change along with increasingly short-term profit-orientation and increased deregulation which (in some cases) make sustainability harder to achieve [vanDijk, 1999]. However to achieve sustainability, allowing equitable allocation of benefits from the exploitation of resources, while avoiding (or minimizing) irreversible effects caused by such exploitation, requires that stakeholders in governance have access to up-to-date, complete, accurate and useful information. This will include information on what resources exist, the spatial extent of the resources, and who has rights, responsibilities, and restrictions in relation to the spatial extents and resources [Nichols, Monahan and Sutherland, 2000].

Web-GIS technologies, though in their infancy, show great promise in aiding informed decision-making to support sustainable development by facilitating the sharing and integration of spatial information among governance. The “GIS” part of the term “web-GIS technologies” is used loosely as most of these technologies are not yet with equipped with the full range of analytical capabilities present in most instances of a contemporary desktop GIS.With the use of a specific real example, together with hypothetical examples, this paper will look at web-GIS technologies and their potential as decision support tools in support of sustainable development.

2. THE IMPORTANCE OF INFORMATION TO GOVERNANCE

Kyriakou and Di Pietro [2000] define governance as being "… all about decision-making with a view to managing … change [in societies], making [change] a friend, not a foe, in order to promote people's wellbeing." If governance is about decision-making (or steering for that matter), then up-to-date, accurate, complete, timely and usable information (which feeds into the acquisition of knowledge) is indispensable to governance. Information is indispensable for knowing where we are, and for deciding where we can, and want to go [Kyriakou and Di Pietro,2000; Reeve and Petch, 1999; Masser, 1998].

Up-to-date, accurate, complete, and usable information has always been important to governance, but a number of factors underscore the importance of that quality of information to governance in today's world. Among them is the emergence of the information society and the information age, advances in technological and scientific developments, globalization, and the concept of sustainable development.

3. THE INFORMATION AGE AND ITS EFFECT ON GOVERNANCE

The information age has been characterized by huge increases in the availability and proliferation of information, and fast developments in information technologies, including information infrastructure and communications technologies. Additionally, there are more workers in data and knowledge industries, and the workforce (and general population) is more educated and aware than before [Rosell, 1999; vanDijk, 1999; Paquet, 1999b]. Today, jurisdictions have to contend with an accelerated pace of change in all aspects of life caused by these developments. These changes are, according to Rosell [1999], "overwhelming methods of organizing and governing designed for a world of clearer boundaries and more limited flows of information."

One of the most significant changes to occur, aided by the information revolution and its consequent developments in information technology, is globalization [Ford and Zussman, 1997]. According to vanDijk [1999] "the world is now integrated into one single world-wide market" due to political will, and the ability to eliminate distance as a result of technological progress. The globalization of markets for goods, services, capital and labor was forecasted from as far back as 1991 [Reich, 1991]. It was also forecasted that trading blocks and bilateral trade agreements will become more important [Reich, 1991; Stanbury, 1993]. By 1998 international trade in goods and services was more than US$6 trillion [Cattavi, 1998].

Today, globalization seems an unstoppable force and integral to the world economy, and governments are going to have to learn its advantages and learn to manage it as it impacts on most aspects of jurisdictions [vanDijk, 1999]. New worldwide networks and increased international competition have caused local firms to engage in cross-border investments, and companies to become internationalized [Paquet, 1999b; Savoie, 1993]. National economies have become more interdependent and increasingly influenced by supranational institutions and trade agreements [Savoie, 1993]. The United Nations Convention on the Law of the Sea (UNCLOS) 1982 has been influential in countries rewriting local laws relating to offshore rights, responsibilities, and restrictions. International forums on global warming and sustainable development have impact on local social, economic, and political institutions and activities as local rights, responsibilities and restrictions are modified to conform with international conventions.

As a result of the foregoing, there are now higher expectations from government by the social and economic sectors that depend on government for the provision of direction, and the provision of information and other services. The issues facing government are increasingly complex and require decisions that have profound impacts on societies and economies as the

public with more information available to them exhibit concerns about their health, safety, and long-term wellbeing [Keough, 2000].

The challenge therefore is how to enact governance in an environment where change is rapid, interconnection is rapidly increasing, all stakeholders have information increasingly available to them, and the workforce (and the general population) is characterized by higher levels of education, expectation and mobility [Juillet and Roy, 1999; Rosell, 1999]. Success in governance will more than likely depend models based on stakeholder relationships with human and electronic connections (aiding the exchange of needed information) to a much broader community [Rosell, 1999; Barksdale, 1998; Paquet, 1997; Covey, 1998].

Government, society, and the economy therefore all require access to current, complete, accurate, and useful information in order to play their parts in the evolving globalization. However, there is ample evidence to suggest that usable knowledge, gained from up-to-date, accurate, complete and useful information so essential to governance, is to be gleaned from scattered data stores that were built to support narrow public and private mandates. Consequently, incompatible data formats and structures, as well as a lack of horizontal and vertical integration among governance stakeholders pose significant obstacles to overcome in obtaining usable knowledge from these scattered stores of information. The social and economic potential of information and communication technologies will depend not only on a balance between the accumulation of new skills and investment in equipment and infrastructure. It will also depend on changes made in governance compatible with local, regional and global conditions [Ford and Zussman, 1997; Mansell et al, 1999; Reeve and Petch, 1999; Masser, 1998].

It is to be noted that although rapid developments in information technology may create many opportunities related to service delivery (and other aspects of governance) [Ford and Zussman, 1997], technological progress is not necessarily an avenue to greater understanding [Senge, 1996]. Service delivery tends to focus more on the technology than on the rationale for the program or the procedures [Paquet, 1997; Kaufmann and Steudler, 1998]. However it may be that "we are out of control, driving down a dark road with little or no light, and most technological progress amounts to is speeding up" [Senge, 1996]. It may not therefore be sufficient to do the thing right and cheaply, but to ensure that the right thing is done [Paquet, 1997]. However, access to up-to-date, complete, accurate, and useful information can also aid in assessing what right thing is to be done.

4. INFORMATION, SUSTAINABLE DEVELOPMENT AND GOVERNANCE

More and more, doing the right thing has become important, especially considering the known and potential negative impacts of industrialization, and other human activities, on the environment. There is evidence that global warming, resource depletion, and other negative human impacts on the environment are apparently affecting the Earth's capacity to meet human needs [Manning et al, 1998; Star, Estes and McGwire, 1996]. The concept of sustainable development has therefore become a very important, and "has been rising on the scene as one of the most central issues for the future of mankind" [Bohlin, 1999]. Industrialization and growth is economically desirable, but as Bohlin [1999] states:

> Industrialization and growth without attention to sustainability may not only be problematic for some ill-fated groups of society, but may seriously limit any region's aspiration for prosperity, as the dynamic repercussions of unsustainability [sic] on its citizens may be significant and take unexpected turns.

To strike this balance between economic, social, cultural, and environmental concerns is essentially a challenge for governance within the realities of the information age and globalization. As globalization becomes more of a reality, jurisdictions are faced not only with ever-faster rates of change, but also with increasingly short-term profit-orientation and increased deregulation which (in some cases) make sustainability harder to achieve [vanDijk, 1999]. However to achieve sustainability, allowing equitable allocation of benefits from the exploitation of resources, while avoiding (or minimizing) irreversible effects caused by such exploitation, requires the regulation of access to the resources [Pinto, 1994]. To achieve this type of resource sustainability management requires that stakeholders in governance have access to up-to-date, complete, accurate, useful information in relation to the resources. This will include information on what resources exist, the spatial extent of the resources, and who has rights, responsibilities, and restrictions in relation to the spatial extents and resources [Nichols, Monahan and Sutherland, 2000; Masser, 1998; Star, Estes and McGwire, 1996].

Essentially the foregoing discussions were about effecting good governance. Continued increase in human population and their attendant socioeconomic needs place ever more pressures on the finite resources of the Earth. Aided by globalization and advances in technologies and science, this situation is compounded by the increased ability and willingness of human societies to exploit these finite resources.

Needs vary as well as overlap from group to group, and the challenge to governance in a world of increased interdependence and limited resources is to address problems caused by collective actions [Friedmann, 1976; Friedheim, 1999; Young, 1994]. Good governance requires that stakeholders cooperate, although there is evidence that negotiations among stakeholders may result in each stakeholder obtaining less than the ideal supply of any collective good [Friedheim, 1999; Olson, 1971]. However in a world of increasingly limited resources stakeholders must cooperate for the common good [Friedheim, 1999; Ostrom, 1990]. Good governance, facilitated by cooperation and the sharing of data to support decision-making, is therefore essential for all societies and will ensure that reasonable needs (i.e. social, economic, cultural, political) are met, public services are efficiently provided, and behaviors that affect the common good are controlled [Manning et al, 1998].

5. WEB-GIS TECHNOLOGIES

Recent developments in internet communications, band width and transmission speeds, and web-GIS and internet cartographic tools have made it possible for spatial information to more easily be shared among geographically dispersed groups via the worldwide web. Specifically, developments in internet-enabled spatial data integration and analysis tools are now allowing decision-makers the opportunity to have access in real-time (or near real-time) to data stores critical to them, but not necessarily managed or maintained by them.

The emergence of web-GIS technologies, that obviate the need for tedious and sometimes clumsy data conversion and sharing processes, is providing the catalyst for easier collaboration, integration and cooperation among organizations with a stake in good governance and sustainable development. This is done by providing an environment for data sharing and integration over the internet, sometimes without organizations having to make any major changes to the structure and formats of the data they maintain. Some of these products include [Langaas, 1996]:

a. AutoDesk's MapGuide
b. Bentley's MicroStation GeoGraphics
c. ESRI's MapObjects
d. MapInfo's proserver
e. Intergraph's GeoMedia Web Msp
f. ObjectFX's Spatial Net and
g. Universal System's CARIS Spatial Fusion

Some of the above technologies handle only vector data (e.g. MapGuide, MicroStation GeoGraphics and proserver) while others like MapObjects, Spatial Net, GeoMedia Web Map and CARIS Spatial Fusion handle both vector and raster data. Certain web-GIS technologies now facilitate the transmission, integration, visualization and analysis via the worldwide web of spatial information stored in geographically dispersed locations. Some of these new technologies also support different data formats (e.g. ESRI shape files, CARIS, Oracle 8I, orthophotography etc.), projections, scales, datums etc., with conversions and visualization being done "on the fly." In some instances data will have to all reside on one server and then geographically dispersed via the worldwide web. Some web-GIS technologies however allow for data to reside on potentially any number of geographically dispersed map servers, which is a most beneficial feature. A user with permission to access the geographically dispersed data sets need only have access to a web browser in order to view, query, and analyze the data sets.

In the strictest terms, a GIS is separate from a mapping or cartographic tool in that it provides spatial analytical functions in addition to mapping and cartographic capabilities [Chrisman, 1997; Wegener and Masser, 1996]. The spatial analytical functions include, among other things, the ability to do buffering, overlays (with true intersection of the data), nearest neighbor computations etc. The full range of analytical capabilities available in most contemporary desktop GIS, are not yet available in those technologies identified as (or identifying themselves to be) web-GIS. This is due to the thin-client browser-based concept of these web-GIS technologies [Fitzgerald, 2000]. To include more functionalities at the client end of the network would seem to defeat the concept of the low cost and convenience of utilizing only a web-browser to access spatial data.

Although still effectively in their infancy, these new technologies show remarkable promise for rapid development. Major potential benefits to stakeholders from the use of web-GIS technologies include having access to another's data set and thereby affording cost-effective data sharing and integration to support the pursuit of each stakeholder's mandate. Also,

having access to another stakeholder's data set facilitates combined decision support toward the sustainable development of whichever resource is of interest. Additionally all this can be done without the costs associated with maintaining a wide range of data sets outside of one's mandate, as well as the costs associated with maintaining computer networks, and employing a large body of qualified human resources among other things [Shu-Ching et al, 2000].

6. WEB-GIS TECHNOLOGIES, GOOD GOVERNANCE AND SUSTAINABLE DEVELOPMENT

What does this all mean to the stakeholders in sustainable development? Typically, these stakeholders operate in one or more of the private, community, and public spheres. Their mandates and interests, though overlapping, may vary considerably. They may have made investments in digital spatial data management in varying degrees according to socioeconomic resources at their disposal, preference for certain technologies, and according to their particular interests and goals. As mentioned earlier, these factors contribute to barriers in the efficient and sustainable governance, as crucial decision-making more often than not depends on access to data and information that may be stored other than in one particular stakeholder's database.

However, the ability afforded by the development of web-GIS technologies for stakeholders to share and integrate spatial information without significant investments in changing the way in which they store their data, also more easily facilitates collaborative, cooperative and integrative governance. Various levels of government, the private sector, and communities with rights and interests in a particular coastal or marine area may now collaborate, coordinate or cooperate on that area's governance by sharing with each other in real-time and over the internet, spatial data they maintain. This level of governance may be attained without any one party being forced to change the way in which it maintains its data sets in order to accommodate integration of that data set with another. This may represent significant savings in time and money.

A concrete example of this collaboration and cooperation in the governance of a marine area facilitated in part by web-GIS technologies is in reference to the proposed Musquash marine protected area located in the Canadian province of New Brunswick's portion of the Bay of Fundy. Spatial data relative to this area has been, and is being collected by the federal and provincial governments, academia, communities, non-government organizations etc. The range of spatial information includes socioeconomic, biology, property rights, hydrography and topography among others. These data sets are collected and stored in a variety of data formats and geographic locations, and among a variety of organizations with different mandates. Web-GIS technologies are being used to integrate, visualize and analyze these data sets so as to determine a management plan that will allow for the economic and social use of the area by all concerned, while affording an appropriate level of protection for the natural resources. The interested parties, after giving the appropriate access permissions to their data sets as is, can each at their own leisure and using only web browser, view the visualization of their data set integrated with other data sets for the same spatial extent.

The potential for the use of web-GIS technologies for improving good governance of environmentally sensitive areas like the proposed Musquash marine protected area was recently demonstrated when multi-beam data of the area was integrated with data representing the proposed boundaries of the protected area using CARIS Spatial Fusion™. Sand waves outside of the proposed boundaries, as revealed by the multi-beam data, gave indication that there may be evidence of tidal flushing actions in and out of the Musquash estuary. The potential for the movements of contaminants in and out of the Musquash estuary was realized gave rise to the consideration that the proposed boundaries may have to be moved in order to give the area the desired protection. Here geographically dispersed parties with varying mandates but collecting data on the same spatial extent, and without changing the structure and format of the data they maintain, were able to use web-GIS technologies to integrate data for more effective decision-making. Scenarios like that mentioned above auger well for the positive impact of web-GIS technologies on the sustainable development of coastal and marine spaces.

Hypothetically then, one can envision a number of situations where web-GIS can aid in sustainable development. One situation could be where stakeholders have a stake in the sustainable forest development in a particular geographic area and each stakeholder separately maintains some different type of spatial data on that same geographic extent. These stakeholders could be maintaining spatial data ranging from forest stands (with analytical data on forest growth and type) to data on the ecological sensitivity, human social and economic activities, geology and spatial data representing the potential impact of human activities on these forest stands. They could then use web-GIS technologies to share these data via the worldwide web to effect crucial decision support with an aim for the sustainable development of the forest stands in question.

Similarly, stakeholders may be interested in the sustainable development of a particular waterway. They could each be maintaining a range of spatial data from data on human activities of potential pollution of the waterway, to traffic volumes, waterway characteristics, population densities close to the waterway etc. Web-GIS technologies could be used to share and integrate data in support of the sustainable development of the particular waterway.

7. CONCLUSION

In our world of limited resources and growing population pressures on these resources, sustainable development has become an extremely important concept. The sustainable development of any resource requires access to complete, accurate, up-to-date, timely and useful information to support decision-making with regard to scarce resources. Web-GIS technologies show potential for delivering this quality of information.

The major benefits of the use of web-GIS technologies is that each stake holder could have access to another's data set and afford data sharing and integration to support the pursuit of each stakeholder's mandate plus combined decision support toward the sustainable development of whichever resource is of interest. Additionally all this can be done without the costs associated with maintaining a wide range of data sets outside of one's mandate, as well as the costs associated with maintaining computer networks. The major drawbacks

associated with web-GIS technologies include the fact that the range of spatial analysis functionalities available to support decision-making are much less than those currently embedded in most desktop GIS.

REFERENCES

Barksdale, J. L. (1998). "Communications technology in dynamic organizational communities.' In *Community of the Future.* Eds. Hosselbein et al, Drucker Foundation Series, Joey-Bass Publishers.

Bohlin, E. (1999). "Editorial." In *The IPTS Report,* No.32, March 1999.

Cattavi, M. L. (1998). "Opportunities in the global economy." In *Community of the Future.* Eds. Hosselbein et al, Drucker Foundation Series, Joey-Bass Publishers.

Chrisman, N. (1997). *Exploring Geographic Information Systems.* John Wiley & Sons, Inc. New York and London.

Covey, S. R. (1998). "The ideal community." In *Community of the Future.* Eds. Hosselbein et al, Drucker Foundation Series, Joey-Bass Publishers.

Fitzgerald J. (2000). CARIS Spatial Fusion: an Internet GIS. White Paper #7 http://www.spatialcomponents.com/techpapers/fusion.pdf. Fredericton, New Brunswick, Canada, February 4.

Ford, R. and D. Zussman (1997). "Alternative service delivery: Transcending boundaries." In *Alternative Service Delivery: Sharing governance in Canada.* Eds. Ford, R. and D. Zussman, KPMG • The Institute of Public Administration • University of Ottawa Libraries.

Friedheim, R. L. (1999). "Ocean governance at the millennium: Where we have been - where should we go." In *Ocean & coastal Management,* 42 (1999), pp. 747-765.

Friedmann, J., and G. Abonyi (1976). "Social Learning: A model for policy research." In *Environment and Planning,* No. 8, pp. 927-940.

Juillet, L. and J. Roy (1999). "Investing in people: the public service in an information age (reflections on the 1999 APEX conference). In *Optimum,* Vol. 29, No. 2/3.

Kaufmann, J. and D. Steudler (1998). "Cadastre 2014: A vision for a future cadastral system." http://www.swisstopo.ch/fig-wg71/cad2014/cad2014/index.htm, FIG Working Group 1, Commission 7. Accessed May 2001.

Keough, K. (2000). "Science advice for government effectiveness: The Canadian approach." In *The IPTS Report,* No.46, June 2000.

Kyriakou, D. and G. Di Pietro (2000). "Editorial." In *The IPTS Report,* No.46, June 2000.

Langaas, S. (1996). http://www.grida.no/prog/norbal/docs/giswww/giswww.htm Accessed January 10, 2002.

Mansell, R. et al (1999). "Indicators of a sustainable information society: policy analysis and application." In *The IPTS Report,* No.32, March 1999.

Masser, I. (1998). *Governments and Geographic Information.* Taylor and Francis Publications.

Nichols, S., D. Monahan and M. D. Sutherland (2000). "Good Governance of Canada's Offshore and Coastal Zone: Towards and understanding of the Maritime Boundary Issues." In *Geomatica,* Vol. 54, No. 4, pp. 415-424.

Olson, M. (1971). *The Logic of Collective Activity.* Harvard University Press.

Ostrom, E. (1990). *Governing the Commons.* Cambridge University Press.

Paquet, G. (1997). "Alternative service delivery: Transforming the practices of governance." In *Alternative Service Delivery: Sharing governance in Canada.* Eds. Ford, R. and D. Zussman, KPMG • The Institute of Public Administration • University of Ottawa Libraries.

Paquet, G. (1999b). *Governance Through Social Learning.* University of Ottawa Press.

Pinto, C. W. (1994). "The United Nations convention on the Law of the Sea: Sustainable development and institutional implications." In *Ocean Governance: Sustainable development of the Seas.* Ed. Payoyo, United Nations University Press, Tokyo • New York • Paris.

Reeve, D. And J. Petch (1999). *GIS Organizations and People: A socio-technical approach.* Taylor and Francis Publications.

Reich, R. B. (1991). *The Working of Nations: Preparing ourselves for 21st century capitalism.* Alfred A. Knopf, New York.

Rosell, S. A. (1999). *Renewing Governance: Governing by learning in the information age.* Oxford University Press.

Savoie, D. J. (2000). *Governing from the Centre: The concentration of power in Canadian politics.* University of Toronto Press.

Senge, P. (1996). "Through the eye of the needle." In *Rethinking the Future: Rethinking business, principles, competition, control & complexity, leadership, markets and the world.* Reprinted (1997). Ed. Gibson, R., Nicholas Brealey Publishing, London.

Shu-Ching, C. et al (2000). ”A high-performance web-based system design for spatial data access.” In *Proceedings of the Eigth ACM Symposium on Advances in Geographic information Systems.* ACM Press

Stanbury, W. T. (1993). *Business-Government Relationships in Canada: Influencing public policy.* Nelson Canada.

Star, J., J. Estes and K. McGwire (1996). ”Integration of geographic information systems and remote sensing.” In *Integration of Geographic Information Systems and Remote Sensing*, Eds. J. Star, J. Estes and K. McGwire. Cambridge University Press.

VanDijk, J. (1999). "A European way into the global information society." In *The IPTS Report,* No.32, March 1999.

Wegener, M. And I. Masser (1996). ”Brave new GIS worlds.” In *GIS Diffusion,* Eds. I Masser, H. Campbell and M. Craglia. Taylor and Francis Publications.

Young, O. R. (1994). *International Governance.* Cornell University Press, Ithaca, New York.

BIOGRAPHICAL NOTES

Michael Sutherland obtained a Diploma in Computer Science from the University of Technology (Jamaica), and a Master of Science in Engineering (land information management) from the Department of Geodesy and Geomatics Engineering, University of New Brunswick (Canada). He is currently pursuing a Ph.D. at the University of New Brunswick where he is developing global models regarding the need for marine boundary information in coastal and ocean management. His work experience includes 18 years in land management with the Government of Jamaica, a number of private consulting jobs related to the development of land information management software in both Canada and Jamaica, as well as lecturing in land administration. Michael is a member of the Canadian Institute of Geomatics and has been president of the Geodesy and Geomatics Engineering

Student Society, the Graduate Students Association (UNB), and the Caribbean Circle (UNB). He is currently the vice-chair (Research) of the Graduate Students' Association of Canada and sits as the student representative on the executive of the Canadian Association of Graduate Studies. Michael has a number of papers published in a variety of conference proceedings, and a publication in *Geomatica*, Vol. 54, No. 4, pp. 415-424, co-authored with Sue Nichols and D. Monahan (2001) entitled "Good Governance of Canada's Offshore and Coastal Zone: Towards and understanding of the Maritime Boundary Issues."

Sue Nichols is a Professor in Land Administration and Property Studies at the University of New Brunswick and has conducted research on tidal and marine boundaries for over 20 years, including a chapter on Coastal Boundaries in Survey Law in Canada[1989]. Sue is a Past-President of the Canadian Institute of Geomatics and has been on the Advisory Committee for the Canadian Minister of Natural Resources. She is currently the Project Leader on a multi-year, interdisciplinary research project on "Good Governance of Canada's Oceans: The Use and Value of Marine Boundary Information" which includes examination of boundary uncertainty. http://www.unb.ca/web/GGE/Research/OceanGov/