The true cost of spatial data in Canada

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The evolution of the Information Age, in Canada, has meant an unheralded parallel social evolution—the development of a class structure, if you will, that is tied to data accessibility. While other countries have made data freely available for use by industry, education and the public, Canada has opted to follow a restrictive data policy under which data are essentially available to a select few—those who can afford the prices. While anyone can purchase the data, not everyone can pay the price.

The implications of this in our society are immense and are felt throughout our social structures. One obvious example of this is the lack of quality, high-resolution Canadian data freely available for use in the Canadian education system, particularly in the university classes in which students today are usually introduced to GIS, visualization and data interpretation. Our students have data to work with, but often they are the freely available American data. They learn from examples derived in the mountains of Wyoming or the forests of Washington.

How did this Canadian data restriction happen? In this paper, the evolution of GIS classicism is explored through examination of the evolution in Canada of GIS itself. The data situation elsewhere in the world is reviewed, the feasibility of 'freeing' data is discussed and a call for a radical change in the way data/information are handled in Canada is presented.

L'évolution de l'Âge de l'information au Canada s'accompagne d'une évolution sociale inattendue—le développement d'une structure de classe, pour ainsi dire, liée à l'accessibilité des données. Si, dans d'autres pays, le secteur industriel, le secteur de l'enseignement et le public bénéficient d'un libre accès aux données, le Canada a choisi une politique restrictive dans ce domaine, les données n'étant généralement accessibles que par un groupe privilégié—ceux qui peuvent payer le prix d'accès. Tout le monde peut acheter les données mais tout le monde n'a pas les moyens nécessaires pour payer le prix demandé. Les implications de cette politique dans notre société sont profondes et visibles à travers toutes nos structures sociales. Un exemple évident est l'absence dans l'enseignement canadien de données canadiennes de qualité à haute résolution, spécialement dans les classes universitaires où les étudiants actuels sont exposés au SIG et apprennent à visualiser et à interpréter les données. Nos étudiants disposent bien de données, mais ce sont souvent les données américaines disponibles gratuitement. Leur éducation se base donc sur des exemples tirés des montagnes du Wyoming ou des forêts de l'État de Washington. D'où vient cette restriction des données canadiennes ? Cette dissertation explore l'évolution du classicisme SIG par le biais d'un examen de l'évolution du SIG lui-même au Canada. Elle traite de la situation des données à l'étranger, discute de la faisabilité d'un libre accès aux données et demande un changement radical de la gestion et de la présentation des données et informations au Canada.

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Introduction

Spatial data have become an intrinsic part of life, and the statement that 'up to 80 percent of data have a spatial component' is now part of our geographical lexicon (e.g., Boulos and Roudsari 2000; Francica 2000; McKee 2001; Swartz 2001). It is obvious that digital spatial data have become invaluable commodities and play a major role in all aspects of society. It is amazing to recall that just forty years ago, the first geographic information system was only a vague concept. At that time, the creation, collection, manipulation and distribution of spatial data were activities restricted to a few individuals—principally government employees—and, aside from a few pioneering individuals and companies, neither the general public nor the private sector were interested in or even aware of spatial data or such activities.

Times have changed, however. Now, both the general public and the private sector have large vested interests in all aspects of spatial data, interests ranging from invasion of privacy and freedom of information to intellectual property and Crown copyright. A 'spatial-data culture' has emerged, one that is increasingly vocal in its demands for access to quality, up-to-date data. In light of the rise of this new culture, there is a need to reflect upon where we now stand with respect to the provision of and access to spatial data. A review of the uniquely Canadian spatial-data culture is presented below, with particular attention paid to the social costs resulting from the restrictive spatial-data culture that exists in Canada (i.e., the costs that result from the practice of charging for and restricting access to Canadian spatial data) and the implications of this for education.

What is the true cost of spatial data in Canada? While we can quickly obtain prices from government web pages, such as those of Statistics Canada or Natural Resources Canada, such numbers only tell us a small part of the story. In order to determine what the 'true' cost of data is, we have to consider more than the data-acquisition costs. This is a multidimensional question that relates to actual dollar costs and to social costs, inextricably tied together, resulting in a profound effect on our society. We need to consider factors such as: How many agencies and organizations cannot use the data simply because the cost is too much, and is this creating a new class structure? How much is spent on cleaning the data, ensuring that they meet the needs of the purchaser? How much more does it cost to do business in Canada because application software requires data that are not readily available? How much is the quality of life in Canada affected because decisions are made without all of the information collected by the government being available?

I will begin by considering the origins of geographic information systems (GIS) in Canada (which led to the development of a spatial-data culture very different from that of the United States), and will examine how standards and procedures that were appropriate and even necessary forty years ago are now inappropriate and overly restrictive. I will consider the changing nature of this culture from government, academic and commercial perspectives as the role each group has had in creating this culture as it has evolved over time.

The First Stage—The Early Years of GIS

In the 1960s, GIS activities were almost solely limited to governmental and academic enterprises (Foresman 1998). At that time, the Canadian government was under growing pressure to monitor change in the landscape and to plan for the future utilization of our natural resources (Switzer 1975). One result of that pressure was the establishment of the Canada Land Inventory (CLI) under the auspices of the Agricultural Rehabilitation and Development Act (ARDA) in 1961. At that time, it was realized that in order to derive the data necessary to meet the government's needs, a new means of analyzing data would be required. The Canada Geographic Information System (CGIS) was created in response to those needs (Tomlinson 1998).

No commercial enterprise at that time would have undertaken such a task in light of the millions of dollars it would eventually take to create the system, the unknown economic return from that investment and the length of time—almost a decade—it would take for the system to become fully operational (Switzer 1975). Only a federal government agency with—at that time—seemingly unlimited resources and with the long-term vision necessary to carry through the project could carry off such a venture. As a result of that vision, the legacy of the efforts of Roger Tomlinson (recently presented with the Order of Canada as the 'father of GIS'), Guy Morton, Ray Boyle and others involved in the creation of the CGIS is still felt today. Some of the software and technology advances associated with the development of the CGIS include raster-to-vector conversion procedures, chain coding and compression (Morton), the first cartographic scanner, the first free-cursor table digitizer (Boyle) and edge-matching routines (Foresman 1998). Canada was clearly a pioneer in the field of GIS, thanks principally to the efforts of the federal government and a few academics such as Boyle. In order to succeed, however, the government participants in projects such as CGIS sometimes had to become very protective of the project. For some time, they even had to 'go underground' (Switzer 1975) in order to avoid the scrutiny of the bureaucrats who questioned the major expenses associated with the project and the little to show (at that time) for that expenditure.

In the academic sphere, forays were being made into the field of digital cartography, and new methods of doing analytical geography were being developed. Programs such as SYMAP (Chrisman 1998), and texts such as Ian McHarg's *Design with Nature* (1969) were two of the significant academic contributions during this first stage. However, it is particularly in the training of individuals that this decade stands out. The seeds of a spatial-data culture were sown in a few government departments and in a small number of academic institutions during the 1960s. Even then, the Canadian soil in which those seeds were sown was very different from American soil. Crown copyright, rigidly enforced, was clearly demarked on the printed topographic maps, while the United States Geological Survey (USGS) published maps without any such caveat. In Canada, the government was clearly steering the spatial-data revolution, while in the United States, academic institutions such as Harvard and the University of Washington were key players, along with government agencies such as the US Census Bureau and the US Defense Mapping Agency.

Commercial activity in the field of GIS was very limited during the early years, since the return on investment was very tenuous and the end-user community was nonexistent. Commercial activity in Canada occurred almost entirely through government contracts, including IBM's contract to develop the first scanner for CGIS and Spartan Air Services's contract to carry out a technical-feasibility study for a computer-mapping system (Tomlinson 1998).

Digital data were, of course, priceless commodities during these early years. Data formats were specific to each program, and data conversion was not a consideration. Given the cost of getting data into the system, large datasets were the sole territory of governmental agencies that had the money and resources necessary to develop them and the hardware and software to use them. Little, if any, consideration was given to the notion that digital datum in and of itself could be a valuable commodity.

The Second Stage—GIS expansion

During the second stage of GIS development—the 1970s and early 1980s—we saw a change in how governments approached GIS and the development of spatial databases. While in-house development continued within the CGIS project (e.g., Desormeaux 1981), and projects such as Agriculture Canada's CanSIS and Statistics Canada's Area Master File (AMF) and Postal Code Conversion File saw the light of day (Forrest 1998), other government agencies were turning to commercial suppliers of hardware and software. For example, the British Columbia (BC) Ministry of Forests purchased Intergraph workstations to be used in the production of forest-inventory maps, the city of Burnaby called upon Synercom to deliver an automated mapping system to them and the first ArcInfo installation in the world was established in New Brunswick (Forrest 1998).

In the academic community, interest in GIS was spreading rapidly, as were commercial spin-offs. Individuals such as Scott Morehouse, Jack Dangermond and David Sinton left the academic community to form companies such as ESRI and Intergraph, while companies such as ERDAS were formed as commercial ventures by academically based labs (Chrisman 1998; Faust 1998). Important conceptual advances in the field of geoprocessing continued to occur, with the development of triangulated irregular networks (TINs) and cartographic generalization routines in the Department of Geography, Simon Fraser University, being notable examples (Peucker *et al.* 1978). Elsewhere in Canada, individuals such as Michael Goodchild, at the University of Western Ontario, and Ray Boyle, at the University of

Saskatchewan, were also developing active GIS teaching and research programs.

As noted above, the commercial market was slowly developing, with commercially available GIS programs available in the latter part of the 1970s. The number of players were very limited, however. Government agencies were the main clients, since the cost of these programs and the hardware on which to run them was still prohibitive (e.g., Tisovec 1976). While the initiative behind GIS development began to shift from governmental agencies and academic institutions to the private sector (Tomlinson 1986), Canadians—mainly federal and provincial government departments and agencies—maintained their positions as innovators in the use of spatial data (Groot 1975).[1]

Data were increasingly available in digital form, as efforts by national mapping agencies such as the Surveys and Mapping Branch of Energy, Mines and Resources (EMR) (now Natural Resources Canada—NRCan) and the USGS flowered and extensive digital mapping programs were put in place (Tomlinson 1986). However, digital spatial data were still relatively rare commodities in the private sector, and the number of applications utilizing digital spatial data were very limited. The lack of a common spatial-data format and of information on what spatial data were actually available also hindered data-sharing initiatives (ibid.). Thus, the costs associated with the collection and manipulation of spatial data were still very high. Restrictive access and distributional policies were not overly problematic at this time, since there were so few nongovernmental users.

The Third Stage—GIS Market Explosion

By the mid- to late 1980s and beyond, commercial GIS software programs were well established, and most governmental agencies had stopped the development of in-house GISs. CGIS, for example, was frozen as of 1989 (Tomlinson 1998). In fact, most agencies that had developed in-house systems switched to commercial GISs (e.g., Agriculture Canada's shift from CanSIS to ArcInfo in 1986; see Agriculture and Agri-Food Canada 'History of CanSIS'). Governments still had to collect spatial data, however, in order to meet their mandates. Furthermore, as a result of the growing awareness of the value of spatial data, and with the increasing availability of relatively inexpensive hardware and software packages, there was an increasing demand for such data by the private sector. Evolving spatial-data standards and software programs with extensive import/export functions also made it easier to exchange data among organizations.

The academic community was now becoming increasingly concerned with the education and training of students who could move into the workforce and make intelligent use of the wide array of software products available. Research was increasingly tied into finding solutions to real-world problems, such as how to handle massive data volumes, maintaining synchronicity in dispersed databases and how best to represent uncertainty. Issues related to the culture of spatial data were also beginning to be explored (Schuurman 2001).

The commercial sector was undergoing a seemingly unlimited expansion in its markets (Forrest 1998; Goodchild 1998). Predictions of increases in hardware, software and data sales were always optimistic and always met or exceeded. Advances in technologies such as Global Positioning Systems (GPS) and satellite imaging systems also continued to fuel the market.

The Dark Clouds

It could be argued that sometime between the first and third stages of GIS development in Canada, the government's role shifted from that of being a leader in the development of equipment (hardware) and concepts (software and data formats) to being a provider of data. This change is very significant, for as Foresman (1998, 11) argues, 'Data remain the fuel for GIS evolution'. This change, of course, was the result of many factors, such as government restraints, economic recessions, and the fact that (American) private industry became the driving force behind GIS software and hardware developments. As Forrest (1998, 342) argues, 'While in the past [Canadian] governments at all levels have tended to set the direction of industry, recession and budgetary restraint are having a major impact on geomatics programs. . . . The Canadian geomatics industry will be influenced much more by developments in the commercial and consumer marketplace'. My contention is that the Canadian federal and provincial governments have never recognized the significance of that change—from being a leader to an enabler—and that their attitudes towards data need to be dramatically revised. The current attitude stifles academic research on GIS per se and on how GIS could be used in our society, it stifles commercial developments in the field[2] and it results in a poorer society as a whole.

This third stage saw the growing realization by Canadian governmental agencies at all levels that digital spatial data could be valuable commodities, that could contribute to that agencies' income stream (but see below). The fact that, in Canada, the government owned spatial data through Crown copyright and could control their use—even after allowing a third party access to it—had a dramatic and lasting impact on our spatial-data policies at the critical time at which policies were being developed. The political culture during the 1980s had a significant impact on the developing spatial-data culture in Canada. 'Federal government expenditure reduction measures implemented during the 1980s contributed to significant increases in the price of STC [Statistics Canada] data. Consequently, STC data were priced beyond the means of most university researchers which resulted in a decline in the use of Canadian data both in research and teaching' (Statistics Canada 'Executive summary'). A similar statement could also be written with respect to the provision of environmental data by Environment Canada (Canadian Library Association 1997).

It is at this time that the differences between the Canadian and US spatial-data cultures become extremely obvious. These differences are predicated principally on the concept of Crown copyright. In Canada, the Crown maintains the copyright on all federally and provincially produced spatial data and collects royalties on the data it sells to resellers. Interestingly, Crown copyright does not apply to municipally produced data in Canada (Evangelatos 1999), although many municipalities appear to have adopted data licencing and pricing policies similar to the federal government's. In the United States, no such copyright exists, and data are available for the cost of reproduction only (Litman 1995). The impacts of these differing views on our societies are far-reaching, and they will be examined in the following sections.

In making a comparison between the availability of digital spatial data in the United States and in Canada, I will restrict my discussion to the major, core, digital spatial-data products produced in each country. In the United States, three national spatial databases stand out: the US Census TIGER files and the USGS Digital Line Graphs (DLGs) and Digital Terrain Models (DTMs). In Canada, the equivalent databases would be Statistics Canada's Area Master File and NRCan's National Topographic DataBase (NTDB), although given the resolution of the USGS DLGs and DEMs, the equivalent digital-mapping products would be the provincial base-mapping product, such as BC's Terrain Resource Information Management (TRIM) or the Ontario Base Map (OBM) series.

The following quotes illustrate the situation in the United States:

> Today's nationwide TIGER file is the backbone of the adoption of GIS in business geographics applications. TIGER frees business users from the drudgery of map digitizing and allows them to concentrate on applying GIS technology to business problems (Cooke 1998, 56).[3]

> The USGS has been guided by ... policies that have had far-reaching effects on the development and acceptance of GIS technology in the United States: GIS database builders in the United States have received a unique benefit in getting access to inexpensive and readily available data.... [U]ser fees ... have the effect of constraining data exchange and impeding the development of GIS technology.[4]

> The availability of low-cost Digital Elevation Models (DEM) created from automated methods is a cornerstone to the development of GIS technology (Greenlee and Guptill 1998, 189).[5]

It is apparent that in the United States, the government has cleary recognized the role that it has at this stage of the development of GIS: to provide free and easy access to digital spatial data so that society (which includes the academic community, commercial vendors and the general public) can benefit from the increased efficiency and equity such access permits. The US government clearly sees itself as an enabler of technological developments. Social justice, while not explicitly mentioned, also benefits from those same policies.

The notion that access to data should be free and easy extends beyond spatial data. The US Bureau of the Census also releases the results of their censuses without restrictions, for example. Via the Internet, it is possible to access, among other available datasets, the 43 gigabytes of data collected as part of the 1990 census (see Merrill *et al.* 1996).

As Goodenough, McKenney and Pendrel (1997) concluded in their report to NRCan after a tour of US spatial-data agencies: 'It was clear to us that the US Government is convinced that there is much greater economic benefit gained by making spatial data freely available than by charging for spatial data. Studies have been conducted in the US and Australia supporting this view. State agencies are encouraged to use the FGDC [Federal Geographic Data Committee] standard and to share their spatial data'. In every country, government departments and agencies collect data for more or less the same reason—to meet their legislated mandates; but what they subsequently do with that data—enabling access and research or restricting access and stifling research—has immense societal implications.

The Canadian approach to charging for government data is not unique, of course. We follow an approach to spatial data ownership similar to England's. The Ordnance Survey—Britain's national mapping agency—maintains copyright on all of the digital spatial data it produces. In two articles in *GISEurope*, Barr (1998a, b) clearly highlights the problems that follow from maintaining the copyright status quo. Crown copyright was originally introduced in order to ensure that government documents were not reproduced inaccurately and that, in the 1800s, a few private companies could not unreasonably profit from the reproduction of ordnance survey maps. Now, however, Crown copyright 'has simply become a mechanism to create an artificial rarity value for mapping data, with the aim of covering the agency's costs' (Barr 1998a, 15). Further on, Barr states: 'Worst of all, civil servants have been forced to think like private sector business managers. At the same time, they are denied the profit motive that would benefit their agencies, so they have no incentive to perform any better than the Treasury demands' (1998a, 15). That the Canadian government does not see this apparent conflict is clear: 'User charges . . . foster a more business-like approach to providing services by increasing the responsiveness of supply to users' willingness to pay and encourages efficiency in service delivery by focusing greater attention on the bottom line' (Corey 1998, 31, quoting from the Treasury Board policy statement on 'External User Charges for Goods, Services, Property, Rights and Privileges').

As concluded in a recent international study on geospatial data policy prepared for the GeoConnections Policy Advisory Node:

> Cost recovery is intended to foster greater equity, efficiency and better business practices in government. Instead, it can have, and has had, the opposite effect. The consequences for businesses are higher costs, lower research and development investments and threatened marginal products. The results for consumers are negative: higher prices and reduced products and services (Sears 2001, 3).

Furthermore, Barr (1998b, 15) notes, copyright restrictions 'create an artificial barrier to the rational distribution of data. The only effective way to overcome it is to put data in the public domain and allow it [sic] to be copied at will. Where that happens, as with government-produced data in the United States, reservoirs of useful and usable data appear all over the place'. Barr goes on to say that while the quality and currency of the free data are often not appropriate for all applications, there is a thriving market in premium-priced value-added products in the US, products that have guaranteed levels of accuracy. In Canada, the government has attempted to partially fulfill the role that value-added retailers play in the US by becoming more 'client-driven', in response to the 1990 Treasury Board of Canada 'Increased Ministerial Authority and Accountability Initiative', which enabled departments to retain certain percentages of revenues generated through the sales of government data (Corey 1998, 42).

Canada has followed England's approach to spatial-data ownership, as have other Commonwealth countries such as Australia and New Zealand. However, the government of New Zealand recently reversed its position with respect to access to spatial data (LINZ 1999). Previously it held a position identical to Canada's, maintaining strict control over the distribution of spatial data through the imposition of Crown copyright and by charging high royalties. Now, however, the royalty-free data are available for only the cost of distribution (e.g., NZ$1,500.00 for the entire set of topographic maps, versus a total cost of two million dollars before the reduction in fees). One of the reasons stated for the reversal was the need to encourage environmental research; the New Zealand government clearly sees the important role that academic research plays in the development of a sound and sustainable economy. Australia is also considering a switch from a Commonwealth model (Crown copyright and royalties) to one more in line with that of the United States (Commonwealth Spatial Data Committee 2000).

One issue that arises in Canada partially in response to the conflicting spatial-data cultures to which we are exposed—the American open-access model versus the English restrictive model—is the wide array of data-access/pricing policies in place. Pricing spatial data is a very complex task, especially when those data are collected by government agencies in pursuit of their mandate. Nonetheless, governments have attempted to derive valid pricing schemes for their data.

> What would be the right price for geographic data that would attract buyers and still earn a reasonable rate of return on the investment? . . . Pricing based on the estimated costs is the most commonly used technique for pricing geographic data. Estimated costs are usually the cost of collecting and maintaining the data, and some additional costs that cannot be allocated to any dataset (overhead, resources . . .). These costs are summed and the sum is often mistaken as the 'value' of the data. The price for the dataset is determined by the summed costs and divided by the number of potential sales. Due to high collection and maintenance costs and a pessimistic estimate of the potential sale this principle leads to high prices and thus reduces the potential sales (Krek and Frank 1999, 1).

Since there is no golden rule by which prices can be determined, a dataset in one province may be sold for $600 (see Ministry of Sustainable Resource Management, Base Mapping and Geoservices Branch) while, in another province, the equivalent dataset may be selling for $175 (see AltaLIS). While some government agencies are willing to freely distribute their data, others price their data beyond the reach of all but a few. 'What is even more disturbing is the fact that some geospatial data of Canada is [sic] available from US organizations at a fraction of the cost charged to Canadian companies by Canadian government agencies. For example, it is possible to obtain DTED (Digital Terrain Elevation Data) data of Alberta from the USA for $750 Cdn; comparable Canadian Digital Elevation Data (CDED) coverage purchased from Geomatics Canada costs over $8000 Cdn'. (Alberta Geomatics Group 2001).

The GeoConnections initiative is attempting to devise a consistent spatial-data culture across Canada, in particular through the national coordination meetings on the Canadian Geospatial Data Infrastructure, but they are a long way from reaching a consensus. An indication of the problems that can arise because of a lack of a consistent spatial-data culture was reported in the minutes of the GeoConnections Policy Advisory Node (Maloney 2000). A recent request for proposals let by the National Centre for Topographic Data for improvements to the content of the National Topographic Data Base (NTDB) road network received no bids in its initial form; issues around ownership of the intellectual property (i.e., Crown copyright) were seen as the main stumbling block. It was also reported that in Ontario, the overly restrictive access/distribution policies associated with Teranet—formed in 1991 as a private/public-sector partnership to develop, in part, a spatial warehouse—created a situation wherein some municipalities would rather develop their own spatial databases than use Teranet data, resulting in a duplication of activities and added costs (Maloney 2000).

A recent study commissioned by the GeoConnections Policy Advisory Node, a federally funded interagency committee led by NRCan, addresses many interesting points (Sears 2001). One of its more interesting findings is that, in the end, the revenue obtained from charging for data is typically less than the costs involved in maintaining a restrictive data policy. It is also interesting to note that this was concluded even as early as 1975, in a report prepared for a government task force on geographical referencing (Groot 1975, 15): 'The impression gathered from officials [from mapping agencies in the United Kingdom, France, West Germany, Finland and Sweden] is that the enforcement of copyright is a nuisance compared to the royalties received'.

'Numerous other studies into the cost-effectiveness of spatial data have been conducted around the world. All have concluded that a government spatial-data infrastructure has significant economic benefits to the community. One study reported a cost : benefit ratio of 1 : 9. Of course, the benefits increase as more people have access to the data' (Commonwealth Spatial Data Committee). Taking such cost/benefit ratios into consideration would only make the economic justification for government departments and agencies for charging for spatial data even less valid. Even if the cost/benefit ratios are as low as 1:1, the social costs need to be considered in the equation. However, since both provincial and federal government departments are increasingly dependent upon the revenue generated from the sales of spatial data (e.g., the 'Revolving Fund' used to support Geomatics Canada activities; Corey 1998, 42), making any changes to the current situation will not be easy.

This apparent conundrum could be resolved, in part, if government agencies were able to 'book' the economic benefits of a more liberal data policy and if the true (economic and social) costs of maintaining the restrictive policy were weighed against the benefits of the revenue generated from the sale of data. That the internal costs (e.g., developing licensing policies, monitoring the use of datasets, duplication of efforts as agencies create their own datasets rather than purchase data from another agency) are often not enumerated as clearly as are the benefits (i.e., revenue from outside sources) is partly a result of the clarity with which one set of elements may be identified versus the often ambiguous nature of another. Given the current political culture, which favours reducing government revenues (i.e., the reduction in federal and provincial tax rates in many provinces) with the expectation that higher disposable incomes will generate economic returns that eventually will result in higher government revenues, now may be the perfect time to address this issue.

The Impact of Data Scarcity

So what are the impacts of the restrictive spatial-data culture that has been created in Canada? What is the true cost of spatial data in Canada? Several significant areas of social and economic costs will be highlighted in the discussion below.

Academic research in the development of advanced spatial-data handling techniques, relevant to the Canadian situation, is reduced because of the restricted availability of Canadian spatial data. Researchers cannot afford to obtain realistic volumes of Canadian-based spatial data, and therefore we must look to data from other countries if we wish to develop methods that depend on manipulating such data. Academic research in areas such as wildlife habitat modeling, ecosystem analysis, social inequities and so on is also affected because of the restrictive and often overwhelming cost of obtaining high-resolution, digital spatial data. Thus, the quality of our environment is potentially adversely affected by data restrictions. The need to support environmental research was one of the reasons why New Zealand reversed its stand on charging for spatial data.

Students learning about GIS in Canada quickly discover that application examples are often derived from American jurisdictions, since US data are more freely available. If Canadian data of the appropriate scale and quality were freely available, our students would be able to learn more about the places they live in while learning about GIS per se. More sophisticated applications are also difficult to demonstrate, since the Canadian data that are available (e.g., Statistics Canada 'Street network file') are often in a format not readily accepted by application programs written in the US, nor is it of high enough quality to enable students to test out such applications using real-world problems. As Saarikivi and colleagues (2000, 832) state with respect to meteorological data, which are also freely available in the US but have restricted access in many other jurisdictions, '[C]ompanies and university researchers are increasingly turning directly to the United States (via the Internet) for information, as it [is] becoming the only cost-effective way to get the data they need'. As the Canadian Library Association (1997) recently stated, 'Ironically, it may be easier to get climate data from Russia than from the Government of Canada'.

The software-development industry in Canada is undoubtedly affected by data restrictions. If data were freely available, then economic justification for using spatial-data analyses in businesses would be apparent, and the demand for GIS software would increase accordingly. The American advantage is clear, as Elizabeth Ireland, MapInfo's vice president of marketing, has stated: 'We see our customers wanting to implement solutions they created in the United States and roll them out all over the world' (quoted in Sherwood 1996, 28). Canada's spatial-data-dependent companies, with limited opportunities in their home country, have a hard time competing against such forces. 'With restrictive data policies in Canada, US and other countries seem more competitively positioned to capture most of this growth' in geomatics technologies (Sears 2001, 61).

The very limited number of spatial-data value-added retailers (VAR) is another obvious result of prohibitive data policies. 'The hope of industry is that this [a reduction in activities beyond the "public good"] will reduce government mapping agencies' growing reliance on revenue generation, and consequently . . . improve value-added business prospects' (Kennedy 1998, 132). A simple examination of the *1993 International GIS Sourcebook* (GIS World 1992) provides some indication of the impact: while 11 percent of the 'surveying services' (i.e., geomatics) firms listed are Canadian, only 7 percent of the 'spatial-data suppliers' firms listed are Canadian. Even for the geomatics industry—one that should not be as directly affected by the restrictive data access policies in place in Canada—'[t]he lead that Canadian firms were once considered to enjoy in the provision of geomatics services is disappearing and, in some areas, the US has already surpassed the Canadian industry' (Sears 2001, 61). A quote from an American that aptly sums up the Canadian government's approach to the provision of spatial data was included in the KPMG report (ibid., 123): 'Canadian geomatic agencies have a nice on-line ordering/delivery system, but the data costs are too high'.

The impact of the government's restrictive policies goes far beyond the immediate economic impact of a stifled industry. For example, consider the experiences of the Prairie Farm Rehabilitation Administration in developing a spatial database (Harron 1997). They estimate that in order to ensure that the data they required were of sufficient quality for their purposes, they had to spend ten times what it actually cost them to purchase the data in the first place. If their experience is at all typical, then we can see that millions of dollars are being spent across Canada by end users in exactly the same situation. If the VAR industry was more vibrant, a number of companies would compete in the development of a quality-controlled database, and in the end both the VAR and the end user would benefit. As Krek and Frank (1999, 32) state: 'For the potential buyer the datasets are only tools towards better, faster and more accurate decision-making. Selling raw data [as is the case with most government agencies] implies that the buyer has the expertise to use the data. This is often not the case'. Even if they have the expertise, the cost involved in getting the data up to sufficient quality is borne by every user.

Potential commercial end-users of spatial data in Canada are also affected. For example, while spatial-data-based fleet management (e.g., optimum delivery/pickup routes) is increasingly being used in Canada, US companies have been able to reduce their costs for a much longer period of time. Courier firms, trucking firms and other organizations working in Canada have had much less access to database-dependent routing software than have their US counterparts. Furthermore, in the US, VARs have enhanced the street-network files by including information on one-way roads, speed limits, turn restrictions and so on. Thus, in the US, the quality of the output from routing software is very good, and drivers readily follow the prescribed delivery schedules. Such information is not as readily available in Canada; as a result, drivers may be less willing to follow the instructions generated by such software, and the efficiency of our courier industry, for example, suffers. Furthermore 'The cost to develop information workers, which I define as an overhead expense for acquiring company-specific knowledge, is very much greater than the depreciation of the fixed assets and greater than the profits for most corporations' (Strassmann 1998, 4). It could be argued that the costs associated with acquiring spatial-data knowledge are of equal value and are another item not considered by the government in its spatial-data–pricing equations.

Social Justice

Perhaps one of the more socially serious outcomes of data restrictions is the effect on end users. Potential nongovernmental/noncommercial end users of spatial data in Canada face greater ramifications because they most often cannot afford to purchase data. 'GIS is expensive, particularly when the costs of assembling data are taken into account. To date, it tends to have been more widely available to those already in power in society and to have served to strengthen that power rather than diminish or share it' (Goodchild 1998, 375). In the US, where data are freely available, many examples of 'data democratization' are taking place (Schön *et al.* 1999; see also McKee 2001). Local community groups—often in the poorer sections of major urban centres—are using publicly available datasets such as the TIGER files and the census files, along with cheaply available software programs, in order to monitor and manage their local environment. The end result is that environmental, social and economic equity are increased in urban areas where such initiatives are taking place. Due to data restrictions in Canada, such data democratization initiatives are extremely difficult to put in place, and inequitable situations are maintained, if not enhanced. The end result of this is that independent, nonpartisan analysis of data is not possible. The public at large must make do with maps and data that are presented to them and analyses that are already done. Checking and testing for data accuracy, validity and gaps in data are not possible; there is a firewall between the public and the original data.

Environmental nongovernmental organizations (NGOs), in particular, suffer as a result of restrictive data policies. In BC, the Western Canada Wilderness Committee (WCWC) is one such NGO that monitors logging activities in environmentally sensitive areas. As Goodchild (1998, 375) notes: 'The computer empowers, and if it is available to only one side in an argument it almost inevitably biases the outcome'. In the case of the WCWC, the organization became aware that the government was providing TRIM digital data to the forest company involved in logging one particular area, free of charge. WCWC requested the data—at a similar, free cost—so that their planners could determine if a more environmentally sensitive logging plan could be devised. The government refused to provide data to the WCWC for free, so the WCWC, through the West Coast Environmental Law Association (WCELA), took them to court under the Freedom of Information Act. WCELA argued that, with a price of Cdn$600.00 per digital map sheet, the government was, in effect, preventing charitable groups such as the WCWC from gaining access to the data. While the court sided with the intentions of the WCWC, it decided, in the end, that the government could charge what it felt was appropriate (for details, see Office of the Information and Privacy Commissioner 1996). The spatial-data culture present in Canada has created a distinct class system. Data are essentially available to a select few—those that can pay the price. While anyone can purchase the data, not everyone can afford to, and those that can afford to are more likely to be provided with it for free.

As Onsrud states in his compelling essay on the 'tragedy of the information commons',

> School children, teachers, private citizens, consumer interest groups, citizen advocacy groups, commercial enterprises and other governmental units have all used extensively and benefitted from data initially created by government for government purposes. These secondary uses have had profound and widespread educational and economic benefits. Allowing all segments of our society to tap into this 'information commons', created for government purposes at taxpayer expense, has been cited as a major factor contributing to overall accelerated economic expansion in the US as compared to those nations with much more restrictive government information policies (Onsrud 1998, 141–142).

In Canada, only the last two groups named—commercial enterprises and other governmental units—have any real access to government data, and even then, such groups use spatial data far less than in the US.

A final example illustrates the ultimate cost of data in Canada. Several years ago, in the interior of British Columbia, a small child fell into her family's pool. By the time a parent was able to rescue the child, she had stopped breathing. The family dialed 911, and an ambulance was immediately dispatched. The ambulance station was located less than a kilometre away from the house from which the call originated. For some reason, however, the ambulance driver made a wrong turn and it took the driver over 30 minutes to find the house. By that time, the child was unrevivable. If the 911 system had been linked into a GIS with an up-to-date road system on-line, the child would still be alive today (such a system now exists in British Columbia).

Emergency preparedness depends on access to quality data. Without it, life-threatening situations such as this one will continue to occur across Canada. With it, lives can be saved, as was the case just recently in the Qu'Appelle Valley, Saskatchewan. A small child was lost in the valley.

The search-and-rescue teams were able to use a database—developed, coincidentally, by the Prairie Farm Rehabilitation Administration—to pinpoint places where the child might be located. Without that database, the RCMP would not have known that their search-and-rescue operations had missed some territory. It was because they were directed to the missed territory by the GIS operator that the child was found (Bill Harron, personal communication 1998). A similar case of a GIS database being available and thereby potentially saving lives occurred during the January 1998 ice storm in eastern Ontario and western Quebec (Hauschildt *et al.* 1999). Such cases should not be unusual occurrences, but rather expected, unremarkable events. That they are newsworthy is the most significant indictment of the current restrictive spatial-data policies in Canada.

Conclusion

Data restriction has created data classism. Economic, educational and social impacts result. As stated above, 'Data remain the fuel for GIS evolution'. The economic impacts of a restrictive data environment are clearly in the tens of millions of dollars per year, since the fuel necessary to drive the industry is, in effect, tightly rationed. Freely available data could also have an important role to play in improving the quality of life for many people in our society. And, ultimately, the lack of spatial data can determine whether someone lives or dies—the saddest statement of all.

The time has come for data providers in Canada to reverse the policy of the past decades and open the doors to a new, free-data world. This is one instance in which Canadians should clearly follow the lead of the Americans and embrace their spatial-data culture. New Zealand has shown us that making such a change is possible. The Canadian government, which played a pivotal role in the early days of GIS software and hardware development, should now recognize that in order to allow Canada to regain their leadership role (i.e., to enable Canadian industries and academics to [re]gain leadership roles), it has to release its reins on spatial data and let it enter the marketplace unencumbered by Crown copyright or license fees. To do anything less almost guarantees that Canadian industry and academics, once recognized for their excellence in GIS, will remain second-class citizens under those who have free access to spatial data.

Many in the government recognize the high cost of Canadian data. However, an apparent contradiction can be found in such statements as 'the high cost of getting data into the spatial databases will continue to impede the growth of GIS. This impediment is the cause of the large gap between the potential of GIS and actual use' (O'Donnell and Penton 1997, 222). The authors making this statement —one of whom was an assistant deputy minister in a department that established the norms for our current spatial-data culture in Canada—then make the statement that 'the inherent right of citizens to access and use public data on a free and low-cost basis is drastically opposed to the right of public institutions to generate revenue from the use of those data' (ibid., 224). That Canadian government departments and agencies are not yet certain about what spatial-data culture they should embrace—the restrictive, data-costing culture that currently exists or an open, free-data culture—is perfectly exemplified by those two quotes. Let us hope that the statement that 'They seem to have become so dogged by history and tradition [that] they cannot conceive of any other way' is not the case (Barr 1998c). Rather, they should adopt the principle that 'data required to fulfil a legal requirement should be free or available at dissemination cost', as is the case in Finland (Craglia *et al.* 2000). Should we, as a nation, have information-society policies with strong social dimensions, like those of Finland, and strive to develop a (spatial-data) classless society, or should we continue to have restrictive policies like those currently in place, and reinforce the developing data class structure?

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Notes

1 Also, on the first page of the January 1986 *CLDS/SDTC Notes*, there is an announcement of CGIS being presented in 1985 with a 'prestigious "Exemplary Systems in Government" award from the Urban and Regional Information System Association (URISA)', the first URISA ever awarded to a Canadian federal department for its 'technological excellence'.

2 'Most indications currently, albeit anecdotal, point towards a relative decline of the Canadian industry compared to the US' (Sears 2001, 61).
3 The entire TIGER coverage for the US can be downloaded for free from, for example, ESRI's Web site at http://www.esri.com/data/(last accessed 10 January 2003).
4 Complete coverage of the US using USGS DLGs is available for free from, for example, the USGS's Web site at http://mapping.usgs.gov/esic/cdrom/cdlist.html (last accessed 10 January 2003).
5 US DEMs are free to download from, for example, the USGS's Web site at http://edc.usgs.gov/doc/edchome/ndcdb/ndcdb.html (last accessed 10 January 2003).

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