Computer-Accessible Resources for Canadian Water Resources Management

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Introduction

Canada is one of the most water-rich countries in the world, with more than 9 percent (approximately 105,000 m^3/sec) of the world's renewable water supply serving less than 1 percent of the world's population (Pearse et al.1985). It is not therefore surprising that Canada also has a long tradition of watershed management and a strong interest in conserving and protecting water resources.

Over the past decade, many authors (e.g. Tate 1987, Pearse et al. 1985, Heathcote 1993, Morrison 1995) have commented on Canada's high water use, low water prices, and lack of legally binding standards for water pollution control. As the MISA Advisory Committee (1991) has observed,

> The traditional assumption of water [in Canada] is there is always enough, it's always clean and it's always free. Today's reality is that there is not enough, it is not always clean, and it will never again be free.

Perhaps because of increasing evidence of strained water resources, Canadians are now very aware of the need to manage water wisely. The Canada-U.S. Free Trade Agreement, and later the North American Free Trade Agreement, with their implications for water sale across borders, further raised public awareness of water management issues in Canada. In responding to public concern, the Canadian federal and provincial governments have begun to explore the use of information technology in acquiring, storing, retrieving and sharing information for the many stakeholders involved in water management. This paper describes some current Canadian initiatives in this area. The discussion is not limited to information available on the Internet, because this area is to date not well advanced in Canada. Indeed, in preparing this paper we found much more promised than was actually available. Most of the federal and provincial information services we contacted were unaware that electronic resources were even under development in their Ministries and could not supply electronic addresses for us. Indeed, we found some of the information given below only through a World Wide Web "roadmap" produced by *PC Computing* magazine (Randall 1995), which is published in the United States!

The following discussion is therefore intended as a snapshot of an evolving system, but should contain enough general information for interested users to pursue specific questions. All addresses were checked at press time, but changes are of course always possible as the system evolves.

Geo-referenced Databases and Information Sources

One of the areas in which Canadian information technology is furthest advanced is in the storage and retrieval of geo-referenced data, particularly satellite imagery, maps and charts. While this information is not usually intended solely for water resources applications, it has many potential uses in land use mapping, resources inventories, time trends, and the extraction of water quality information using custom sensing filters. The Canadian federal government has established an Access and Marketing Working Group of the Inter-Agency Committee on Geomatics, and this group publishes a *Report on Current Status and Trends in Federal Digital Geographic Data in Canada.* This report, originally published in May 1991, is now being updated. The original report included 314 data sets, each of which was held by a federal government department, described Canadian territory, was directly geo-referenced to a coordinate framework, was at a scale smaller than 1:500, and was in digital form. This report is therefore a useful summary of digital databases managed by departments across the Canadian federal government. More information on this report can be obtained from Gordon Plunkett, IACG Access and Marketing Working Group, GIS Division, Geomatics Canada, 615 Booth Street, Room 753, Ottawa, Ontario Canada K1A 0E9; fax: 613-952-0916; Internet plunkett@emrl.emr.ca.

The following examples illustrate some of the kinds of data available directly on-line or on CD-ROM or other electronic format.

In 1995, Canada's first Earth observation satellite, RADARSAT, will be launched as a joint venture between the Canadian Space Agency (CSA), provincial governments and private industry. Unlike conventional optical remote sensing satellites which require sunlight to obtain useful imagery, RADARSAT is equipped with an advanced microwave radar sensor which can transmit and receive signals through clouds, fog, haze and darkness. RADARSAT will provide a variety of beam modes to suit different commercial, government and scientific users. It will cover the Arctic daily and most of Canada every three days. The entire Earth will be covered every 24 days using standard beam mode. Data from RADARSAT will be downlinked in real time to a receiving station, or stored on on-board tape for later downlinking. Users should be able to obtain data on-line within a few hours of the satellite passing over an area. Information about RADARSAT data and operation can be obtained from Salvatore Carboni, RADARSAT Program Office, Canadian Space Agency, 6767 Route de l'Aeroport, Saint-Hubert, Quebec, Canada J3Y 8Y9 (telephone 514-926-4436; fax 514-926-4433; Internet site ftp "anonymous": adro.radar1.sp-agency.ca; World Wide Web: http://adro.radar1.sp-agency.ca/adrohomepage.html; or reach Salvatore Carboni directly for technical information at coord@adro.radar1.sp-agency.ca.

In another satellite imaging program, the Canada Centre for Remote Sensing routinely produces reduced resolution "quicklook" images of all data they receive from Visible Infrared imaging satellites. These images were originally stored and distributed on microfilm, but more recently have been stored in NTSC format on analog videodisk. Since 1992, CCRS has been investigating the feasibility of storing these images in computer compatible format using industry standard JPEG compression. CCRS now has a working system accessible via Internet, with a directory structure based on satellite, track or path, and frame or row. Each image is uniquely identified and accompanying text describes the data source, acquisition date and location. About 8,000 Landsat and SPOT images are currently supported on-line, with documentation. The Uniform Resource Locator address for this site (available after June 1995) is:

> http://www.ccrs.emr.ca/cdql/cdql.html
> (English version)
> http://www.ccrs.emr.ca/cdql/cdqf.html
> (French version)

Alternatively, potential users can access the Natural Resources Canada URL address at http://www.ccrs.emr.ca then select the "GCNET (CCRS)" and the "Digital Browse" links. CCRS is now completing digitization of the more than 400,000 images acquired from 1991-1994 and plans to add more images as they receive and archive new satellite imagery data. Potential users can contact Ken Barkman of the Systems and Methodology Division of CCRS (telephone: 613-947-1369 or Internet barkman@ccrs.emr.ca.

As in many other jurisdictions, an increasing volume of geographic information is now available on-line in Canada. Although this is not necessarily always current information, it provides a wide range of information easily accessed through the World Wide Web. The National Atlas Information Service (NAIS) of Natural Resources Canada offers on-line geographic information on a variety of themes including land use, demographics, geology and ecological issues. It provides electronic samples of National Atlas map products, descriptions of information sources, and a facility that allows users to create their own maps on-line. Also available through NAIS are data from the National Atlas Digital Data Base, including data on drainage, coastlines, and river and lake management, and the Canadian Geographical Names Data Base, a collection of 500,000 geo-referenced place and feature names. The Universal Resource Locator address for NAIS is http://www-nais.ccm.emr.ca/ or contact Dan Mackay, Products and Services Division, Geomatics Canada, 615 Booth Street, Ottawa, Ontario Canada K1A 0E9; telephone 613-992-4252; fax 613-943-8282.

Digital data products for the Canadian Hydrographic Service are distributed by Nautical Data International, Inc. (NDI), a private sector firm. Available information is primarily hydrographic charts and data for major lake and ocean systems, with the data available in a variety of GIS-compatible vector and raster formats and can be delivered in various physical data forms including floppy disk, CD-ROM, DAT and other tape formats, or can be downloaded via Internet. Potential users of this information should contact NDI (telephone: 709-576-0634; fax: 709-576-0636; Internet: info@ndi.nf.ca) and should be prepared to provide an ENC reference number or CHS chart number, the intended use of the product, the digital format required, the media format and method of delivery preferred, and invoicing information. NDI will issue a licence based on the intended use and will ship the required data when the signed licence is returned to them. Licences can be granted in several forms: end-user licences allow users to use the data in-house only; value-added reseller licences are granted to manufacturers of electronic chart systems who wish to convert the data for use with their systems; and experimental licences are granted to researchers who want to use the data for new or unusual applications.

A number of databases (few for water quality or water quantity, but several relevant to watershed studies) are available on CD-ROM, although not (as yet) via

Internet. Examples are data for a boreal forest test site near Whitecourt, Alberta (northwest of Edmonton), which includes C-band Radar images, forest field parameters for 95 stands, optical data, weather recordings, explanatory notes and references. This database, available in both Macintosh and IBM-PC compatible file formats, can be obtained from Frank Ahern, Applications Division, Canada Centre for Remote Sensing, 588 Booth Street, Ottawa, Ontario K1A 0Y7 (telephone: 613-947-1295).

Geological maps and data from the Geological Survey of Canada are also available on CD-ROM in a variety of internationally accepted formats. This database is designed to be accessible to both large workstation computers and desktop systems. For information, contact the Geological Survey of Canada Bookstore, 601 Booth Street, Ottawa, Ontario Canada K1A 0E8; telephone: 613-995-4342; fax 613-943-0646;
Internet: gsc_bookstore@gsc.emr.ca.

Electronic Research Consortia

Water resources professionals interested in Canadian water management issues may also benefit from access to electronic research networks. As government and private industry become more aware of the advantages of electronic communication (and as the technology advances to allow linkages to be made easily), more and more of these networks are emerging. The following are examples of activities currently underway.

The Boreal Ecosystem-Atmosphere (BOREAS) is an international cooperative research initiative based at two sites in central Canada: Prince Albert National Park and the Candle Lake Area in Saskatchewan, and a northern study area west of Thompson, Manitoba. This research is sponsored by several Canadian and U.S. agencies and is intended to develop an understanding of the interactive processes between boreal forest ecosystems and the atmosphere as they relate to global climate change. The research program includes an impressive range of data collection activities including satellite observations, airborne sensors, gas flux measurement aircraft, helicopter data collection, gas flux towers, canopy towers and a variety of devices on the ground. The data were collected in five separate field campaigns, the first of which emphasized characterization of the hydrology of snowpacks and the forest radiation regime. A second campaign defined melting snow dynamics, while three summer campaigns studied soil-vegetation-atmosphere interactions. Most of the information collected is intended to support forest ecosystem research, but hydrologic data may also be of interest to water resources managers. Information on BOREAS is available from Josef Cihlar, BOREAS Secretariat, CCRS, Telephone: 613-947-1265; fax 613-947-1385;
Internet: cihlar@ccrs.emr.ca.

A Canadian groundwater research group provides information on "Groundwater and the Internet" through a federal server at http://gwrp.cciw.ca/Internet/Internet.html. The posted information is a comprehensive set of links to other groundwater-related sites, including data sources and recent research findings.

We suspect that there are many more research consortia now developing on-line information services, but to find these on the Internet may take some patient searching. Some government agencies list experts in a number of environmental concerns; following up these leads can take the user into World Wide Web pages giving details of research programs underway. Although it is possible to access provincial networks directly, the easiest approach may be to go through the Canadian federal government's WWW page (http://cs910.cciw.ca:80/opengov/), which contains links to provincial government information services and to other national governments (e.g. United Kingdom, France, Japan, Australia, Italy and others). This Web page is a recent pilot project sponsored by Industry Canada. If it is well received, we expect that federal government use of Internet resources will expand quickly.

Policies and Procedures

We found a number of guidelines and procedures available on Internet. Examples are the Guidelines for Canadian Drinking Water Quality, which we accessed through Andrew Park at umpark@ccu.umanitoba.ca; Ontario guidelines and procedures (including approvals) for air, water and waste, available through a World Wide Web page at http://www.gov.on.ca/; and British Columbia (http://www.ENV.GOV.BC.CA/). Several provinces list recent environmental assessment decisions and supporting documentation. Again, Ontario and British Columbia are prominent here, accessible at the addresses given above or through the main federal government Web site.

Although not strictly policy, newly developed ELADA 21 software (Electronic Atlas of Agenda 21) uses multimedia and geomatics technology to access and disseminate information about Agenda 21, the action plan developed at the 1992 Earth Summit in Rio de Janeiro. ELADA 21 is intended to facilitate worldwide exchange of information generated by the Agenda 21 guidelines and support the implementation of reporting processes on sustainable development policies. The project is funded by the International Development Research Centre (IDRC), the Canada Centre for Remote Sensing and private industry. Six countries, the Bahamas, Costa Rica, Canada, Kenya, Poland and Thailand, and one organization, the International Plant and Genetic Research Institute (IPGRI) in Italy are associated with IDRC and CCRS in the development of a biodiversity chapter under Agenda 21. This prototype project will focus on selecting, collecting and integrating biodiversity data and on producing interactive scenarios linking biodiversity with socioeconomic issues. At present, ELADA 21 information is available only in a CD-ROM package, for release in 1996. Interested users should contact Marc Beaudoin, the ELADA 21 Project Manager, Applications Division, CCRS; telephone

(613) 947-1257; fax (613) 947-1408; Internet: beaudoin@ccrs.emr.ca.

Index to Canadian World Wide Web Sites

Because the Canadian system is changing so quickly, it may be helpful for users to access a general index to Canadian World Wide Web sites. While this index contains all sites, not just those related to water, it may be a useful route to find Web sites developed after this paper goes to press. The index can be contacted at: http://www.csr.ists.ca/w3can/Welcome.html.

Summary

In summary, Canadian governments and researchers are only just beginning to use electronic media to communicate with each other and with the public. At the time of writing, we found an infrastructure which is skeletal at best, but which appears to be evolving quickly. By press time, however, this situation may have changed significantly.

In terms of information sources, we found a reasonable index to federal and provincial agencies, with more detailed sources (experts with phone numbers; report titles, and so on) at some locations. There is considerable listing of documents already in print, particularly environmental guidelines and procedures and the results of environmental tribunal hearings; some of these documents are also available on-line. Presumably this sort of textual information dominates because it is more straightforward to transfer to a Web page than, say, GIS "metadata." A few research groups are beginning to use the Internet to communicate among themselves and without outside groups, and we anticipate that this number will grow quickly. Much more information--although still a tiny fraction of the total available--is accessible in CD-ROM format; it may only be a matter of time before this is also available on-line.

By far the farthest advanced in information technology application was the remote sensing/GIS community. A vast amount of satellite information, much applicable to water management, is now available on-line, including "quick look" services so potential users can pre-screen information. At present, much of this data is maps and images, but some commentary and data are also available.

In preparing this paper, we found that although the bare bones of an electronic information system are in place, the support system is weak indeed. Telephone calls to the information desks of major federal departments caused confusion: did they have such a service? who might know about it? Even a student who worked with Environment Canada to set up their World Wide Web pages had difficulty finding information once it was on the system! Throughout this paper we have therefore provided the names, telephone numbers, and fax numbers of knowledgeable contacts, in addition to Internet or World Wide Web addresses.

We presume that these are growing pains that will soon be worked out. Once we reached the appropriate contacts, we found considerable enthusiasm and strong commitment at staff and managerial levels, particularly in the federal government and in certain provincial governments, to "talk" to the community on-line. With that level of commitment, the reality of a user-friendly information system should soon follow.

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