Geographic Information Systems Seminar

The Coming of a New Decade - What have we learned from the '80s?

September 1990

Ontario

Ministry of Natural Resources

THE CANADIAN INSTITUTE OF SURVEYING AND MAPPING

ASSOCIATION CANADIENNE DES SCIENCES GÉODÉSIQUES ET CARTOGRAPHIQUES

Intentionally
Blank
Page

Geographic Information Systems Seminar

The Coming of a New Decade - What have we learned from the '80s?

September 20 - 21, 1990

Co-Sponsored by
The Ministry of Natural Resources
Canadian Institute of Surveying and Mapping

Ontario
Ministry of Natural Resources

THE CANADIAN INSTITUTE OF SURVEYING AND MAPPING

ASSOCIATION CANADIENNE DES SCIENCES GÉODÉSIQUES ET CARTOGRAPHIQUES

FOREWORD

This year's GIS Seminar, hosted for many years by the Ministry of Natural Resources, was co-sponsored by the Canadian Institute of Surveying and Mapping. We felt that it was appropriate at this stage of the development of GIS activities in Ontario to invite a national learned society to co-host this important event.

The end of the current decade and the beginning of the decade of the '90s is approaching rapidly. We felt, therefore, that this year's seminar should reflect on our experience in the '80s and provide direction for the '90s. Hence, the theme of our seminar, "The Coming of a New Decade, What Have We Learned From the '80s?".

The keynote speaker, Dr Michael Goodchild, provided an excellent perspective of the past developments in GIS technology, hopes and aspirations of the GIS community as well as a clear vision of a bright and challenging future.

Other speakers shared their practical experiences and projected them into the future.

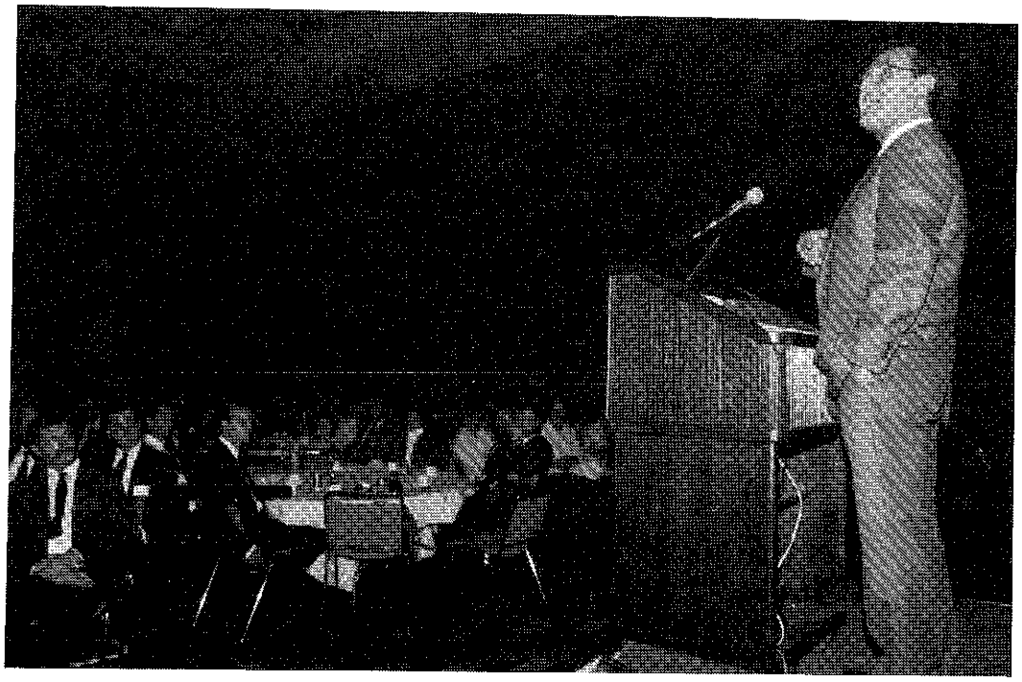
Oral presentations were supplemented by forty exhibits displaying the latest in GIS technology. This was the largest number of exhibitors every displayed at the MNR GIS seminars. It is an indication of the growth in this relatively new field.

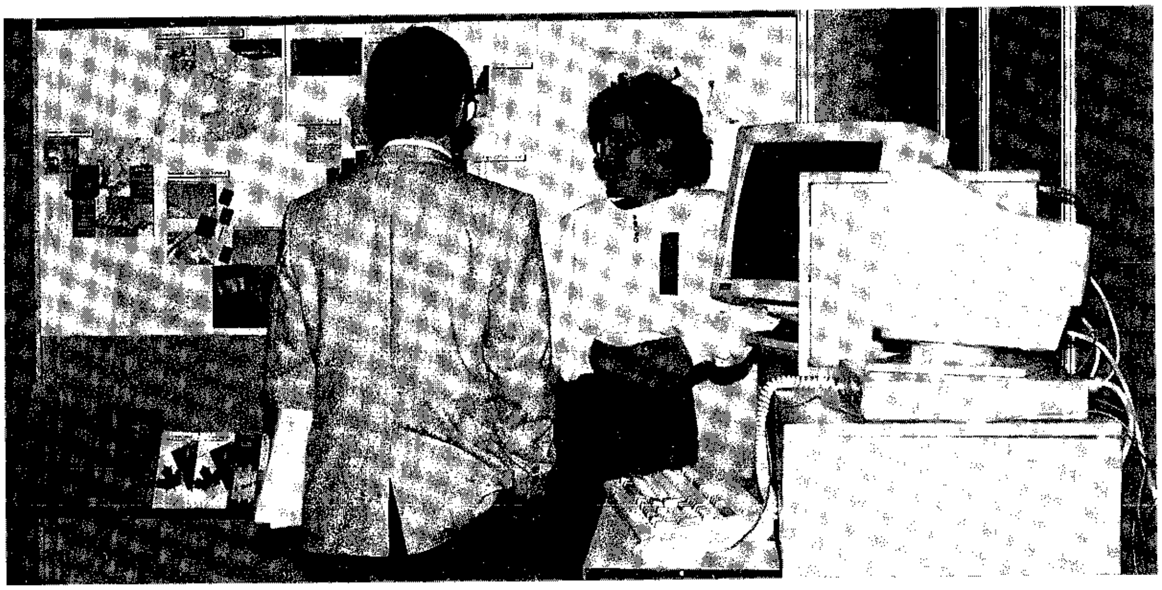
Amongst the highlights of the Seminar was the presentation by Stephen Lewis who received a standing ovation for his discourse on the plight of the children of this world and his compassionate appeal for something to be done about it. No doubt many in the audience left the seminar thinking about the potential of GIS to alleviate some of the conditions that have led to the disease and hunger that plague the children of the Third World countries.

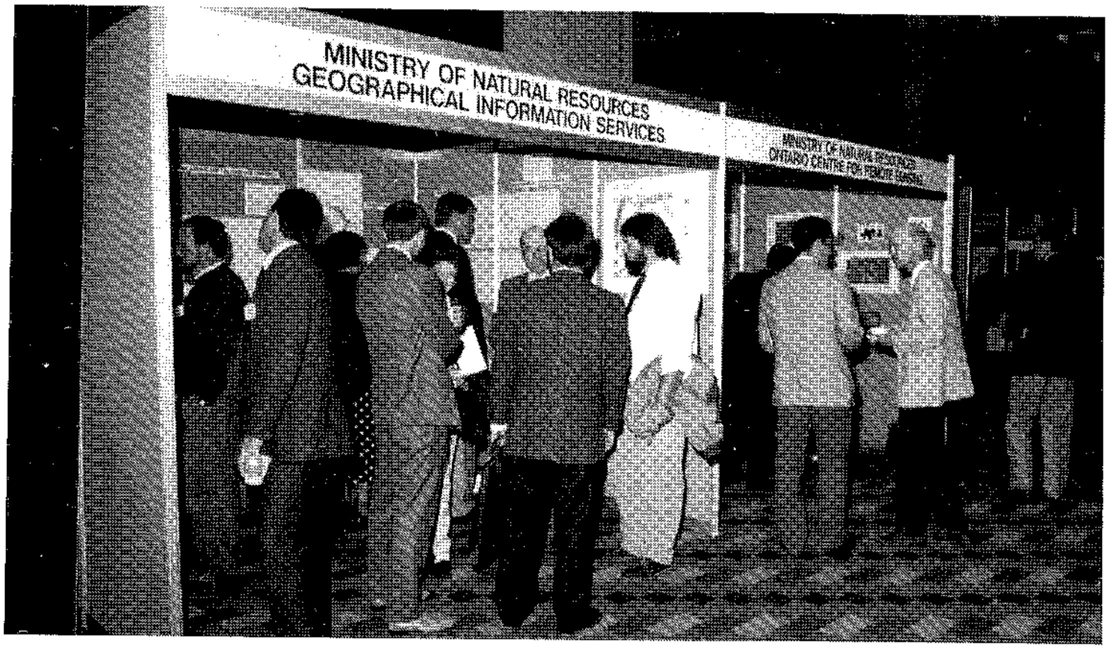
In keeping with its mandate to provide leadership and direction in the development of GIS in Ontario, the Surveys, Mapping and Remote Sensing Branch has for many years continued to provide this forum where delegates can come, hear about and see the latest in GIS developments and what is happening with respect to provincial GIS systems and standards. The Ministry pays close attention to what is said at these Seminars, often taking direction from issues raised. That is why it is so important at the beginning of an new decade to stop, look back for a moment and take stock of what we collectively have learned from the past in order that we might jointly plot our course for the future.

We trust as you review these proceedings you will gain a wealth of knowledge from the experiences described and as well some food for thought on the direction GIS development should be heading in your organization. The Ministry of Natural Resources and the Canadian Institute of Surveying and Mapping are indeed grateful to those who have participated in this Seminar and have willingly shared their knowledge and experience with us all, as well as to all those who have devoted so much energy and effort in organizing this seminar.

Dr J.M. Zarzycki, F.C.A.E., P.Eng.
Director
Surveys, Mapping and Remote Sensing Branch






MINISTRY OF NATURAL RESOURCES
GEOGRAPHICAL INFORMATION SERVICES


ONTARIO CENTRE FOR
REMOTE SENSING
DATA INTEGRATION


PAMAP

TABLE OF CONTENTS

THURSDAY MORNING SESSION, 20th SEPTEMBER 1990

INTRODUCTION OF DEPUTY MINISTER
MINISTRY OF NATURAL RESOURCES

DR J.M. ZARZYCKI
Director, Surveys, Mapping and Remote Sensing Branch
Ministry of Natural Resources

Good morning, Ladies and Gentlemen.

Sorry for the delay in starting this morning, unfortunately, we had some problems with the technology at the registration desk.

I would like to welcome you all and extend a particular welcome to all of those who have come from far away places. I understand that we have people here from five continents.

It was our intention to have the Minister of Natural Resources open the seminar this year. However, as a result of a change in government, due to our recent provincial election, a Minister has not yet been appointed. We are, however, very fortunate to have with us the Deputy Minister of Natural Resources, Mr George Tough, who has agreed to open the seminar.

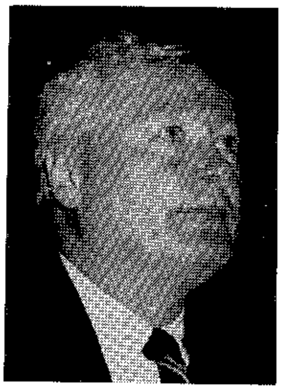
Mr Tough has a B.A. degree in Geography from the University of Western Ontario, where he was a gold medallist, and also an M.A. in Resource Geography from the University of Calgary. He has over twenty years' experience in government. And since 1987 has been the Deputy Minister of the Ministry of Natural Resources in Ontario. Prior to his current position, he was Deputy Minster of Northern Development and Mines.

Before that he was with the Federal government as Assistant Deputy Minister of the Federal Department of Finance, from 1983 to 1985. From 1970 to 1983, Mr Tough was an Assistant Deputy Minister in the Federal Department of Energy, Mines and Resources. Prior to that, he was policy analyst for the Department of Energy, Mines and Resources, and in 1973, he was seconded to the Ford Foundation and spent more than two years in Botswana as advisor to the government in their mineral policy.

Mr Tough is a great supporter of GIS. Not only in words, but also in deeds. I can attest to that as my GIS budget has survived many of the financial constraints imposed on other government programs. He appreciates very much the importance and the value of GIS to our own Ministry and to the Government of Ontario as a whole.

Ladies and gentlemen, please welcome Mr Tough.

OFFICIAL WELCOME



GEORGE TOUGH
Deputy Minister
Ministry of Natural Resources

Good morning, ladies and gentlemen. Welcome to the Ministry of Natural Resources' 1990 GIS Seminar.

I want to extend a special welcome to those of you from out of town and indeed, from outside Canada. Your presence indicates the truly international scope of Geographic Information Systems - and it also says something about the relevance of the seminar program. It would be difficult to find another area in resource management that has grown as quickly as GIS. The incredible part of it is that there is still such enormous potential for growth. I think the papers at this year's seminar give some indication of that potential, and represent a good cross-section of the exciting applications now being developed.

I think the seminar theme this year is very appropriate. In the GIS field, just as in others that are growing quickly, it's important to pause for a moment and look back on where we have been. It's equally vital to assess where we are - and where we are going. I would like to borrow the seminar theme for my remarks, and talk for a few minutes about what I hope we have learned from the 1980s, and what the major challenges of the '90s are likely to be. Let me start with some of the major trends that emerged during the 1980s.

The most significant trend has been the growing public concern about the environment. A Gallup poll released in July found that 95 per cent of Canadians are concerned about the state of the environment. Of those surveyed, almost three-quarters said they were "very concerned." Throughout the 1980s, growing environmental concern led an increasing number of people to get involved in environmental issues. In 1982, there were about 200 environmental organizations in North America. Just seven years later, in 1989, there were more than 4000. Another trend we saw during the 1980s was people growing increasingly sceptical of institutions, including government - in fact, of professionals and experts in general.

Throughout the 1980s in the resource-management area, we saw increasing competition among resource users, as well as closer links between natural resources and the environment in general. As a result, the public, which was concerned and well-informed about environmental issues, demanded greater involvement in decisions made about resources. Over the past decade, the Ministry of Natural Resources came under increasing pressure to justify our policies and programs - both to specific resource user groups and the general public.

In some cases, we were told to do more - and we heard calls for more enforcement of hunting and fishing regulations, as well as more control over land-use planning on Crown land. In other cases, we were told either to do less, or to do something different - and we heard frequent calls for better policies, programs and resource management decisions. MNR, as you know, is responsible for managing Ontario's resource base - its forests, fisheries, wildlife, provincial parks, Crown land and water and some minerals. Our mandate embraces conservation and protection of resources. It also requires us to manage the development of the province's resources in ways that are environmentally sensitive and sustainable, and socially and economically beneficial.

During the 1980s, meeting this mandate become more complex and required greater comprehensiveness on our part. Looking back, I believe we came a long way. We moved from managing individual resources, such as trees, animals and fish, in isolation, toward managing all natural resources as interdependent elements of complex ecosystems.

One of the turning points of the 1980s was the publication of "Our Common Future," the final report of the Brundtland Commission on the world environment. Ever since that document appeared, the Ministry has been coming to terms with the concept of sustainable development - which means managing resources so that the needs of the present are met, without compromising the ability of future generations to meet their needs. We see sustainable development as a cornerstone of our strategic directions for the '90s - and we are continually coming to grips with it practical implications.

The combination of changing public attitudes, increasing pressure on resources and tighter budgets has made the jobs of resource managers much more challenging. And the context within which we do business is much different today than it was 10 years ago. What has not changed is the Ministry's commitment to excellence in serving the public, and maintaining our role as Ontario's lead conservation agency, and chief steward of the province's natural resources.

What about the 1990s? Clearly, the biggest challenge facing the Ministry over the next decade is to develop new policies, programs and practices that enable us to manage Ontario's resource base in an environmentally sustainable way. Sustainable development, as I said, is our focal point - but achieving it will require dealing with many other related challenges.

As we develop our new policies and programs, for example, we will need to be more precise about what we are trying to achieve, and how we plan to go about it. Our policies and programs will need to be better integrated, and more precisely targeted, to respond to the needs of the public, and to the demands of the resource base. We also face some major challenges in closing gaps in our knowledge.

In the decade ahead, the Ministry's effectiveness will depend to a great extend on having the right kind of information, and being able to use it to generate acceptable options for sustainable resource development. We will need to satisfy a concerned public that our resource management activities are based on a sound analysis of high-quality data. The challenge for us here will be not only to improve the quality of our information, but also to enhance our ability to use it effectively. We must also ensure that others can get access to it in user-friendly ways, so that they can participate in meaningful ways in decisions that affect their interests.

Over the last decade, we heard a lot about the Information Age, and how computers were going to transform our lives. And I think it's fair to say that at least some of these predictions have started to come true. Computers have been a tremendous boon to society. They have made it possible to generate new kinds of information - to make complex comparisons and projections that were simply not feasible only a few years ago. GIS technology is a good case in point. To the non-specialist, the whole notion of satellite-based digital cartography, land-related digital databases, and the other high-tech tools associated with GIS can be just as overwhelming as it is exciting. The technology is, after all, highly complex - and so are the uses to which people are putting it. Ontario has established a leadership position in the development of GIS technology, including leadership in its practical applications.

I believe MNR's GIS development work has been right on track. It has struck an exemplary balance between theoretical development and practical application. The Ministry's goal for the 1990s will be to achieve sustainable development of the province's natural resources, for the benefit of all the people of Ontario. That means our decision-making process must give full consideration to the wide range of environmental, social and economic demands and values placed on Ontario's resources. To achieve this large - and very ambitions - goal, we will pursue three strategies.

One strategy is to intensify our policy of working with others to accomplish effective resource management. We must form more partnerships in which the decision-making process and the available knowledge about the resources are shared. To realize the full potential of partnerships, we must, for example, be able to share digital information in the course of conducting business with groups we work with. This is already being experienced with certain forest industries who have used GIS to automate the Timber Management Planning process and want to submit their results in digital form. Unfortunately, we do not have the capability at present to receive and use it. Of course, partnerships are not new to MNR - but the Ministry must develop an even wider range of working relationships, and involve key user groups, agencies, communities and individuals more fully in the resource management decisions that affect them.

The second strategy required to achieve the sustainable development goal is to establish adequate values for resources, based on the full range of benefits they provide. Well-defined resource values will help us set priorities for using or conserving resources. Resource values will also help us allocate where and how resources are used, and identify the real cost of protecting and renewing them. The possibility of this complex process succeeding, of course, depends heavily on the effective use of information technology.

The third strategy to achieve sustainable development is the enhancement of the information about, and the knowledge of, the resources we manage. It is here, as a tool for resource managers, that I believe GIS has a crucial role to play.

After all, the foundation for all the Ministry's resource information is Ontario's land base. That is why we are so fortunate to have the digital topographic reference system developed under our Ontario Basic Mapping program. A common geographic referencing system is vital to our ability to describe what's on the land, and to attach attributes about the land to particular points.

It is clear that, to meet the challenges of the 1990s, the Ministry will need a sophisticated GIS, one that not only can store, analyze and manipulate data, but also access and share information with databases at other resource agencies and clients. Over the next few years, we will need to build fully integrated databases, with high-quality information drawn from many disciplines, and many different sources.

During the 1990s, we will need to exploit GIS' potential more fully, because I believe it will become an indispensable tool for resource managers throughout our organization. The high priority we will place on acquiring and managing information in the future was reflected in the Ministry reorganization announced a few weeks ago. The organization structure now contains the new position of assistant deputy minister, natural resources information. The individual selected for that position will head up a division that brings all of MNR's information and knowledge functions under the same umbrella. The challenge for this division will be to bring the Ministry's information systems to the forefront of technology - and to ensure that all resource information databases are fully integrated and accessible to all users. One of the division's priorities will be to bring the tremendous potential of GIS out of the laboratory, so to speak, and into daily life at MNR and elsewhere.

But that is only part of the story. Improved ability to manage information is also vital to the administrative functioning of our highly-regionalized Ministry. As you can see, the 1990s promise to be an exciting period for the Ministry, and particularly for the staff in our new information division.

Over the next two days, you will hear presentations from people who have worked out some interesting and practical GIS applications. This work is important, because as I have said, we need to begin tapping into the technology's tremendous potential. The great value of a seminar such as this is that hundreds of people in related fields, people who may work independently for most of the year, suddenly come together, and are exposed to a broad spectrum of new perspectives. They compare notes, and share experiences. And they engage in the kind of dialogue that pushes the practical applications of the technology forward.

I know that this year's seminar will stimulate that kind of progress, and I hope that you have an enjoyable and very productive two days.

CHAIRMAN ZARZYCKI: Thank you very much, Deputy, for your very thoughtful remarks and for taking time off from your very busy schedule to be with us this morning. As you see from the program, this year's seminar is cosponsored by the Canadian Institute of Surveying and Mapping, and I'd like now to call on Tony Sani, who is the Toronto area Council, to say a few words.

WELCOME FROM CISM

TONY SANI
Provincial Councillor - Ontario Region
Canadian Institute of Surveying and Mapping

The Canadian Institute of Surveying and Mapping welcomes all members and delegates to the first jointly sponsored seminar with the Ontario Ministry of Natural Resources on Geographic Information Systems. This seminar provides the Institute with a forum to present leading-edge GIS applications and demonstrations to our members, as well as to providing an opportunity for discussing technology issues with vendors and consultants. In keeping with our policy on public awareness, the Institute has installed a booth in the exhibition area and all delegates are encouraged to visit this booth. To those of you who are not members of the Canadian Institute on Surveying and Mapping, we would welcome your participation as members and solicit your applications.

The Institute is a scientific and technical non-profit association of over 2500 members dedicated to advancing the development of surveying, mapping and related sciences in Canada, and promoting Canadian interests in these fields internationally. The Institute is comprised of branches, and the Toronto Branch serves approximately 600 members in Metropolitan Toronto and the greater part of Ontario excluding the Ottawa-Carleton Area. This Branch will be hosting a General Meeting in the coming months and all are welcome to attend. Details of this meeting are available at the booth.

At this time, on behalf of the Canadian Institute on Surveying and Mapping, I would like to express a word of thanks to the Ontario Ministry of Natural Resources for providing the Institute with the opportunity to co-host this year's seminar.

CHAIRMAN ZARZYCKI: Thank you, Tony.

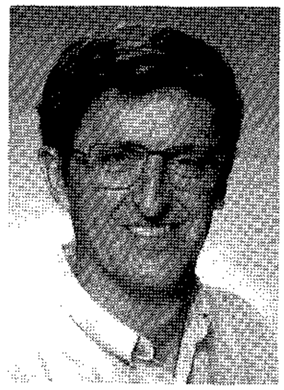
I would now like to introduce Dr Goodchild, our keynote speaker. Dr Goodchild received his

B.A. in Physics from the University of Cambridge in 1965 and his Ph.D. from McMaster University in 1969. He taught at the University of Western Ontario for 19 years, and moved to his present position of Professor of Geography, University of California, Santa Barbara, in July 1988.

He is currently Co-Director of the NSF-Funded National Centre for Geographic Information and Analysis. His research interests focus on the generic issues of geographic information, including accuracy and the modelling of uncertainty, the design of spatial decision support systems, the development of methods of spatial analysis and data structures for global GIS.

Ladies and gentlemen, please welcome our keynote speaker, Dr Goodchild.

KEYNOTE SPEAKER
GEOGRAPHIC INFORMATION SYSTEMS -
WHAT HAVE WE LEARNED FROM THE 1980s?



MICHAEL F. GOODCHILD
National Center for Geographic Information and Analysis
University of California, Santa Barbara, CA, USA

Introduction
The GIS boom that began in the early 1980s is still accelerating. New vendors are entering the market with new and exciting products, education and training programs are proliferating, the GIS software industry is reporting growth rates in excess of 40%, new textbooks and magazines are appearing, and GIS technology continues to find new applications and new acceptance. All the same, 1990 seems an appropriate time to reflect on where we have come, and where we are going. The 1980s were years of unprecedented economic growth, both in Western economies generally and in GIS, and it is clear that the resources that were available to fund this growth in the 1980s will be much harder to find in the new decade. The 1980s also saw unprecedented changes in computing hardware with the development of personal computing and the workstation. What have we learned from the 1980s, and how can we learn from retrospection as we enter the new decade? Where do we stand in GIS research, and what are the important items in the research agenda? What is the state if GIS education, and will it adapt to the demand for trained staff?

I would like to focus this presentation on four issues:
- Where are we now?
- Where are we going?
- Current deficiencies in GIS.
- Prospects for the future.

The emphasis in the paper will be on research and education, which are the primary objectives of the NCGIA. The Center was founded by the National Science Foundation in 1988 as a three-institution consortium of the University of California, Santa Barbara; the State University of New York at Buffalo; and the University of Maine. In research our primary goal is to address what we see as impediments to the successful adoption of GIS technology. These range from technical issues such as data models and data structures, through generic ones such as coping with uncertainty in data, to social problems such as the measurement of the benefits of GIS, and the impact of GIS on institutions. In education, our efforts are directed at increasing the supply of trained personnel in GIS, and the major focus to date has been the Core Curriculum Project, a set of teaching materials for a one-year university course sequence in GIS. More information about the Center can be obtained from the address above, or by contacting the Buffalo or Maine sites.

Where are we now?

The roots of GIS go back well into the 1960s, and we owe a great amount to the early Canadian efforts by the federal government, IBM Canada and others at that time to develop CGIS. In fact the system made a remarkable number of technical breakthroughs, including:

- the use of a scanner and raster/vector conversion
- the separation of attributes and spatial data
- representation of polygons by arcs
- chain code
- the use of Morton order for indexing.

But it wasn't until the late 1970s that GIS really began the period of rapid growth that continues today. Several developments allowed this to happen. On the hardware side, 1980 saw the introduction of the super-mini, a multi-user system with virtual memory management for around $200,000 and an ideal platform for a stand-alone, turnkey GIS. On the software side, 1980 saw the release of the first GIS to take advantage of a relational DBMS, providing enormous flexibility in the handling of relationships between spatial entities. Finally, 1980 saw the beginnings of the trend towards personal computing and the mass popularization of word processing and desktop publishing.

Ten years later, GIS is a large and growing industry. Estimates vary, but expenditures world-wide on GIS hardware, software and services are certainly in the billion-dollar range. But despite its growth, GIS is a remarkably diverse set of interests. Its applications range from resource management through urban infrastructure to emergency response, from political districting to forestry. It runs on platforms from the PC to the large mainframe. It includes an enormous range of software architectures, from the simple, self-contained raster systems such as GRASS and IDRISI to the large database managers such as IBM's

GFIS. Some vendors focus on a single platform, while others, notably ESRI, offer a single product over the full range from DOS to VM. The GIS community includes an extraordinary range of disciplines, from archaeology and landscape ecology through forestry to civil engineering and computer science. And there is as much variety in the definitions of the field. GIS is variously described as a spatial decision support system; a system for input, storage, analysis and output of geographic data; or a geographically referenced information system (to cite only three of the competing definitions). Finally there is LIS - is it the same as GIS, or is one a subset of the other, and if so, which?

But despite the diversity, there is evidence of convergence. The past few years have seen the emergence of several series of conferences aimed at the full GIS community. In the US, the annual GIS/LIS series sponsored by a consortium of five societies (AAG, ASPRS, ACSM, AM/FM and URISA) has grown quickly to over 3,000 attendees. In Canada, the Ottawa meetings in early March have been similarly successful. The lone textbook of 1986 by Peter Burrough (*Principles of GIS for Land Resources Assessment*, Oxford) has now been joined by several others (e.g. Aronoff's *GIS: A Management Perspective*, WDL, Ottawa; Star and Estes' *Introduction to GIS*, Prentice-Hall), and many more are on the way. New organizations have appeared, and the Association for Geographic Information (AGI) in the UK seems to be a particularly successful example. In many countries there have been efforts to develop national GIS policies, e.g. the UK's Chorley Report[1], and the US Department of the Interior's *Study of Land Information* (1989), although with mixed success. And new databases, such as the US Bureau of the Census's TIGER, have provided focus and impetus.

The GIS community seems to be converging not around a single, uniform software product (a standard GIS) or a single application, but around a set of generic issues that emerge from the technology[2]. Whatever the application or EDP solution, every user of GIS faces the same set of problems in dealing effectively with digital geographic data, and these problems in turn form the agenda for discussion at GIS meetings - the 'glue' of the GIS community. Some of the more prominent are:

[1] Department of the Environment (1987). *Handling Geographic Information: Report of the Committee of Enquiry chaired by Lord Chorley*. HMSO, London.

[2] Digital Cartographic Data Standards Task Force (1988). The proposed standard for digital cartographic data. *The American Cartographer* **15(1)**.

- data capture - how to convert data from raw to digital form in an efficient, cost-effective manner;
- data modelling - how to represent the infinite complexity of the real world in a discrete, digital machine - whether to use raster or vector, layers or objects, how to model complex objects;
- accuracy - how to cope with the uncertainty present to varying degrees in all geographical data;
- volume - how to deal with the fact that demands for geographical data will often exceed the space available for storage;
- access - how to design data structures, indexes and algorithms to provide rapid access to large volumes of geographic data;
- analysis - how to link GIS databases with advanced modelling capabilities;
- user interfaces - how to present the GIS database to the user in a friendly, comprehensible, readily used fashion;
- costs and benefits - how to measure the benefits of GIS information and compare them to the costs;
- impact on organizations - how to introduce GIS successfully into a complex organization.

All of these issues transcend the technology itself, and all of them in one way or another affect the technology's usefulness, whatever the application and whatever the platform. In recent years they have emerged in various guises as the basis of the research agendas of the NCGIA[3], URISA[4] and the UK Regional Research Laboratories (Masser[5] and Maguire[6]).

---

[3] NCGIA (1989). The research plan of the National Center for Geographic Information and Analysis. *International Journal of Geographical Information Systems* **3(2)**: 117-136.

[4] Craig, W.J. (1989). URISA's research agenda and the NCGIA. *Journal of the Urban and Regional Information Systems Association* **1(1)**: 7-16.

[5] Masser, I. (1990). The Regional Research Laboratory initiative: an update. *AGI Yearbook 1990.* Taylor and Francis, London: 259-263.

Once we begin to see the generic issues that underlie GIS, and transcend the particulars of its technology and its applications, then we can begin to understand how GIS can affect our view of the world. Traditionally, information about places on the earth's surface has been stored and transmitted in the form of maps, images, text and to some degree sound. The focus of early GIS was on the digital database as a store of maps - maps were the input, the output and the metaphor of GIS applications. But increasingly GIS is seen as a means of access not to maps but to the real world that those maps represent. The purpose of the database must be to inform the user accurately about the contents of the real world, not about the contents of a source document. A DEM, for example, should be assessed on its ability to return the elevation of any point on the earth's surface, not the position of an abstract contour line.

GIS has also affected the role of geographic information within an organization. It encourages the notion that geographic information is a commodity that flows through the organization, and that has a value determined by its accuracy, currency, accessibility etc. In fact it may be the central commodity in some organizations, for example forest resource management agencies. Geographic data needs careful planning and budgeting if it is to be collected and updated on a regular basis, and accessible to the organization's analysts and decision-makers. Finally, if information is important, then it is rational to use different types of information as the basis for the organization of departments and systems.

In summary, GIS in 1990 is a diverse collection of interests, software and hardware solutions, and applications. Two software products applied to the same problem (e.g. ESRI's ARC/INFO and IBM's GFIS applied to management of a utility company's facilities) would produce entirely different solutions; and the needs of forest resource management and school bus routing appear to have very little in common. But there is a growing sense that the issues that hold the GIS community together, and produce convergence rather than divergence, are the generic issues of dealing with geographic information - with representing it in a digital computer, and working effectively with it to produce answers to problems.

Where are we going?

First, the current growth of GIS shows no signs of abating and should continue for some

[6] Maguire, D.J. (1990). A research plan for GIS in the 1990s. *AGI Yearbook 1990.* Taylor and Francis, London: 267-277.

time into the 1990s. New magazines are appearing, and existing ones, such as *GIS World* and *Mapping Awareness*, are growing and increasing circulation. Conferences are numerous and successful, offering workshops on increasingly specialized topics and access to the latest vendor products. New software vendors are entering the market with exciting and innovative products. GIS is finding new applications and strengthening its penetration into existing markets. GIS courses are proliferating at universities and colleges, and are finding increasing interest from students anxious to acquire useful skills. Over 100 institutions participated in the testing phase of the NCGIA Core Curriculum Project, and over 250 have acquired the revised version of the materials to date.

On the other hand there are increasing signs of diversification, and this trend is likely to continue to strengthen in the next few years. GIS applications such as facilities management fall under the spatial information paradigm, whereas scientific and resource analysis applications fall under the spatial analysis paradigm. The former emphasizes the database and query aspects of GIS, whereas the latter tends to focus on modelling. The split is illustrated by the case of two Canadian companies - TYDAC and GeoVision - one marketing 'spatial analysis systems' with the very successful SPANS product, the other marketing 'geographic information systems'. Within the PC marketplace, there is increasing divergence between products aimed at GIS applications in resource management, facilities management, or market research (compare, for example, PAMAP, TYDAC's SPANS, Facility Mapping Systems' FMS/AC and Strategic Mapping's ATLAS*GIS).

This trend to diversification is appropriate and rational, as it matches software and platforms with different functions and applications. The complex modelling and analysis of resource management require a very different solution from intensive digitizing or the management of large facility inventories. In time, we can expect this trend to lead to more and more specialization within the GIS industry, as it becomes less and less possible to offer a single software solution for all platforms and all applications. One vendor may specialize in digitizing stations using PCs, another in database maintenance using large mainframes and terminals, another in spatial analysis using advanced personal workstations, and another in 3D applications.

There is an interesting analogy between the development of GIS and the history of communication. The written letter, an unstructured analog format, was first replaced by the highly structured digital telegraph, then by the unstructured analog telephone. Electronic mail, a highly structured digital format, is now in competition with relatively unstructured but digital FAX. Having spent the past three decades working to replace the unstructured, analog map with the digital GIS database, we are only now beginning to realize that there can be great value in combining other types of information, particularly unstructured images, text and even sound, with GIS. The multimedia GIS is already functioning in many highway maintenance organizations, where unstructured digital or NTSC images are linked with GPS-determined locations in a structured digital database, and multimedia GISs are also finding applications in resource management and marketing. In part this is a technical problem, as the software and hardware tools to manage multiple media have only recently become available, particularly in the Macintosh world. But it is also a conceptual problem, having to do with the role of the symbolic map in GIS thinking. If the GIS is a window on the world, then it makes sense to combine the view provided by its structured database with other media, whether digital or analog. We tend to see the structured GIS database as exclusive, and to know little about the relative value of other media.

In this and many areas the future of GIS will continue to be determined by developments in hardware. The cost per cycle will continue to drop in the next few years, as will the cost per megabyte of RAM. The 1990s will see the proliferation of 3D technology, as high performance graphics adapters become available for mass-produced workstations from vendors such as Silicon Graphics. The recent generation of workstations, typified by the IBM RS/6000, include 3D adapter options with display rates as high as 10^6 3D vectors per second, with polyhedral rendering capabilities, in a platform running at 25-45 MIPS. GIS will no longer be confined to the plane, and the DEM display capabilities of today will seem very primitive in a few years. It will become possible to model and visualize subsurface conditions, and to analyze distributions over the surface of the earth without the distortions and interruptions produced by conventional map projections. In 3D the map metaphor is completely inadequate, and the user interfaces for these systems will have to explore entirely new territory. How, for example, should a system allow the user to build knowledge of subsurface conditions from a variety of different types of evidence? In 2D this task of map compilation takes place on paper, but in 3D it can only take place in the abstract domain of the digital database. What tools does a user need to explore a model of the subsurface once it has been built? What icons should be provided in an appropriate user interface?

If GIS has been dominated by the map, then fundamental changes now occurring in mapping will have significant effects in the coming decade. Low-cost GPS receivers are already available with higher accuracy than the base mapping available over most of North America (1:100,000, 1:24,000 in the Continental US), and provide a significantly cheaper method of primary data collection for many mapping activities. GPS is already being used to map road and rail networks, and to track vehicle movements. At the same time the funds available to support large, public-sector mapping programs are diminishing. In this new environment it is vital that the public agencies adopt a lead role in coordinating research and education programs, in ensuring the health and vitality of the GIS industry, and in defining standards of data quality, data formats etc.

What is deficient?

It is becoming increasingly impossible for any one vendor to be all things to all GIS users - to offer one product on all platforms, under all operating systems, as a solution to all applications. One way to view specialization in the GIS industry is in terms of three measures: functionality, capacity, and accessibility. Ideally, a GIS should offer a wide range of forms of spatial analysis and manipulation on a large and accurate database, and provide responses immediately. In practice, these objectives conflict. Fast access to large databases is feasible only if the number of possible operations is severely limited, and systems that offer complex modelling and analysis often restrict capacity. In GIS there is no limit either to functionality or to capacity, since users will always find reasons for more.

If the future of GIS lies in specialization, then the key to success will be standards. Encouraging progress is being made in data exchange formats (e.g. USGS's SDTS, DMA's DIGEST), and in standardizing terminology (DCDSTF 1988). But terminology is notoriously difficult to standardize, and there is little indication to date that the proposed term for the common boundary between two polygons ('chain') will replace those in current usage ('arc', 'segment', 'edge' etc.). It is also difficult to standardize when the central concepts of GIS are so poorly articulated. Key terms such as 'raster' and 'vector', 'object' and 'layer' need to be standardized if we are to develop a well-defined set of data models. Standards are needed for data sources, particularly in describing quality, and for user interfaces. However the diversity of the GIS community makes the development of standards difficult. For example, the needs of the US Bureau of the Census in a street network database are very different from those of the vehicle navigation industry, or the emergency response community.

To date, the major success of GIS has been in capturing and inventorying the features of the earth's surface, particularly as represented on maps, and in supporting simple queries.

There has been much less success in making effective use of GIS's capabilities for more sophisticated analysis and modelling. It is hard to find examples of insights gained through the use of GIS, or discoveries made about the real world. GIS has not yet found widespread application in the solution of major social problems - disaster management, environmental quality, global issues or health. In part this comment is unfair, because such insights would be next to impossible to document. In part the reason is commercial - the market for GIS as an information management tool is far larger than that for spatial analysis, and vendors have invested relatively little in developing and promoting analytic and modelling capabilities. And although GIS is a major improvement, it is still difficult to collect, display and analyze data in geographical perspective. Finally, Couclelis[7] has made the point that the current generation of GIS concentrates on a static view of a space occupied by passive objects, and offers little in support of a more humanistic view of dynamic interactions.

Prospects for the future

In this last section I would like to offer two contrasting views of GIS in the 1990s. The first is negative and the second positive, and my guess is that the second will prevail. However there are actions we can take to strengthen the odds.

In the negative view, GIS will fragment and disappear, and by the end of the decade will be nothing but a memory. Geographers often draw a parallel between GIS and the introduction of quantitative methods to geography in the late 1960s, and comment on the lack of interest in quantification, at least in human geography, in the 1980s. GIS will fragment because it is too loose to hold together, and because the 'glue' is too weak and abstract. Users of IBM's GFIS, Intergraph's TIGRIS and Map/Info will cease to see any reason to attend the same conferences. The consortium of five organizations responsible for GIS/LIS will break up and each will concentrate on its own agenda. GIS will be seen as the Edsel of EDP, too awkward and expensive except in some specialized applications.

In the positive view, the GIS consortium will continue to converge. A constant supply of better tools seems assured, particularly in computing speed, software integration, network communication, graphics and storage capacity. The infrastructure of the GIS community will continue to improve, with better magazines, organizations, textbooks, meetings, and all

[7] Couclelis, H. (1989). Geographically informed planning: requirements for a planning-relevant GIS. Presented to the North American meetings of the Regional Science Association, Santa Barbara, November.

of the symbols of an emerging specialty. Less assured is a constant supply of new players in the industry, since the pattern has been that new players are the source of a disproportionate share of technological innovation. New players bring new ideas to the industry, such as Prime/Wild with System/9, Small World, or ATLAS*GIS.

In the positive view, the public agencies will promote and develop standards for data exchange formats, structures, models, and data quality. Training and education programs will develop through cooperation between vendors and institutions, and lead to the emergence of a strong set of core concepts. Funds will be available through cooperative agreements to support the development of teaching facilities, and to ensure that these keep pace with developments in the technology.

The results of research currently under way will emerge in improved products. Of particular significance will be:

- data models to handle 3D and time dependence, and complex interactions between objects
- support for complex analytic applications, including tracking of data lineage, tools for visual interaction with the stages in the analysis process, propagation of uncertainty
- support for quality assurance and quality control (QA/QC) especially in GIS applications where litigation is a constant problem
- support for multiple media - unstructured images, both digital and NTSC, text and sound
- integration of GIS with the capabilities of GPS for data collection and compilation
- tools for visualizing 3D and time-dependent data
- tools for data compilation, particularly in 3D
- improved techniques for conducting functional requirements studies, evaluating costs and benefits, benchmarking and other aspects of the GIS acquisition and project management process.

Finally, the GIS community will converge around a common concern not only for the technology of GIS, but more importantly for the common issues that transcend the technology and pervade all of its applications. GIS can survive by constantly developing new and exciting capabilities, or by constantly finding new applications, but the really fundamental issues in GIS are those that are common to all users of geographic information - how to capture a complex and dynamic world in a digital database and provide access to it in a useful, accurate and cost-effective manner.

CHAIRMAN ZARZYCKI: Thank you very much, Mike, for that very stimulating speech.

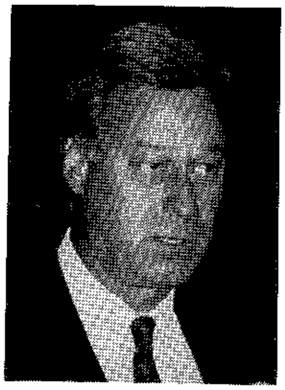
Ladies and gentlemen, we will now break for coffee and an opportunity to see the exhibits which are set up in Rooms 105 and 106 down the hall. Please be back here at 11:00 sharp.

CHAIRMAN ZARZYCKI: Welcome back. The Chairman for the remainder of this morning's session is my boss, Ron Vrancart, the Executive Coordinator, Lands and Waters Group, Ministry of Natural Resources. A wide range of provincial activities fall within Ron's jurisdiction including but not limited to: the management of crown lands and waters, the disposition and acquisition of public lands, mineral aggregates and fuel mineral management, policy and financial assistance to conservation authorities, surveying, land-related geographical referencing, mapping, remote sensing and other high tech computer applications as well as matters relating to Indian Land Claim and Resource Issues.

Ron received his B.A. in 1965 from the University of Western Ontario where he majored in geography. He subsequently received a diploma in town and regional planning from the University of Toronto and his master's degree in town planning for the University of London.

Ron has been with the provincial government since 1969. His career has spanned a broad range of activities including a series of management and executive positions in the lands and waters and outdoor recreation programs. He was Director of the Niagara Escarpment Commission ... has lectured on urban planning as well as conservation and recreation planning ... been with management board ... and just prior to returning to MNR was Executive Director of the Planning and Administrative Division in Northern Development and Mines.

THURSDAY MORNING, 2ND SESSION, 20 SEPTEMBER 1990



SESSION CHAIRMAN

R.J. (RON) VRANCART
Executive Coordinator, Lands and Waters Group
Ministry of Natural Resources

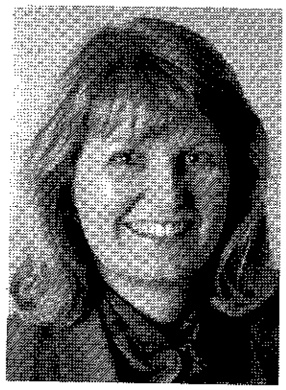
DR ZARZYCKI: Good morning, Ladies and Gentlemen. It would appear, Mr Vrancart, your Chairman for the Second Session, has been called to the telephone, so I shall stand in.

Our next speaker is Gabriella Zillmer. Gabriella is currently the General Manager of the Geographical Information Services Section at the Ministry of Natural Resources. In this position she is responsible for the Ontario Basic Mapping Programme, the Provincial Digital Topographic Data Base, GIS applications and Technology Transfer, Topographic and Thematic Mapping. Gabriella has certificates in both Industrial Relations and Public Administration as well as an Honours degree in Geography from Queen's University. Gabriella started with the Ministry of Natural Resources in 1981 as a Research Technologist. In 1983 she became a Land-Related Information System Analyst and Technologist subsequently playing a key role in:

- the Provincial/Municipal LRIS User Needs Study,
- the creation of digital mapping specifications for Ontario Basic Maps,
- the development and monitoring of a series of pilot projects involving the Provincial and Federal Governments and several Ontario Municipalities ... and
- the design and creation of the Provincial Digital Topographic Data Base.

From 1987 to 1988, prior to becoming General Manager, Gabriella was the Manager GIS Applications and Technology Transfer during which time she was project manager for several GIS projects and worked on a large and varied group of GIS applications. Gabriella hardly needs an introduction as she is so well known in the field of GIS having written many papers and given hundreds of presentations on different aspects of the subject. Ladies and Gentlemen please welcome Gabriella Zillmer.

UPDATE ON MNR'S GIS ACTIVITIES



GABRIELLA ZILLMER
General Manager - Geographical Information Services
Ministry of Natural Resources

The purpose of my paper is to summarize GIS activities within the Ontario Ministry of Natural Resources (MNR). I will be examining GIS standards, data bases, projects and other related activities and I will conclude my paper by tying in to the theme of this conference, "The Coming of a New Decade: What Have We Learned from the '80s". In fact, I will take the liberty of going back to "What Have We Learned from the 70s" as my starting point.

The MNR was involved in GIS activities long before acquiring any GIS hardware or software. In the early 1970s, the Government Committee on Productivity recognized the need for common geographical referencing standards for all government ministries and agencies and recommended that the MNR provide leadership in the development of a comprehensive geographical referencing system for Ontario.

This geographical referencing system forms the foundation on which GIS tools can be used most efficiently. The Interministerial Committee on Geographical Referencing (ICOGR) was formed and proceeded to develop several standards that have been endorsed and adopted by all government ministries and agencies. These include:

1. The adoption of the Universal Transverse Mercator (UTM) projection system as the official provincial referencing grid for Ontario.

2. The establishment of a grid referencing system based on the UTM.

3. The development and publication of control survey specifications (OS '79) and guidelines (OG '79).

4. The establishment of the Control Survey Information Exchange (COSINE) data bank which stores horizontal control information for the province.

5. The development of the MANOR adjustment program which is to be used in conjunction with COSINE.

6. The development and publication of digital mapping specifications.

7. The adoption of feature coding standards.

8. The development of the Map Data Interchange Format (MDIF) which is currently being tested.

9. The design and implementation of the Ontario Basic Mapping (OBM) system.

All of these standards were developed through the 80s and the process of establishing them has created a wealth of knowledge and understanding of geographic information and associated technologies that can be carried into our work of the 90s.

The MNR will continue to live up to its responsibility to administer and/or maintain these standards and will identify and develop, through ICOGR, any new standards that are required. Further information can be obtained about any one of these standards through the Surveys, Mapping and Remote Sensing (SMRS) Branch.

While all of the standards provide the foundation for GIS activities in Ontario, the Ontario Basic Mapping (OBM) program provides a product key to data integration. The OBM map (either in digital or hard copy form) facilitates the integration of various themes of data that are required for decision making. If everyone who generates data references it to the OBM common base, users will be able to easily integrate data from a variety of sources and incorporate this information into automated GIS models which are, in turn, applied to decision making.

THE DATA BASES

Ontario Basic Mapping Program

The OBM program produces the Digital Topographic Data Base (DTDB) for Ontario. This data is based on the UTM projection system and provides both a hard copy and a digital product. At medium scales, the mapping is compiled from 1:50 000 scale photography in Northern Ontario and 1:30 000 scale photography in Southern Ontario. This permits the creation of 1:20 000 scale hardcopy maps in the north and 1:10 000 scale hardcopy maps in the south. The map content includes hydrographic features such as lakes, rivers and marshes, cultural features such as roads, railways, power lines and buildings and the digital elevation model (DEM). The DEM data is used to generate the contours on the hard copy product but, more importantly, can be used in digital form for a variety of applications including generating perspective views, slope analysis, etc. John Houweling will be expanding on the DEM data and some of its applications in his presentation this afternoon.

The OBM program also provides municipal mapping at a scale of 1:2000 in hard copy. This mapping is compiled from 1:6000 or 1:8000 scales of photography and is cost shared with the local municipalities.

The OBM began as a conventional mapping program in 1978 and became 100% digital in 1986. The MNR is committed to completing the populated and resource development areas of the province by 1997. Data is available in hard copy form through the MNR Public Information Centre (PIC) or in digital form through Barry Costello, Manager Topographic Data Base. Figure 1 indicates the current status of data availability.

Forest Resource Inventory

Another data base activity within the MNR that is GIS related is the digital compilation of the Forest Resource Inventory (FRI). The FRI is an integral data theme required for a number of GIS applications in resource management. It has existed in hard copy form for at least 40 years but is now also being automated. The 80s saw the completion of the automation of all tabular records associated with the FRI and the beginning of automation of the spatial component of the inventory.

The FRI describes the forested areas of the province in terms of tree species composition, age, height, stocking and site class and is referenced to the OBM base. The FRI is used for forest protection planning, silvicultural planning, forest access planning and other forest management related activities by forestry specialists within MNR. It is also used by land use planners and wildlife managers for such applications as determining wildlife habitats. Figure 2 depicts the current status of digital data availability for the FRI since production began in 1987. For further information on the FRI products, contact Mr. Joe Kapron, Supervisor, Forest Geographic Information Management Unit.

THE MNR PROJECTS

The 80s held many unanswered questions about GIS technology which gave rise to the need for projects that further explored it. It was hoped that further research could give us a better handle on the utility of GIS as a resource management tool as well as a better understanding of a possible implementation strategy for this technology.

MNR projects that were started in the 1980s in GIS include the Model District GIS Project taking place in Cambridge and Timmins Districts and the Forest Management Decision Support Systems (FMDSS) or Plonski project taking place in the Plonski Forest of Kirkland Lake District.

The Model District GIS Project

The Model District GIS Project was established to develop a GIS to support integrated resources management in a typical northern and southern Ontario MNR district. Specifically, the objectives are to:

1. Improve:
   - customer service
   - accessibility to resource information
   - decision making
2. Demonstrate:
   - District GIS applications and continue to advance MNR's knowledge of these applications
3. Evaluate:
   - the benefits and potential for MNR in using GIS technology by establishing this project as a benchmark
   - mechanisms for sharing digital resource data
   - the implications to MNR of adopting GIS technology

Figure 3 summarizes the major emphasis of each of the three years in the project and also provides an overview of the successes and problems encountered to date.

The project began in 1988. The 1988/89 year was focused on hardware and software acquisition, data preparation and receipt of the OBM and FRI data bases. All equipment and software was installed and appropriate project management staff were hired. The preparation of data for digitization commenced. This effort was largely geared towards

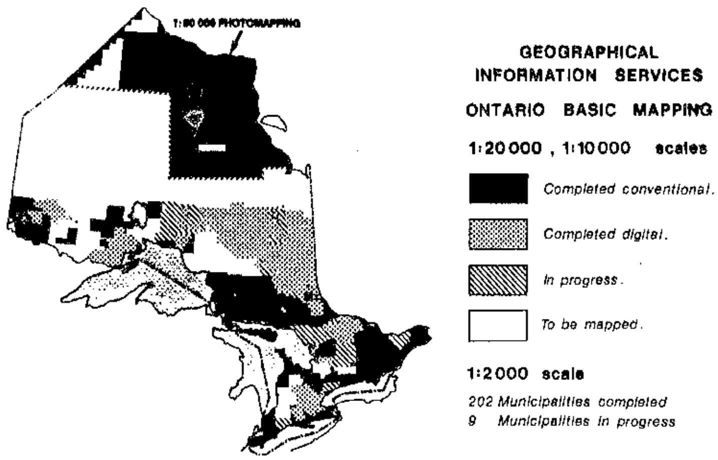


Fig. 1

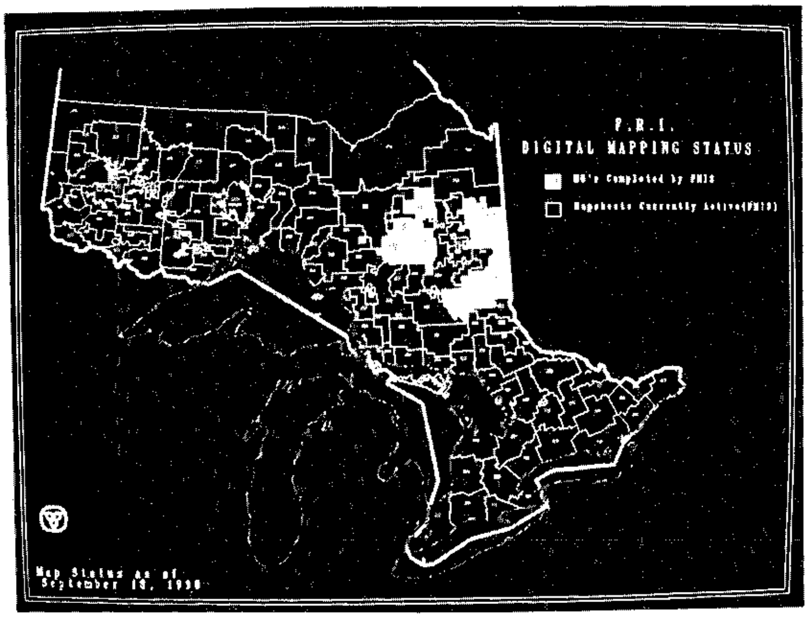


Fig. 2

Fig. 3

PROJECT STATUS

	1988 - 1989	1989-1990	1990-1991
EMPHASIS/ THRUST	• hardware & software • data preparation • receipt of OBM & FRI	• data input • completion of Benefits Measurement Plan (BMP) • conduct time studies for BMP	• application development • evaluation period • document results • technology transfer
SUCCESSES	• all equipment installed • appropriate staff hired	• cost of digitizing is less than anticipated • opportunity to review district data • identifying information needs for MNR • identifying policy issues re: digital data • time studies underway	• completion of data output
PROBLEMS	• delayed approval/$ • delayed hardware & software delivers	• staff turnover • data quality is poor • lack of policies & standards hinder • not all digitization completed	• carryover of digitization • evaluation and documentation carried over to six months beyond applications development

transcribing mapped resource data to the OBM base and reviewing the quality of current district data, both tabular and spatial. These tasks were accomplished in spite of delayed project approval, delayed funding and delayed hardware and software deliveries. The second year of the project (1989/90) was designed to complete all data input, produce a Benefits Measurement Plan which would ultimately be used to evaluate the project and to commence time studies and other measurement tasks on current district operations. These time studies will be used as the baseline measurements for comparison with future time studies for the same operations utilizing the new GIS tools.

Several successes were met in this second year including the fact that data capture costs came out slightly less than anticipated. The tasks completed in this year also provided an opportunity to review district data in light of GIS technology and identify information needs for the MNR. This proved useful for several other activities which were concurrently being developed within MNR including the Information Technology Strategic Planning exercise and the development of an Integrated Natural Resources Inventory and the Natural Resource Information Service which John Rollock will be speaking about this afternoon. The work completed in this year also provided some insight into the requirement for data standards prior to implementing GIS corporately and the need for policies regarding digital data including dissemination, liabilities, etc. Finally, time studies have been underway at the districts to provide the base line for measurement of GIS benefits.

The year was not without its problems. Staff turnover has plagued the project. GIS is a booming technology everywhere and qualified people are difficult not only to find but to hold onto. Once a person has experience in the application of this technology, many opportunities are available to them. As everyone knows, new staff require training and divert resources from completing the tasks at hand and the high turnover rate has resulted in more training time than originally anticipated.

Secondly, the data quality is in many ways poorer than expected for input into and use by GIS. This required a great amount of effort within each district. Effort that has been put into upgrading or enhancing data before input into the system. We greatly underestimated the time and effort that this would require.

Thirdly, the lack of policy and standards regarding automated data within MNR has also hindered the project. We were hoping to adopt any existing standards and policies throughout the project and have instead been faced with generating them. We have spent a lot of time ensuring that any standards generated reflect the program areas involved in developing the data bases. This consultation process, as is expected, takes time which has diverted efforts away from other phases of the project including the development of applications.

Finally, the data capture for all data themes was not in fact completed in this year as originally anticipated. This was a result of a number of factors including funding allocations, the poor quality of data and the lack of standards. Consequently, the remaining data capture has been rolled over to the third, and current year, of the project.

Year three (1990/91) of the project was designed to complete application development, conduct an evaluation and document the project results. The Benefits Measurement Plan has been completed for this year and results can be documented as applications are completed. However, applications development is only now beginning, halfway through the third year. This is a direct result of the delayed data capture task from year 2. In spite of this, I do have two examples of applications to talk about today. The remaining applications will be completed by March 1991. The evaluation and documentation will take place in the 6 months following the applications development or by September 1991.

The applications development phase of the project has again provided a great deal of insight into the complexity of the tasks MNR requires of a GIS. The staff have learned a great deal about applications development which can be applied to future work in GIS within MNR. In fact, some of this work need not be repeated and can be incorporated into future plans for GIS implementation.

Now for the two applications. This slide depicts one of the applications developed in Timmins District. The application examines a proposed hydro corridor across an area of Timmins District. The district office needs to determine the natural resource values that would be affected if this corridor right-of-way went through.

These resource values include moose concentration and aquatic feeding areas, private lands, fisheries habitats, etc. A series of tabular reports and maps is produced identifying the areas and types of resources that would be affected by the corridor. The staff can then establish alternatives to this corridor and produce the new reports and maps to illustrate the impacts of these alternatives. This is a critical component of any MNR GIS capability. These modelling simulation tools will prove invaluable for making more informed decisions.

The second application is depicted in this next slide. The application assists the Cambridge District office in administering the Conservation Land Tax (CLT) Reduction Program. This program encourages the protection of natural heritage lands by offering landowners 100% reduction in property taxes on all eligible properties. It is the District's responsibility to compile and analyze the data for each rebate application. This is a time-consuming task which is made easier with GIS technology.

As the plot illustrates, by running the appropriate program, the system automatically compiles the relevant information based on the criteria previously established so that staff can make the correct recommendation on the application. This example illustrates that only part of the property is eligible for the CLT Reduction. You'll note the area in green, which represents an MNR managed forest and is excluded from the CLT Reduction.

The Forest Management Decision Support System Project (Plonski Project)

The second project that I mentioned as an MNR GIS activity is the Plonski Project. The goal of the project is to develop Forest Management Decision Support Systems that will improve the quality of the timber management planning process in Ontario. This is a three year project being conducted in partnership with several organizations outside of MNR. Decision making in the context of timber management planning involves identifying, evaluating and selecting alternatives for such things as timber harvesting, regeneration, tending and access planning.

All of these questions have a spatial and temporal dimension to them. The decisions to be made are numerous, wide ranging and often dealing with conflicting and competing factors. They include linking short term decisions to long term implications, relating site specific treatments to forest level impacts, accounting for the risk and uncertainty associated with insect, disease, fire and climatic changes, and accounting for the values of other forest users.

The Plonski Project uses GIS as one of many tools for timber management; more specifically, it will utilize GIS to investigate spatial relationships and present information visually for public review. The project commenced this year (1990) and will be completed in 1993. For further information, please contact Dan Marinigh, Project Administrator.

OTHER ACTIVITIES

As well as these two projects, there are a number of activities within MNR that are GIS related. The Geographical Information Services Section hosts a GIS Interest Group meeting approximately 2-3 times a year for MNR staff. This is a forum which provides informal discussion about GIS related topics specifically geared to resource applications.

The Section also publishes a quarterly newsletter titled LOCUS FOCUS. This newsletter prints brief articles on GIS related subjects in Ontario and provides updates on the GIS Model District and Plonski projects.

The GIS Section also conducts training sessions on the use of the topographic data base for resource applications with GIS technology. There are two types of training sessions; one for resource technicians and one for senior managers. To obtain more information about any one of these items, please contact Tom Malone, Acting Manager GIS Applications and Technology Transfer.

Finally, MNR has also established a Geographic Information (GI) Policy Committee which is chaired by the Director, Surveys, Mapping and Remote Sensing Branch. The purpose of this Committee is to provide a co-ordinated ministry-wide forum for policy, strategic and operational issues in support of the GI activity. Also, to address matters of remote sensing and surveying as they relate to geographic information; to facilitate the co-ordination of MNR's activities in the provision and use of geographic information technologies and to facilitate the establishment and implementation of standards and specifications. Specifically, the Committee will be:

- co-ordinating geographical information activities within MNR
- developing and adopting common standards in these activities
- exchanging information on GIS, remote sensing and surveying activities and technologies
- sharing experiences to facilitate the economic and efficient application of these technologies
- educating MNR employees about GIS, remote sensing and surveying activities and technologies
- identifying and resolving GIS implementation issues

- providing co-ordination for the GIS Model District project
- providing advice/recommendations to MACSIC on GIS proposals
- providing advice/recommendations to Policy Committee regarding policy related issues specific to GIS

This committee has developed a detailed work plan for this fiscal and have, in fact, completed some of the tasks identified in that work plan. This committee has also provided the forum for some very lively discussions surrounding GIS at MNR.

CONCLUSION

GIS technology is evolving at an ever increasing rate. Ontario's comprehensive approach to geographical referencing and geographic information through the '80s has helped put us in a position to take advantage of GIS technology to the fullest.

The foundation was laid in the '70s to best utilize the tools only now becoming available to us. Our continued efforts in the '80s provide a better understanding and knowledge base within MNR to best apply GIS technology.

What did we learn from the '80s? We learned that digital data bases need to be implemented consistently across the province and we spent much of the '80s designing and implementing some of these data bases. Our work is not complete but the ground work has been laid to continue to build these data bases at an accelerated rate. We also learned that we needed to explore the operational aspects of the technology before full scale implementation.

Hence, we designed and implemented projects to review operational GIS issues.

Our efforts in these projects will set the stage for a co-ordinated and phased implementation of GIS and information systems technology at MNR. Finally, we recognized the need for a stronger commitment to technology transfer about GIS and related issues. While our efforts have not been focused in this direction through the 80s, I believe the '90s will see a greater emphasis on this crucial aspect of GIS implementation.

What have we learned from the '80s? I say a great deal, all of which will catapult the MNR through the '90s and into the new age of the 21st century.

---APPLAUSE

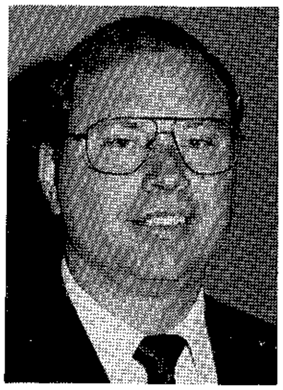
CHAIRMAN VRANCART: Thank you Gabriella. Good morning. My name is Ron Vrancart. I apologize for being delayed, and I'm sorry that I wasn't here in time to introduce Gabriella as I got caught up in the exhibits upstairs.

Our next speaker on the program is Michael Landreville, the Marketing Manager, GIS Division of Intera Kenting. Intera Kenting is a organization which offers data acquisition, analysis and integration services in the fields of remote sensing, geophysics, GIS and environmental sciences. At the moment Intera Kenting is extensively involved in the digital mapping of Qatar, a small, oil rich country adjacent to Saudi Arabia.

Before joining Intera Kenting, Michael attended the Nova Scotia College of Geographic Sciences in 1988 and 89. Prior to that he was a self employed consultant dealing primarily with Environmental Planning and Resource Management projects such as the development of area-specific environmental guidelines governing operation and maintenance activities within National Parks. Much of Michael's experience with the land base and the environment and factors impacting it came from his earlier employment with the Lands Directorate, Environment Canada and with Hardy Associates where he was involved in Protection Planning and Project Management.

Ladies and Gentlemen, please welcome Michael Landreville.

THE QATAR EXPERIENCE



MICHAEL LANDREVILLE
Marketing Manager - GIS Division
Intera Kenting

Introduction
For those of you unfamiliar with our company, Intera Kenting is a high-tech/multi-disciplinary company with divisions in GIS, Remote Sensing, Environmental Sciences and Geophysics. This morning I will be presenting a brief overview of our experiences on a digital mapping and GIS application project currently being conducted by the State of Qatar. I should point out at the beginning that I am making this presentation on behalf of Mr. Mike Kirby of our company who has been unavoidably detained on other matters. Mike extends his apologies for not being able to present this paper in person.

I would like to begin by stating that while we did not initially expect it, the Qatar project has been a very important initiative for our company. We have learned a lot through our involvement in the Qatar project and my intention this morning is simply to provide for you a contractor's perspective of some of our experiences. I also confess that for many of you my comments will not be new or particularly revealing but in our view they are important considerations which are easily overlooked in a large international project such as this.

Background
The peninsula of the State of Qatar is situated half-way along the west coast of the Arabian Gulf covering a total area of 11 437 sq. km., (Figure 1). The terrain consists primarily of flat rocky surfaces, arid plains and sand dunes, and some fertile areas in the north and central regions. The climate of Qatar is typically desert with hot summers, warm winters and minimal rainfall, usually averaging less than 75.2 mm. per year. Minimum/Maximum temperatures for the summer months range between 25 and 46 degrees centigrade. Qatar is an independent and sovereign state following traditional Arab mores. Islam is the official state religion, Islamic jurisprudence the principal source of law and of course the official language is Arabic. The capital city of Qatar is the city of Doha, (Figure 2).


TEHRAN
BAGHDAD
IRAN
IRAQ
KUWAIT
ARABIAN GULF
SAUDI ARABIA
QATAR
DOHA
RIYADH
ABU DHABI
UAE

Fig. 1

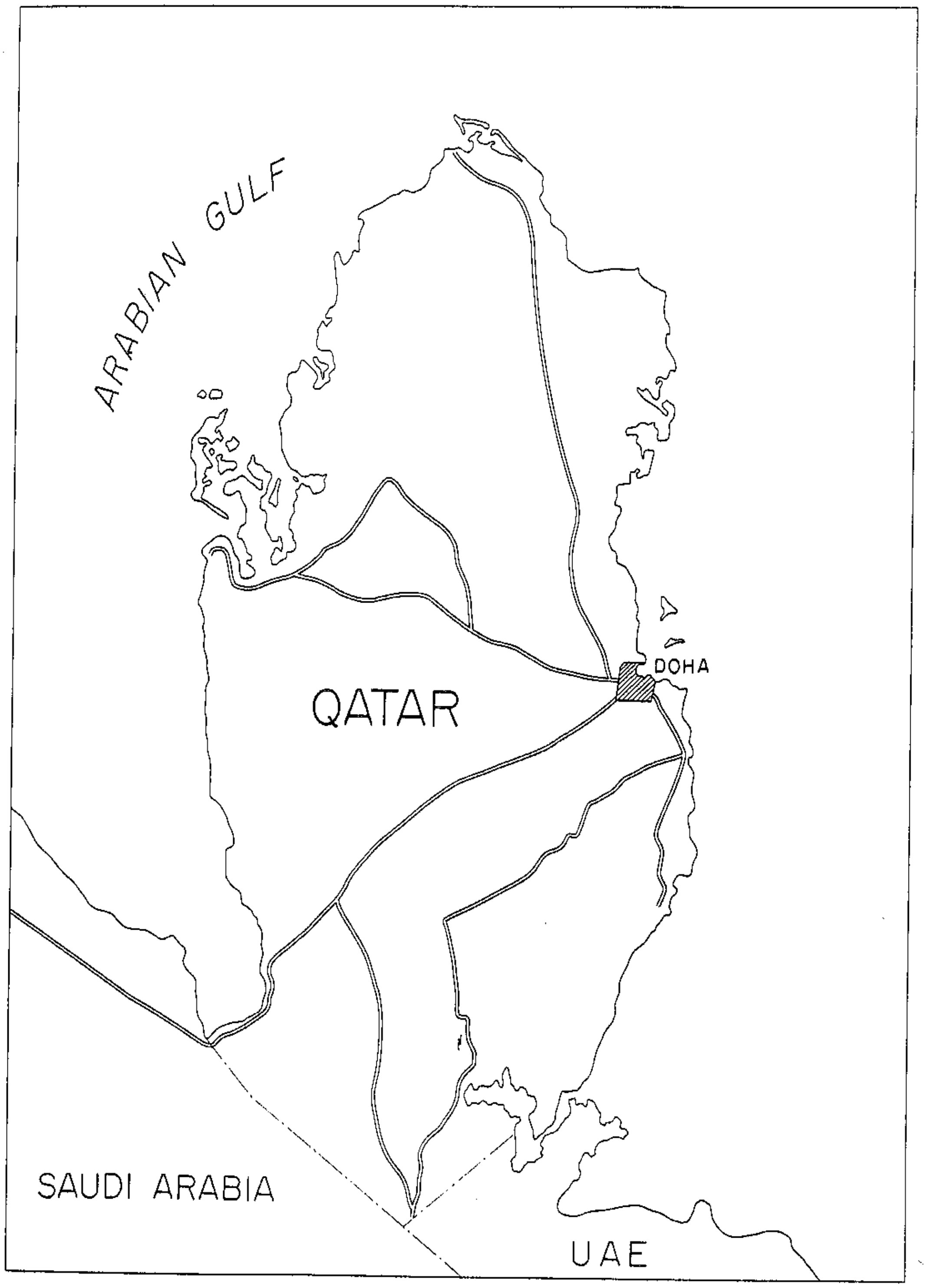


Fig. 2

Qatar's interest and subsequent involvement in digital mapping came about in response to a very real need for accurate maps. Before oil was discovered in the 1940s, pearl diving, fishing and some seafaring trade were the main sources of livelihood. Following the discovery of large oil reserves within the territorial boundaries of Qatar, the State's economic growth increased dramatically. This economic boom precipitated land investment to a point where prices for land in the towns and in particular the city of Doha, exceeded those in the City of London. However this demand also revealed many discrepancies in the existing analogue mapping and these led to expensive and embarrassing land-related disputes. In 1986 the government of the State of Qatar identified the need for new mapping of all its urban areas. The current digital mapping project now being conducted is co-ordinated by the Survey Section, Civil Engineering Department, Ministry of Public Works of Qatar.

Intera Kenting has the responsibility for digital mapping of the urban areas of Qatar at the scales of 1:10 000 and 1:1000, (Figures 3 and 4). Data is topologically structured and provided in ISIF format, or more recently in ARC/INFO coverages. The digital data is quality checked by an independent firm, Trillium Data Group here in Ontario, and then sent to Qatar where it is imported to a VAX running ARC/INFO GIS software. Accompanying hardcopy maps are edited in the field and prior to being returned to Intera Kenting the Ministry signs the sheets off and provides the correct arabic spelling for those features that are labelled on the mapface.

The technology used by Intera Kenting on the Qatar project is not unlike that used by most contractors on large digital mapping initiatives. As a result we would like to share with you other experiences we have gained from this initiative which, although they are of a more general nature, we believe are just as important to the success of such projects. It is our belief that the following topics emphasize the co-operation and communication factors underlying the success of many large overseas projects.

1) How we heard of the proposed project
2) Factors which helped us land the project
3) Problems encountered during the project and their solutions
4) Project benefits

How we heard of the proposed project

Historically, States in the Arabian (or Persian) Gulf have had a strong bias towards British suppliers and experts. In tendering the original mapping for Qatar only firms resident in

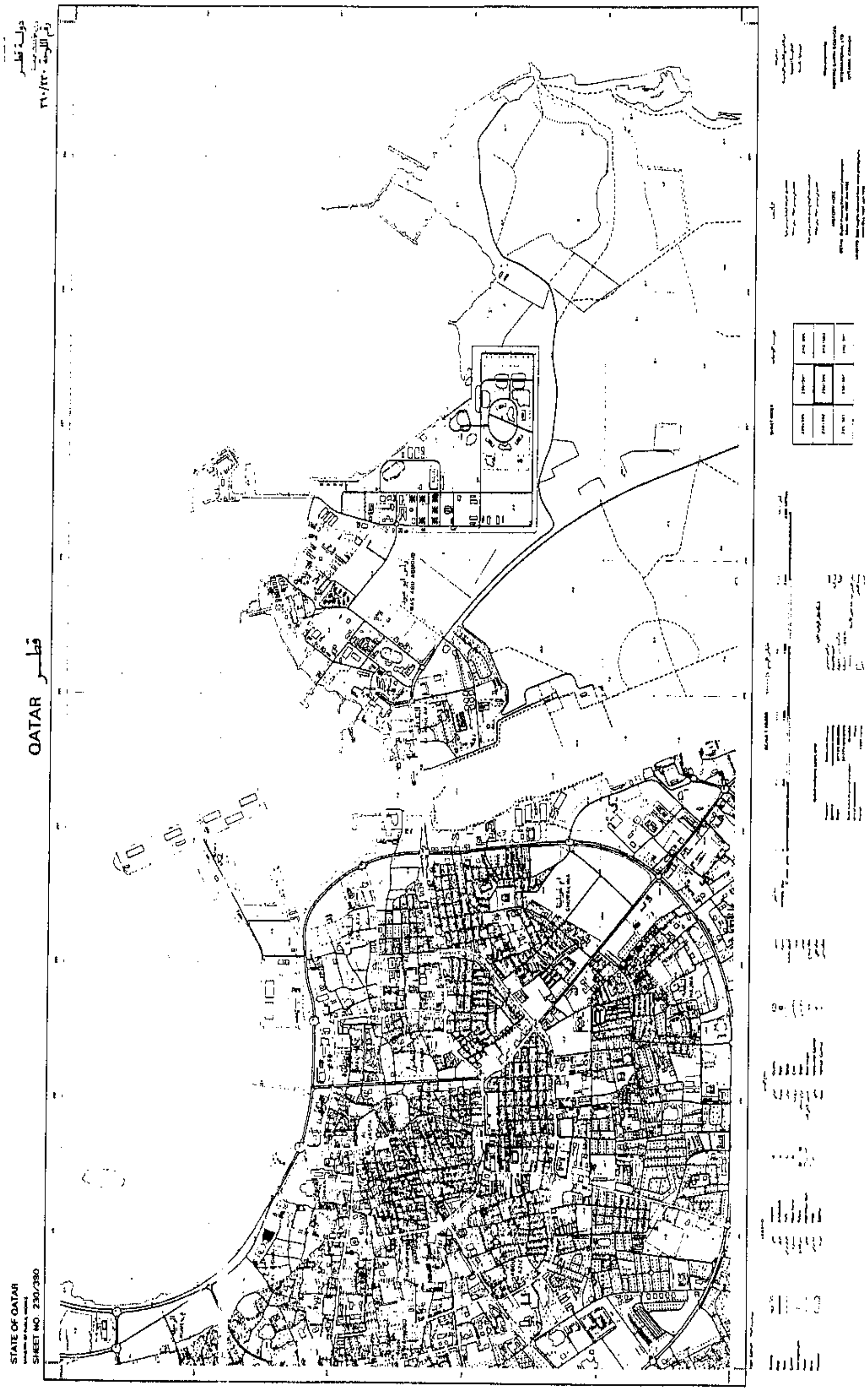


Fig. 3

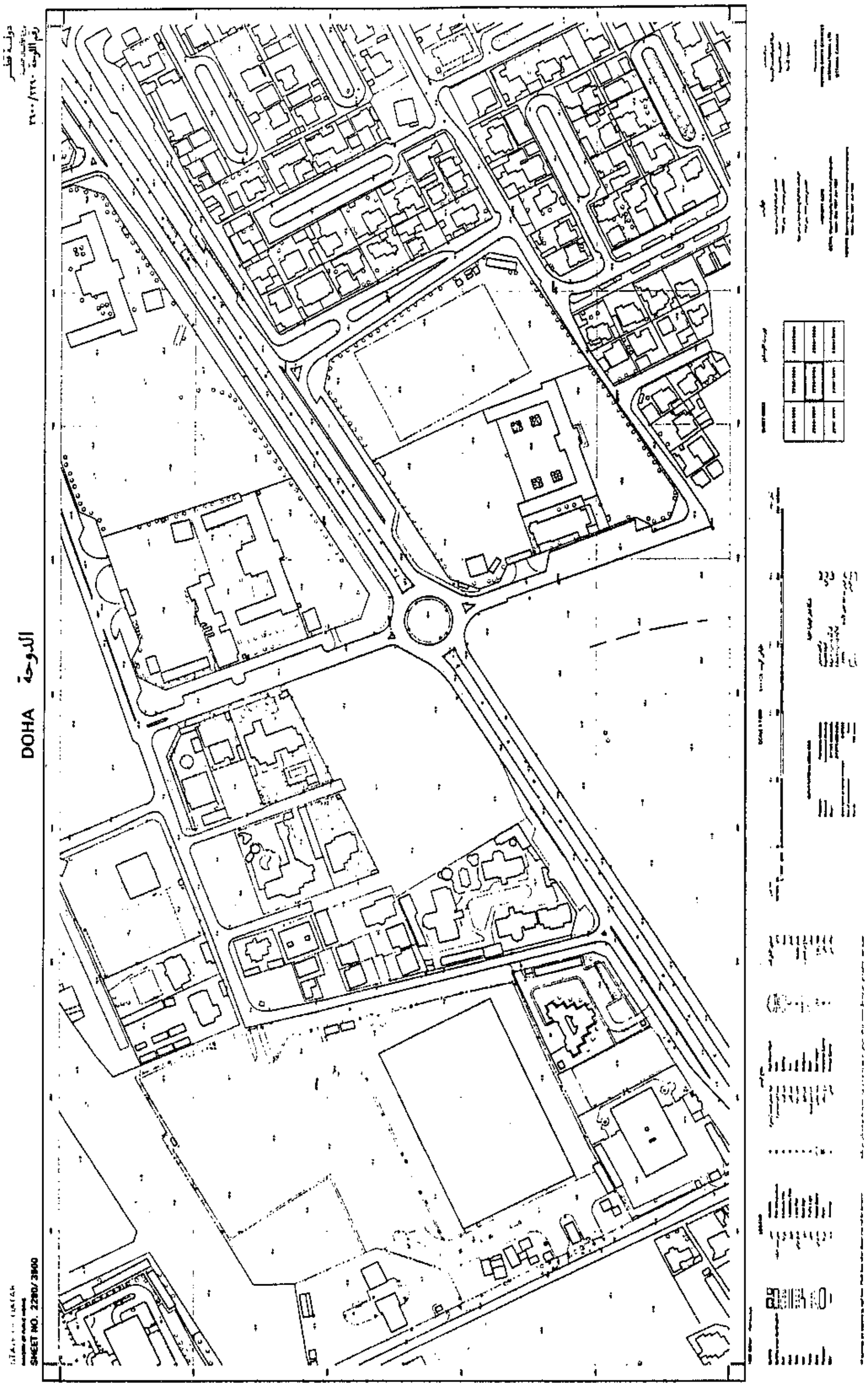


Fig. 4

Doha were invited to bid. These naturally were British firms who either had a branch office in the country or survey firms who had formed an association with a local airphoto and mapping contractor. Intera Kenting was not aware of the tender and believe that no other Canadian firm knew of the potential project either. Tenders for new aerial photography, aerial triangulation and digital mapping were called in 1986. All price submissions exceeded the Ministry's budget by a wide margin.

To overcome the budget problem, the Ministry divided the contract into three phases and tendered again. On this second go-round Intera Kenting was approached by a local survey company in Qatar to jointly bid for Phase 1. The local company had previously asked the Qatar Survey Section for the name of a "reputable" mapping contractor. By chance, the head of the Survey Section was familiar with Intera Kenting, having met our crews on a project in Nepal, and he suggested the survey company contact our firm. As a result of that recommendation Intera Kenting was contacted by the local survey firm with the documentation for the upcoming tender and a representative was dispatched to Doha to assist in the preparation of the bid for the airphoto, ground control and aerial triangulation contract.

Thus, the comment I would make regarding how we heard of this very important project is simply this. When it comes to hearing about or being asked to participate in new business opportunities we believe the scenario just described is not as unusual as one might first think. In fact it has been our experience, and the Qatar project is a good example of this, that good or bad the reputation of your company will always precede you. Of course, nothing beats a recommendation from someone else and in many cases it is your company's good reputation that gets your foot in the door. A little luck and a strong and reputable name abroad worked for Intera Kenting in this instance.

Factors which helped us land the project

As Intera Kenting learned more about the Qatar proposal a number of concerns surfaced. For example, discussions with the staff at the Ministry in Qatar indicated that the Survey Section were not entirely familiar with current digital mapping procedures and techniques. This was reflected in the mapping specifications for the project which were basically a copy of those issued some years ago by the State of Bahrain and which did not reflect more recent advances in this discipline.

Intera Kenting felt that Canada had established itself as a leader in this field and that given the opportunity we could demonstrate the state-of-the-art in digital mapping procedures and technology. Intera Kenting therefore invited two officials from the Ministry of Public Works to Canada. Their 10-day tour sponsored by a PEMD grant from the Federal Government, included visits to EMR, MNR, the County of Oxford, ESRI Canada, and the Trillium Data Group. This tour clearly demonstrated that the digital mapping concept had progressed so much that the Qatar's proposed mapping specifications were obsolete. Also, by visiting actual GIS projects such as the County of Oxford, the Ministry's perspective and requirements changed to take advantage of recent advances in the fields of digital mapping and GIS.

Over the next few months the Ministry adopted the MNR specifications in principle as well as the philosophy behind them. The Ministry, Trillium Data Group and Intera Kenting then worked together to modify these specs to suite the local conditions in Qatar. During that time close contacts between the Ministry in Qatar and MNR here in Ontario were developed and maintained. Also at this time the Trillium Data Group were given the task of providing quality control of the digital data files produced by the successful contractor. Again, criteria for acceptance were based largely on those currently being used in the Ministry of Natural Resources OBM (Ontario Base Mapping) Program. The final tender resulting from the issue of the revised specs produced two competitive bids and Intera Kenting was eventually awarded the project.

The point to be made here is that two initiatives helped Intera Kenting land the Qatar proposal. Firstly, it is our belief that our interest in demonstrating to Qatar firsthand, Canada's expertise in digital mapping and GIS was pivotal in our being awarded the project. This is because it helped them to define exactly what they required and it alleviated their concerns regarding the competence of the mapping community to provide it. In effect, it demonstrated to them that Intera Kenting and the Canadian mapping community as a whole had the expertise to meet their mapping requirements and solve their problems as they arose. There is also no doubt that while Intera Kenting's international experience played a major role in recognizing what was required by Qatar for a successful project implementation, without the cooperation and help of the federal and provincial governments we would not have been successful. The second factor which helped land the proposal was Intera Kenting's efforts to assist the Qataris in understanding state-of-the-art mapping and in working with them to upgrade their own mapping specs etc. This essentially started the relationship building process which is so critical to the success of any large overseas venture.

Problems encountered and their solutions

1. **Lack of understanding and expertise within Qatar in modern digital mapping procedures and technology. A new scale of mapping (1:1000) and new and unfamiliar features for Intera Kenting to map.**

At the outset of the project it was recognized by both the Client and Intera Kenting that the success of the project was dependent on raising the level of understanding of the client in the areas of digital mapping and GIS. Intera Kenting's involvement here was to assist in planning visits to Canada for various people involved in the Qatar project. These clients were given tours of various facilities within Ontario and also spent considerable time at our offices working with our production people. This process is continuing and representatives from Qatar visit Canada frequently to attend GIS Conferences etc. It should be pointed out that this learning process was a two-way street and that we benefited as much from the Qatari visits as they did. They assisted, for example, in training our operators in recognition of various topographic features unique to Qatar.

It is also worth noting that while the Ministry of Public Works started out with very little understanding of modern mapping procedures and techniques; they have, in an amazingly short period, progressed to a point were they can now come back to Canada and advise us in these areas. Those who heard Zul Jiwani's talk at the GIS Conference in Ottawa last year can attest to this.

2. **Risk associated with working overseas.**

As many of you know there are always some risks and problems associated with working on overseas projects. Monetarily, there are concerns regarding foreign exchange rates and payment schedules. Communication with the client is also of concern. The time difference between Canada and Qatar is about 7 hours and the overlap in the work week is only three days. Finally, as contractor in another country there are concerns related to working within a different cultural setting.

In this project the solutions to these concerns again are rather simple, yet we feel very important to its success. Intera Kenting made every effort to learn and be respectful of the client's Islamic traditions and manner of doing things. The company also placed top priority on constant and ongoing communication with the client at every stage in the project. We also visited their facilities in Qatar on a regular basis.

Project benefits
The Qatar project has had a number of very positive benefits. As was noted at the outset, this project has helped Intera Kenting in determining its future direction within the Geomatics industry and has helped us to enhance and broaden our capabilities to take on a more consultive role. It also provided the first opportunity for the Trillium Data Group to perform data quality and assurance on a large international project. More importantly, as a result of this project the State of Qatar now has a Ministry with extensive understanding and expertise in digital mapping and GIS and this can only work to benefit the entire geomatics community in the future.

In closing then, I can summarize by saying that for Intera Kenting the Qatar project has been both interesting and challenging. The people of Qatar have been friendly and helpful and the Ministry of Public Works has been a model client. Intera Kenting's emphasis on constant communication throughout the project combined with the cooperation of MNR, the federal government and many others has made this project an educational and rewarding experience and certainly one which we would like to repeat.

---APPLAUSE

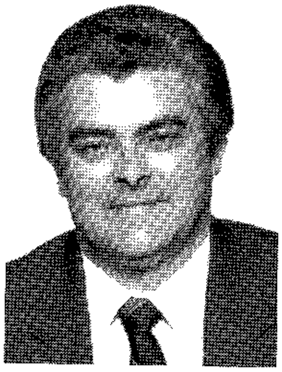
CHAIRMAN VRANCART: Thank you, Mike.

Our last speaker on this morning's programme is Jim Milbrath the Vice President of Overseas Operations for Terra Surveys Ltd. Jim graduated in Survey Engineering from the University of New Brunswick in 1970. He subsequently became a commissioned Canada Lands Surveyor and an Ontario Land Surveyor. Jim spent two years with Energy, Mines and Resources in Ottawa before joining Terra Surveys Limited where he has gained a wide and varied experience having managed major projects in Ghana, Tanzania, Morocco, Bhutan and most recently in the United Arab Emirates.

It is this latest project that Jim is here to share with us today. Ladies and gentlemen please welcome Jim Milbrath.

THE UNITED ARAB EMIRATES EXPERIENCE

JIM MILBRATH
Vice President of Overseas Operations
Terra Surveys Limited



Introduction

The purpose of this presentation is to give a brief overview of the experience gained on an ongoing project in the United Arab Emirates. We are currently in the eighth year of a multi-function project giving us the rare opportunity to set the initial base for ultimate GIS applications. The major functions are comprised of establishing a Geodetic Network, Aerial Photography, Mapping of a 90 000 sq.km area and printing of over 1.5 million map copies requiring 12 transport air lifts to the Arabian Gulf.

Unique Nature of the Land

The country incorporates seven emirates or sheikdoms (Abu Dhabi, Dubai, Sharjah, Umm al Quywan, Ajman, Ras al Khaimah and Fujeirah). It is bordered by Saudi Arabia, Oman, The Gulf of Oman and The Persian Gulf. Topographic relief ranges from flat lands to rolling sand dunes and finally to rugged mountains. The flat lands, zero to 5 metres above sea level are generally situated in the western part of the country and along the north shore. Rolling 5 to 10 metre sand dunes commence 15 km from the Persian Gulf shoreline and gradually increase in size to 150 metres in the "forbidden quarter" to the south. Very rugged and extremely steep mountains are located in the north quarter of the country and range in size from 600 metres to 1600 metres.

Since more than fifty percent of the country is comprised of sand dunes, the first hurdle to cross by our Canadian crews was to learn how to drive in the desert sand and avoid the quicksand sabka areas. This was no simple task and resulted in several accidents during the first year. The second major hurdle was to learn how to survive and operate in an harsh environment of fog, blowing sand, near constant sunshine and temperatures up to 55 degrees centigrade. One can not imagine how tedious it becomes to rise every morning with the radio commentator cheerfully announcing that it is going to be another fine, sunny, and warm day.

Geodetic Survey Network

A Geodetic Horizontal Survey Network was established as a chain of 96 triangulation stations along the Persian Gulf, 107 first order traverse stations around the border and across the interior, 56 second order north/south second order traverse stations, 33 Laplace Azimuths and 12 Doppler satellite stations. In addition, a special order (+/- 3mm sq. root K) Geodetic Vertical Survey Network was established and was comprised of 535 bench marks and 2040 km of levels. Three tide gauges were constructed to determine the vertical datums.

The poor visibility due to haze and blowing sand quickly forced a rethinking of utilizing normal survey methods. The use of laser EDMs with a range of 60 km proved barely adequate for the 15 to 20 km distances required for the Horizontal Network and the use of automatic levels rather than manual ones provided the best results for the Vertical Network. Fairly large monuments, 900 mm square at the base, 600 mm below ground level and 1300 mm above ground level with a 1800 x 150 mm plinth all weighing over 700 lbs were constructed along the coast and mountain areas to provide stable platforms on which to set instruments. In the interior, double buried monuments were constructed with the lower steel mark driven to refusal and 1.5 metres below the upper buried reinforced concrete monument. The final results of the survey of four long hard years showed that an excellent network had been established. The configuration and results of the second order traverses were of such high quality that we were able to adjust the whole network of triangulation stations, first order traverse stations and second order traverse stations as one block and still achieve first order geodetic results of better than 20 ppm relative accuracy. Similarly for the vertical network , the average level loop adjustment was 2.7 times better than the allowable misclosure.

Aerial Photography, Photo Control and Aerialtriangulation

Aerial photography was flown at scales of 1/30 000 and 1/60 000 over a two year period. In 1986 1/30 000 target photo was flown first for all 259 horizontal geodetic stations as well as all vertical bench marks along the southern and western borders. This represented no easy task in locating all buried marks in the shifting sand dunes and maintaining targets in remote areas with almost continuous blowing sand. Mounting doppler navigation equipment with directional gyros in each vehicle made the task of locating stations much easier. North/south 1/30 000 scale photo was flown over the entire area. Due to haze and blowing sand approximately four months were required to complete this task. In the second year, 1987, 1/60 000 scale photography was required to be flown as a background for subsequent maps as well as to lessen the number of ground photo control points to be established. Infra-red photography at a scale of 1/70 000 was flown along the shoreline to delineate the low water line in the extremely shallow coastal areas. The photo specifications were very stringent whereby, for the 1/60 000 scale photography, each photo must be flown within one hour of that of a photo on an adjacent photo line. Fortunately, the best weather conditions in six years prevailed and the task was completed in a two week period.

Ground vertical photo control of more than 1400 points, in east/west bands 25 km apart at 5 km spacing, were established by trigonmetric heighting methods with accuracies achieved being generally less than 1 metre.

A combination of good control and excellent photographic film quality made the task of aerial triangulation relatively easy despite the large number of models to adjust. A total of 9965 models were adjusted, 2325 at 1/60 000 photo scale and 7640 at 1/30 000 photo scale. In addition separate colour 1/30 000 scale photography was integrated into the block adjustment for use in the town mapping program.

Mapping

The complete mapping inventory required under this project included the production of a series of bilingual (Arabic and English) topographic maps in six colours at scale 1:50 000 with orthophoto background and 10 metre contours to cover the whole of the United Arab Emirates, including all the coastal islands and 5 km of outlying foreign territory. Other bilingual multicolour map series at scales 1:100 000, 1:250 000, 1:500 000 and 1:1 000 000 will also be produced. In addition, road maps and relief maps at scale 1:500 000 will be derived from the previous series.

Unilingual Arabic five colour line maps at scale 1:20 000 will be prepared for the towns of Abu Dhabi, Al Ain, Dubai, Sharjah, Ajman, Umm al Quywan, Ras al Khaimah and Fujeirah.

All maps are being prepared and printed in Ottawa. The United Arab Emirates Air Force are currently running C130 transport planes to Canada to pick up approximately 120 tonnes of maps with each flight capable of handling 10 tonnes.

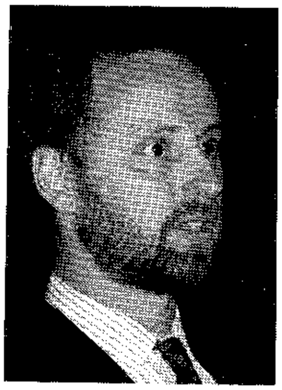
Conclusions

Our experience in The United Arab Emirates has been a major program of innovative techniques to overcome the numerous unexpected problems to provide the most comprehensive base for ultimate GIS applications. It is the goal of the UAE client to establish a world class survey and mapping department to carry on the tradition of maintaining this often forgotten but vital service to the country. As part of the contract program, Terra has been running a series of eight UAE training sessions in all individual production phases to give "hands on" experience to UAE departmental employees. To date, all Geodetic, Photographic and Mapping products have been to the highest international standards and will service as an excellent sound base for their digital aspirations in the future.

CHAIRMAN VRANCART: Thank you very much, Jim, for a very interesting presentation on mapping in the Middle East and an insight into some of the problems that can be encountered by contractors working there.

Ladies and Gentlemen, we shall now recess for lunch and to review the exhibits in Rooms 105 and 106. Please be back here at 1:30 pm. sharp. Thank you.

THURSDAY AFTERNOON SESSION, 20 SEPTEMBER 1990



SESSION CHAIRMAN

BARRY COSTELLO
Manager, Topographic Data Base
Ministry of Natural Resources

Good afternoon, Ladies and Gentlemen, my name is Barry Costello and I am your Chairman for the afternoon session.

Our first speaker on this afternoon's programme is Volker Kromm, the Forestry Systems Supervisor with the Lakehead Woodlands Division of Abitibi-Price Inc. In this position Volker is responsible for forestry information systems, the development of an operational GIS, PC applications and implementation and field training and support.

Volker started with Abitibi-Price in 1981 and became involved in applications of GIS in forestry. After implementing a GIS in 1986 at Abitibi-Price he went on to develop an operational forestry database. Volker is currently involved in expanding the applications and functionality of this database. He is also actively involved in the Regional GIS User's Group.

Ladies and Gentlemen, please welcome Mr Volker Kromm.

GIS IN THE FOREST INDUSTRY - WHAT HAVE WE LEARNED FROM THE 80s AND WHERE ARE WE GOING IN THE 90s?

VOLKER KROMM
Forestry Systems Supervisor
Lakehead Woodlands Division, Thunder Bay
Abitibi-Price Inc

The 1980s was a period of significant change for the forest industry. It had weathered yet another recession between 1981-83 which was followed by a period of unprecedented growth. Industry embarked upon a course of upgrading old mills, building new ones, developing product diversity, and expanding markets. The global picture emphasized the increasing pressures being exerted on our forestry resources, and the demand to compete internationally. It became evident that in order for us to survive we had to focus our attention; to reevaluating our role in the market place, dedicating our efforts toward quality, and achieving optimal performance.

It is to this day that we are in pursuit of innovative ways of doing business. The industry is encountering what may prove to be one of its most challenging global economies. There is new capacity coming on stream world wide and with increasing environmental, and recycling awareness we must endeavour to be the best at what we do. These forces no less determine how we must administer our forests today and in the coming years.

It became clear in the 80s that a change was required in order for us to achieve our goals. These new social and economic pressures made GIS technology a legitimate alternative. GIS was a burgeoning new technology with a promising future. As we were all wrestling with the requirements of the day, a number of industry leaders were exploring new opportunities.

Proceeding with GIS was not an easy decision for our board of directors to make. The investment was high and the cost benefits were dubious. A payout in excess of $250,000 for sta tup equipment and software was not a minor expenditure. The proposal won approval partly by weighing the sheer volume and complexity of the data required against the trouble we were having dealing with the data; or more correctly put, not dealing with it. It is more significant, that we proceeded on the knowledge that in the near future important decisions would have to be made at all levels of our Woodlands operation, based on our ability to analyze this data.

There was another caution light out to the early Ontario pioneers. We were treading into an area where very little data existed, very few standards had been established and co-operation was something that was belaboured at meetings over cost sharing. The prospects were not always encouraging. The feeling of the day was that we could ill afford to wait for direction, given the political machinery in place. Those that proceeded were merely getting on with the task of conducting business.

What have we learned?
Lesson number one is that the solutions are the consequence of a well devised plan conceived only until after one has encountered all the unplanned impediments. These are usually well known at the outset, but are obscured by our own ambitious overtures. The impediments exist in every organization and describe the way our organization functions.

These included:

1. obtaining management approval
2. system selection and acquisition
3. personnel training/hiring
4. development of database/standards
5. data capture methodology
6. application generation
7. data acceptance and proliferation
8. maintaining system
9. keeping pace with technology trends
10. data transfer/conversion
11. data ownership

These are but a few and one could go on at length over their significance. These were issues that needed to be addressed during the 80s. They were often brought to the forefront at conferences and formal "talk-abouts", but were usually resolved independently at GIS user shops or at working sessions with other users in informal surroundings.

If there was one lesson that I personally learned from the experience, it was that the undertaking was larger than I expected. The problem may have been alleviated with more money; increasing trained staff, adding computing power, or reducing expectations.

I also have two regrets. The first involves the wish "that I had known about this earlier" syndrome. I discovered that by the time solutions were "state of the art", the problem variables had altered, resulting in obsolescence and restructuring. This revelation is not intended to alarm managers, as it is the backbone of the systems analyst's environment, since it enhances his continuum. The second regret is that a formulae was not more rigorously pursued for some form of joint development with the province, as was in New Brunswick. It was a positive decision from an industry perspective in retrospect. It will provide us with the databases and expertise required to cope with the challenges of the nineties. Let's commit the 80s to the past for a few moments.

What is the current industry status ?

Industry is taking an aggressive approach to GIS or more generally to the whole question of data automation. The majority of forest companies either have operational systems, are in the acquisition process, or are giving it serious consideration. This is a rather meaningless statement when one ponders upon the entire data processing evolution which is occurring unrelentingly.

GIS at our regional level of north-western Ontario is just a reflection of the way we do things. Todate there are approximately 7 219 361 hectares being managed by Abitibi-Price, Boise Cascade, Canadian Pacific Forest Products, and Domtar. Each company having its own system and each in varying stages of data capture and application development.

Canadian Pacific Forest Products (CP) is the largest of these with 5 217 200 hectares. CP has completed approximately 27% of FRI loading. They have estimated 68 person months to completely manually digitize their limits. Concurrent with this activity they are generating TMPs for 1991, 93, 94, 95, 97; plus loading silviculture and other relevant forest layers and databases. CP has estimated their storage requirement alone to be around 4.3 gigabytes for base data only.

Other initiatives have been taken. Boise Cascade has had their limits digitized by their parent company in Boise Idaho who have been in the digital business from the beginnings of GIS. Domtar in Red Rock has contracted out their digitizing to Lakehead University and is now nearing completion.

We at Abitibi-Price also have an operational database on a system that by today's standards is out of date. Like our counterparts we do produce standard TMP and silviculture products. Our efforts have been to automate many of the laborious functions of maintaining a current forest landbase. Those industry representatives with operational systems will tell you that most of your resources and energies will be dedicated to maintaining or inputting the basic FRI data. Glamorous unlimited functionality and analytical applications are unfortunately sometimes reserved for the moment to visionary organizations without spending restrictions and time constraints.

I feel as though we have gone through the evolutionary cycle once with our system. We nurtured its development, found its limitations, expanded our expectations and are only now preparing to venture toward new horizons. An important aspect of this growth was the incorporation of the intended users or data recipients, either in your own organization or co-agencies. Designing a system which will meet perceived needs in order to ensure commitment and compatibility is a much under estimated human relations/engineering undertaking. It would be propitious to have built a system that could satisfy our respective requirements.

Where are we going in the 90s?

The 90s is going to be the decade of high expectations. Changing management styles will demand higher productivity from systems and resources. Managers will be expected to digest and analyze larger volumes of data in order to make responsive decisions. Greater numbers of people will be seeking access to data. We will be held responsible for a wider range of issues affecting our management of the forest. We will be asked for the information now. People will expect incredible precision, and no one will care about the tools used to generate the data. The process will become irrelevant. The novelty will have worn off on our choice of medium.

The question becomes, how do we meet these expectations ?

Technology fortunately will solve many of our "we want it now" demands. Hardware performance has escalated while costs have dropped dramatically. Zero priced hardware is a phrase flaunted by vendors of software, whose products have exploded the way we perceive data. We need to be cautious when we go shopping. The reality is that although the CPU prices are impressive we need be cognisant of: the array of peripherals available, software costs, maintenance, and licensing. Technology has put these tools within our grasp and who amongst us can refuse the allure of electrostatic plotting, scanning, image analysis and of having a powerful workstation on every desk. No respectable GIS shop should be without them.

To address specifically where we are going with GIS I will use our Division of Abitibi-Price as an example. A greater emphasis will be on automated data capture. Image analysis or document scanning will replace manual input. We want to be able to compress the viewing window on the growing forest, from harvest, through regeneration, and return to landbase. Field foresters are demanding to have a current description of their forest for their daily planning. The time frame will be reduced from an 18 month period to less than a year.

The development of user friendly software tools will be an essential part of our approach in order to make the technology available to our field level decision makers. It will not be essential that they be intimately familiar with the software nuances in order to gain access to data. Applications will allow unlimited strategy development, information updating, and resultant automated hardcopy output. It has to be fast, responsive, and perform the task in a manner accustomed by the user.

The 90s are going to produce enormous databases with great depth. It is not significant that our data structures are not identical, or that our hardware and software are totally compatible. Those are technological issues that will be resolved by systems persons and market demand.

The critical issues will be those of partnerships and the development of shared databases across corporate barriers. Over the next few years we will address data ownership, conversion processes, agree upon resolution of data that is to be shared and come to grips with accountability.

GIS will unquestionably be a way of doing business in this decade. It will function as one component within a comprehensive information management system. It will become very sophisticated, yet look very simple.

GIS rose to prominence within the forest industry in the 80s. It is becoming an integral part of our operations with much promise of providing a treatment to some of our information woes of the 90s.

It is my hope however that in the nineties we will get together to resolve specific issues that confront us. The issue will no longer be GIS, but acquiring solutions to our problems. Lets get past the captivation with the tools and get on with the job. We have a lot of work to do. Let's do it together.

---APPLAUSE

CHAIRMAN COSTELLO: Thankyou very much, Volker, for a very interesting presentation.

Our next speaker is Larry Simpson a man who has been prominent in the GIS scene in New Brunswick for some time. In April of this year Larry was loaned from the Province of New Brunswick to the Council of Maritime Premiers to operate the LRIS and establish MAPLINC.

In the previous year Larry was the president of the New Brunswick Geographic Information Corporation as well as the chief executive officer of the LRIS a position he held for the past ten years. In the past he has held a variety of colourful positions with the New Brunswick Government including: Economist, Director of Budget and assistant Secretary to the Council of Maritime Premiers.

Today Larry will be telling us about the co-ordinating of GIS activities in the Maritimes. Ladies and gentlemen please welcome Larry Simpson.

COORDINATING GIS ACTIVITIES IN THE MARITIMES

LARRY SIMPSON
MAPLINC Maritimes

Introduction

The Land Registration and Information Service was established in 1973 to implement a comprehensive program of surveying and mapping in the Maritime Provinces. It brought together the surveying and topographic mapping operations of the three Maritime Governments. The intent was to create a network of survey monuments, to produce and update maps of the provinces and to develop a computerized land registry and information system.

The agency reports to the Council of Maritime Premiers through a Board of Directors made up of representatives from each province. The head office is in Fredericton, New Brunswick and major divisional offices are in Halifax and Amherst, Nova Scotia and in Summerside, Prince Edward Island.

The Program

The LRIS program was redefined in an agreement signed in March, 1980 between the three provinces as:

- the emplacement and maintenance of a co-ordinate system of control;
- the production and revision of large scale maps;
- the production of property maps;
- the establishment and maintenance of a parcel index file; and
- the provision of assistance in the implementation of an improved system of land registration.

Many of the original goals of LRIS have been met and a modern land information system is being developed. Because of this progress, and the unprecedented interest of the user community in the products and services provided, the Council had considered several ways to co-ordinate public land information activities, while providing more scope for development of the private sector. Factors in the discussions included technological change, organizational structures, responsiveness to provincial priorities and the desire to take advantage of business opportunities.

A decision was announced by Council in March, 1989 that each province would be tailoring the program and system to its own circumstances and priorities:

1. Prince Edward Island had already merged Property Mapping, Registry and Assessment to become the P.E.I. Land Records Centre, a division of the Department of Finance;

2. New Brunswick was establishing the N.B. Geographic Information Corporation (effective 1 April 1989) to be responsible for all LRIS functions and Land Registry and Assessment. LRIS Land Information Centres in New Brunswick were transferred to the NBGIC effective 1 April 1989.

3. Nova Scotia had commenced a study to examine options for handling similar problems there.

At the same time it was announced that LRIS would be wound up as a Council Agency after fiscal year 1989-90 and that most functions and employees would be transferred to the provinces during 1989-90. The Head Office performed the dual role of managing LRIS and the newly created NBGIC. An interim Board of Directors was established to oversee all aspects of the transition of LRIS from a Council Agency to a provincial service. The board was also charged with recommending to Council on organizational options for the provisions of Survey and Mapping Services.

In December 1989, as a result of a recommendation from the LRIS Board, The Council agreed to establish a new regional land information agency which would be an expansion of the already existing LRIS program. This regional crown corporation will deliver land information services to all Maritime governments, firms and individuals. It will be structured to enable it to facilitate the growth of the land information industry in the region and help ensure that local firms are able to compete effectively in the rapidly expanding national and international market for land information services. It will move beyond the existing LRIS and apply, on a regional basis, the initiatives taken by the Province of New Brunswick in its decision to establish the NB Geographic Information Corporation.

Status of the LRIS Program

The LRIS Survey Control system allows the co-ordinate positions of geographic features to be determined. The network of survey monuments is maintained by inspecting a portion of the established monuments in each province every year. Destroyed monuments are replaced and new ones added as priorities permit. The system is improved, serviced and kept mathematically consistent by the Summerside office of LRIS. The actual physical maintenance is carried out by the Provincial Regional offices. New monuments added to the system in 1989-90 were: 310 in New Brunswick, 244 in Nova Scotia and 82 in Prince Edward Island. Total monuments on file now number over 50 000 in the three provinces.

During 1989-90 production of the new series of digital topographic maps continued. Each province sets its own priorities for digital base mapping. As of March 1990, the resource mapping at 1:10 000 scale was 67 per cent complete in New Brunswick while urban mapping, begun only recently has 16 sheets complete. In Nova Scotia all of the Halifax-Dartmouth area has been mapped at urban scales (390 sheets at 1:1000) while resource mapping is 32 per cent complete. For Prince Edward Island 82 per cent of resource mapping is complete, and 24, 1:1000 urban sheets covering the Summerside area were finished.

Property mapping, which involves the mapping of individual land parcels and the creation of data on each parcel, is 100 per cent compete in New Brunswick and Prince Edward Island, and 60 per cent complete in Nova Scotia. An estimated 153 000 parcels remain to be mapped in western Nova Scotia where work began in 1989-90. Of the estimated total of 963 000 land parcels in the three Maritime provinces, 810 000 have now been mapped.

Currently, the Maritime provinces rely mainly on a grantor/grantee system for keeping track of title to lands, but A Guaranteed Land Titles system has been operating in Albert County, New Brunswick since July of 1984. During that period 30 per cent of the land parcels in the county have been brought under the new system. The Land Titles office is now part of the ongoing operations of the Province of New Brunswick, and is being considered for expansion into other counties. Nova Scotia has a study under way for implementing Land Titles in that Province.

During 1989-90 the Amherst Division was integrated as an integral part of the LRIS program. LRIS Amherst provides an extensive range of services in support of resource information management for the Maritimes. The services include interpretation and distribution of aerial photography; cartographic and drafting services; and the collection, manipulation and distribution of information for land and marine management. During the current year the major program effort for New Brunswick and Nova Scotia was in digital property mapping where a total of 16 195 properties in N.B. and 6967 in N.S. were completed. In P.E.I., the Department of Energy and Forestry was assisted with the preparation of their new forest inventory.

1989-90 Highlights

On 1 April, 1989, sixty-five employees transferred from the LRIS payroll into the New Brunswick classification system. They had previously worked in the N.B. Land Information Centres (Saint John, Moncton, Bathurst, Edmundston and Fredericton) and in the Albert County Land Titles Registry.

On 19 December 1989, the Council of Maritime Premiers agreed to establish a new regional land information agency which would be an expansion of the present LRIS. This announcement followed an indepth examination by the LRIS Board of Directors of the options for providing a coordinated land information system within the region.

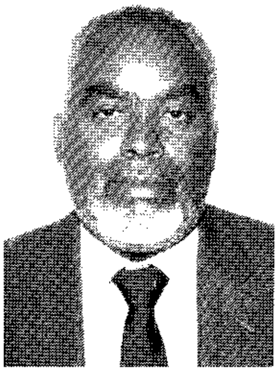
The property law course offered by LRIS to employees of legal firms, government and the real estate industry was given in French during the fall of 1989 and was well received. It will continue to be offered in both official languages. Two P.C. based computer programs (LORIS & ROCS) were developed to automate and decentralize the entering, storing and retrieving of parcel data in the parcel index system. They were successfully piloted in the Halifax and Sydney regional offices, and will be introduced in other offices during 1990-91.

CHAIRMAN COSTELLO: Thank you, Larry. That was most interesting.

Our next speaker is John Rollock, Director of the Systems Services Branch in the Ministry of Natural Resources. John was educated at Queen's University where he majored in Finance and Marketing. His career spans twenty-two years in the manufacturing, computer services and telecommunication industries, the last six of which have been in the public sector with the Ontario Provincial Government. John has had extensive experience in information strategic planning, development and management.

Ladies and gentlemen please welcome John Rollock.

ONTARIO'S NATURAL RESOURCE INFORMATION SYSTEM



JOHN A ROLLOCK
Director, Systems Services Branch
Ministry of Natural Resources

The Customer

"Serve the customer.....we must think the customer is the middle of the thrust of what we are doing. I think that's what we've learned. I don't think its much more complicated than that, and I would suggest it to you for your consideration."
- Edson P. Williams, Vice President, Ford Motor Company.

We learned many things during the decade of the 1980s. But perhaps, the most important lesson we did learn in Government and the private sector was to put the customer where he belonged, in the middle of every thrust for new products and services. We learned that our customers needed increasing amounts of information, and that much of this information was either needed on demand, or a timeframe specified by them and not the information provider. We learned that our customers needed more direct access to our information, and that they wanted the information in digital form.

The customer we discovered also wanted more reliability and accuracy in the information that we provided. They were even willing to pay for good information, if it helped them meet their business objectives. Our customers became increasingly sophisticated during the 1980s, both as information users, and processors of information. Many entrepreneurial ventures were started in the business of value added information services.

Information

We also learned several principles about information. First we began to treat information as an asset of an organization as opposed to a cost. This shift in perspective enabled us to begin to measure the value of the new asset information. Although not appearing on many balance sheets, information is perhaps the most valuable asset in most organizations to-day. We realized that information had to be as professionally managed as all other assets in the organization. Because of this, we began to organize our information in such a way that it could be managed. This gave rise to new data information architectures. An enterprise information architecture was a major enabler to two more information principles. It facilitated the sharing of information, because it allowed us to build systems that could share data, once the data structures conformed to the architecture. Secondly it facilitated the improved communication of information through our knowledge of where and how to get at the information.

Finally, we learned that information must be secure. In a world where direct digital access to information is going to be the norm, strict rules of information ownership, use, dissemination and access will be critical. This is further complicated by the freedom of information laws within which all governments started to operate during the 1980s.

Information Systems (Applications)

The last decade taught us a lot about building information system applications. We learned that the most successful systems were those that were customer/client oriented. Improving the customer interface was the key to success. Information systems had to be both data driven and interactive. Interactive systems were needed to satisfy on demand information services. Data driven systems enabled an organization to ensure that all of its data needs were considered and accounted for. Our information systems also had to be integrated. Information collected and processed in one system had to be available to all other systems that needed it. Finally, we understood that information systems had to be reliable, maintainable and cost effective, as the degree of dependence of an organization on its automated information systems increased.

Information Technology

The 1980s brought us rapid advances in the development and implementation of information technology. We can expect that the rate at which this occurred during the last decade will continue during this decade. The cost benefit ratio is still improving because of this trend.

All information technology must be integratable. This means that we must be able to network it, and it must be able to communicate with other network devices. We learned that we must not be technology driven but use technology as an enabler to achieving business goals. Finally, we learned that our information technology must be both reliable and secure. The most sobering lesson of all however, was that the surfeit of information technology will always outpace our ability to use it.

Society in the 1990s - the MNR response
By the end of the decade we had little doubt that the information age was upon us.

The Society We Face During the Decade of the 1990s
What type of society do organizations face during the 1990s? Understanding the lessons from the 1980s and the type of society we face during the 1990s will allow us to properly design, develop and implement our new information products and services. We are already living in the global village. Global communications and computer processing capabilities allow us to send and receive information when and where we want it, in a timeframe that we need it. Our society is becoming more computer literate, driven by ever expanding information needs. Most of the new services and products will be information based, and more legislation will be put in place to regulate information, its use, products and services. Society will be increasingly concerned with the environment, information about the environment and especially information about the state of its natural resources.

Ministry of Natural Resources
The Ministry of Natural Resources is the lead conservation agency for the natural resources of the Province of Ontario. As a byproduct of their mandate, they are therefore, expected to be the lead natural resource information agency in the Province of Ontario. Achieving sustainable development of our renewable resources, and conservation of our non-renewable resources, while satisfying current demand will be the major challenge facing the Ministry of Natural Resources during this decade.

Having learned its lessons about the Customer, Information, Information Systems, and Information Technology from the last decade, and with a good understanding of what is needed for success in this decade, the Ministry's response to the growing demand for information is to develop a NATURAL RESOURCES INFORMATION SERVICE designed to meet the needs of its managers, customers/clients, partners and the public for information about its natural resources.

Natural Resources Information Service - Origin
The genesis of this idea is credited to Dr Bob Rosehart, president of Lakehead University who made it his first recommendation in a report commissioned by the Ministry of Natural Resources entitled "An Assessment of Ontario's Forest Resources Inventory System and Recommendations for its Improvement". (Sept. 1987). Rosehart recommended "That the

Ontario Ministry of Natural Resources establish the Natural Resources Information Service as a central natural resource data secretariat within the Ministry which would incorporate Forest Resources inventory data, as well as wildlife and other natural resource data..." The Ministry has through its strategic planning exercise for information technology and information management during this decade, embraced and indeed enhanced the concept.

Natural Resources Information Service - Goals

The goals of an NRIS (the acronym for Natural Resources Information Service, and used hereafter) are as follows:

- To satisfy the demand of MNR's management, partners and clients for natural resources information of the province of Ontario.

- To improve access and provide in a timely fashion natural resources information to all who need it in the most cost effective manner.

- To improve the quality of natural resources information.

Natural Resources Information Service - The Service

NRIS will be an information service which will provide:

- "Single Window" access to:
  - Natural Resources data and information
  - Support tools (i.e. predictive models, digital maps)
  - Interpretive/analytical expertise
  - Direct entry/update of natural resources data from MNR's staff as well as its partners.
- Input to the establishment of data and methodology standards for natural resources information.
- Custodianship of some natural resources data bases.
- Quality control of natural resources data for dissemination.
- The servicing of customer/client requests for data and information.
- Co-ordination of the acquisition, aggregation, modification and other tasks needed to provide information in the form requested by the client.
- Provision of documentation on the data rules, regulations, standards, specifications and

attributes of data and information disseminated.
- Operation of natural resource information centres.
- An education program to improve natural resource data literacy.

Natural Resource Information Service - Information Types

The following are examples of broad categories of information that will be available through an NRIS:

- The inventory of each resource.
- The location of the resource.
- Natural resources laws, policies and regulations.
- Management plans for resource use.
- Management actions and results.
- Effects of natural occurrences such as flood, fire and pestilence.
- Some financial information about the resources.

Natural Resource Information Service - Design

The design of an NRIS will be based on an understanding of the information needs of MNR's clients. What information is needed, in what form, in what timeframe, will differ by client group.

The major client groups are as follows: (Figure 1)

- MNR managers and knowledge workers
- The public
- Other Ontario Government Ministries
- Ontario's municipalities
- Industries that use natural resources
- Partners/stakeholders involved with resource management
- Other provincial and the federal government.

An NRIS will be based on MNR's data architecture. (Figure 2). It will also be based on the development of major integrated resource systems applications, financial and administrative systems. (Figure 3).

NRIS DESIGN - CLIENTS/ORGANIZATION

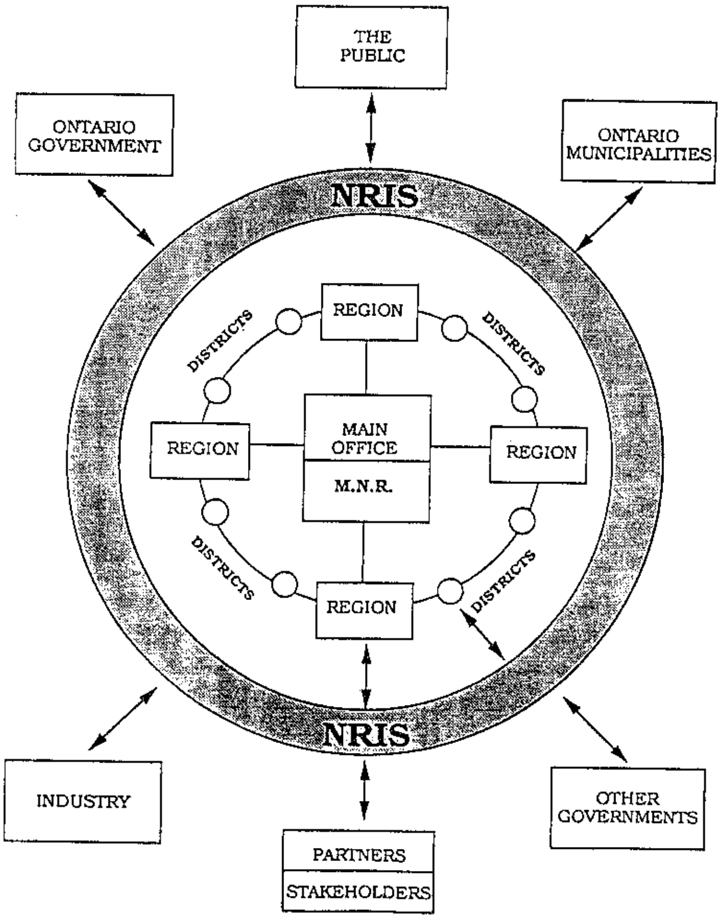


Fig. 1

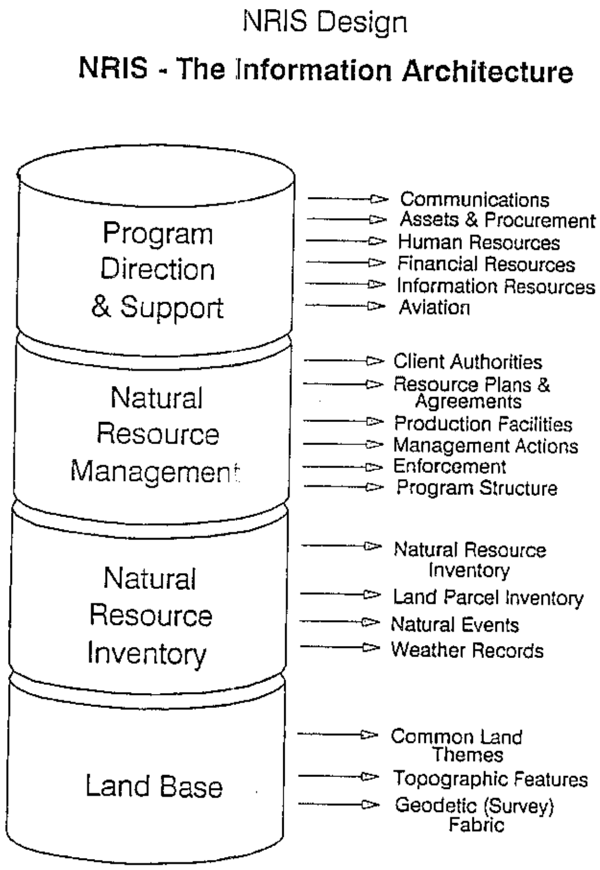
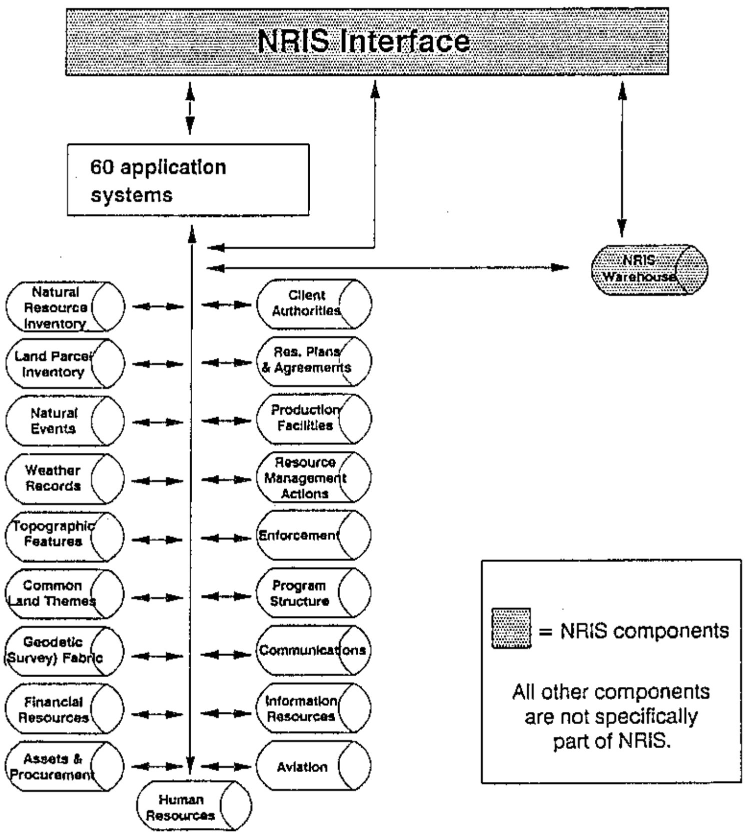


Fig. 2

NRIS - The Information/The Systems

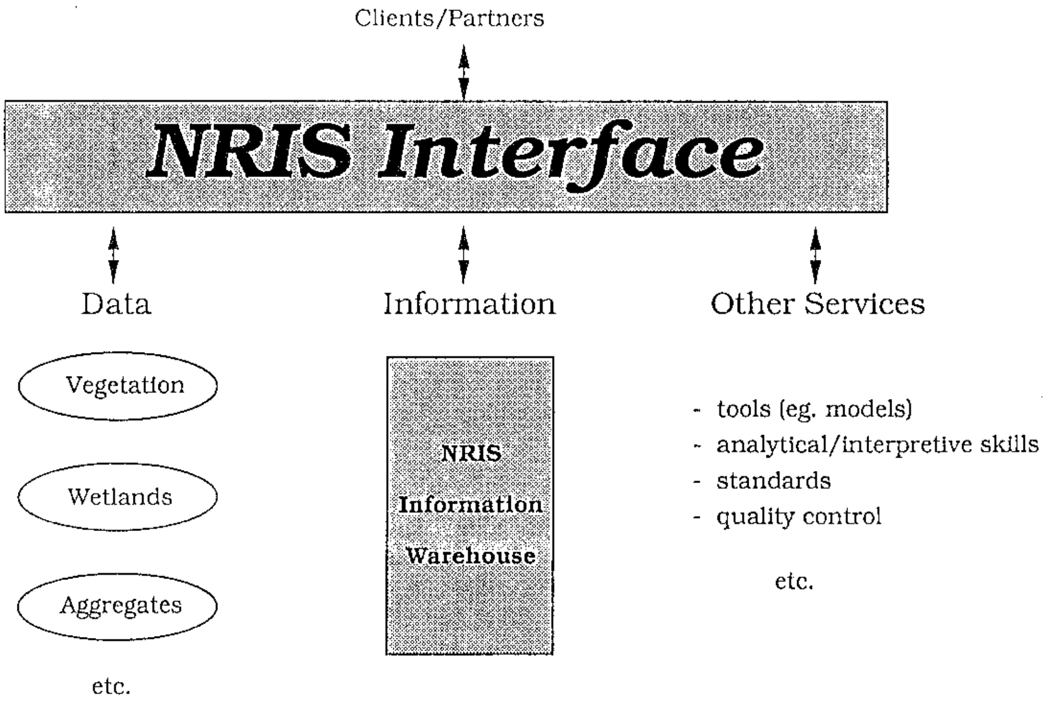
Fig. 3



NRIS

Design

Fig. 4



An NRIS organization will have to be established to co-ordinate the interface between the client and MNR's data, information and information services. (Figure 4). It should be noted that NRIS services could be provided through existing MNR organizational units, such as Region or District offices, or through specialized information centres.

A wide array of information technologies will be used to implement NRIS. Some of these are as follows:

- Management Information Systems
- Geographic Information Systems
- Executive Information Systems
- Artificial intelligence approaches
- Communications techniques such as:
  - EDI
  - Voice/data/image
  - FAX
- Relational DBMS

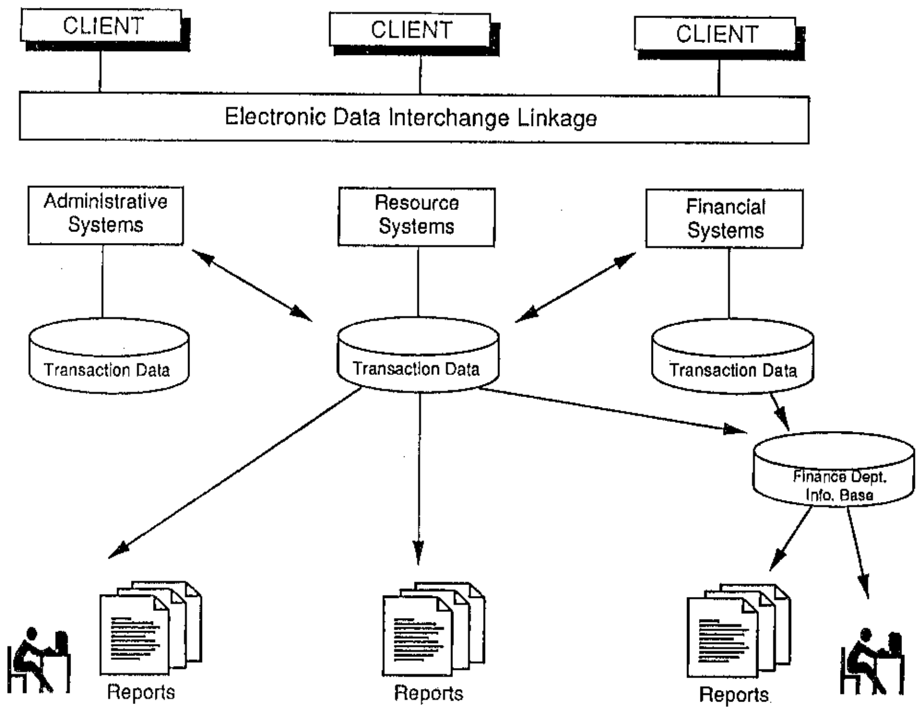
Natural Resource Information Service - Evolution

The implementation of NRIS will be an evolutionary process. In the short term the Ministry will look at existing systems such as the Forest Resources Inventory System, Ontario's basic mapping program, and a Crown land titles and indexing information system to determine what degree of computer access can initially be developed as a service. The provision of information through information centres such as our existing Public Information Centre will also be examined in the short term. However, the evolution of the longer term view of NRIS is described in Figures 5, 6, 7, and 8. These diagrams describe the building blocks for totally integrated computer, data and communications facilities needed to provide automated interfaces to potential MNR clients of the future through an NRIS. The steps are as follows:

- Existing and new transaction systems must be extended out to clients and end users, as a first step.
- An information warehouse must then be developed to service client information on demand, and for quality control and consistency of information for dissemination.
- The Ministry, its clients and end users must be networked together to facilitate internal and external information communication services.

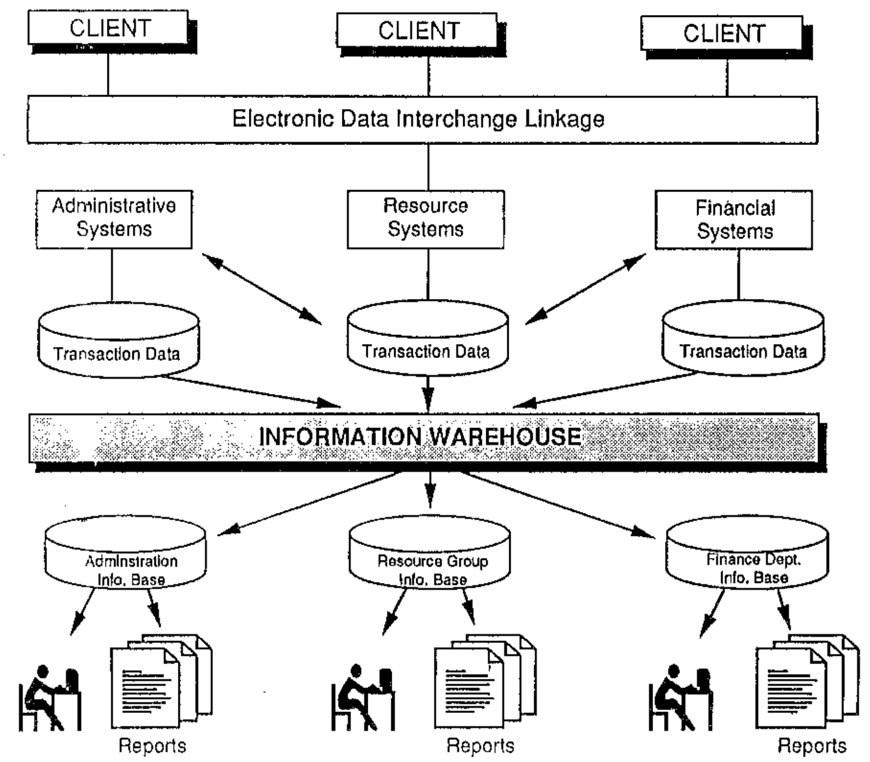
Extend the Transaction Systems Out to the Clients and End Users

Fig. 5



Install an Information Warehouse for Consistency and Control

Fig. 6



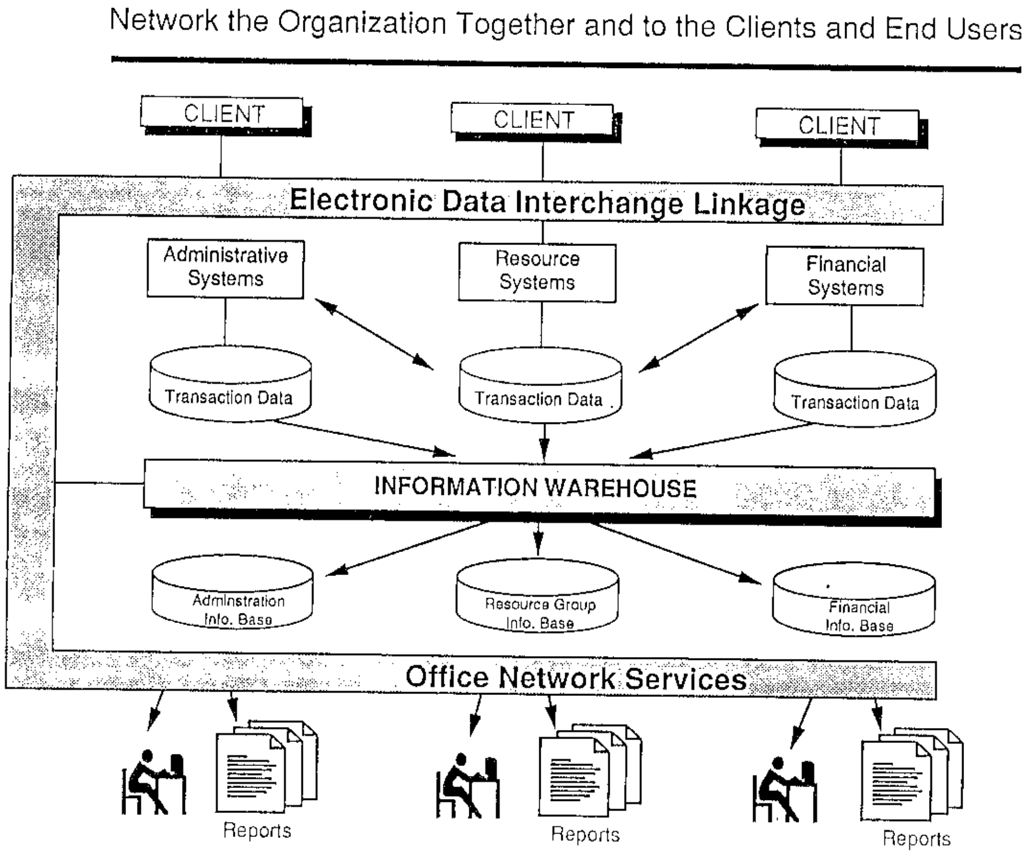

Network the Organization Together and to the Clients and End Users
CLIENT
CLIENT
CLIENT
Electronic Data Interchange Linkage
Administrative Systems
Resource Systems
Financial Systems
Transaction Data
Transaction Data
Transaction Data
INFORMATION WAREHOUSE
Administration Info. Base
Resource Group Info. Base
Financial Info. Base
Office Network Services
Reports
Reports
Reports

Fig. 7

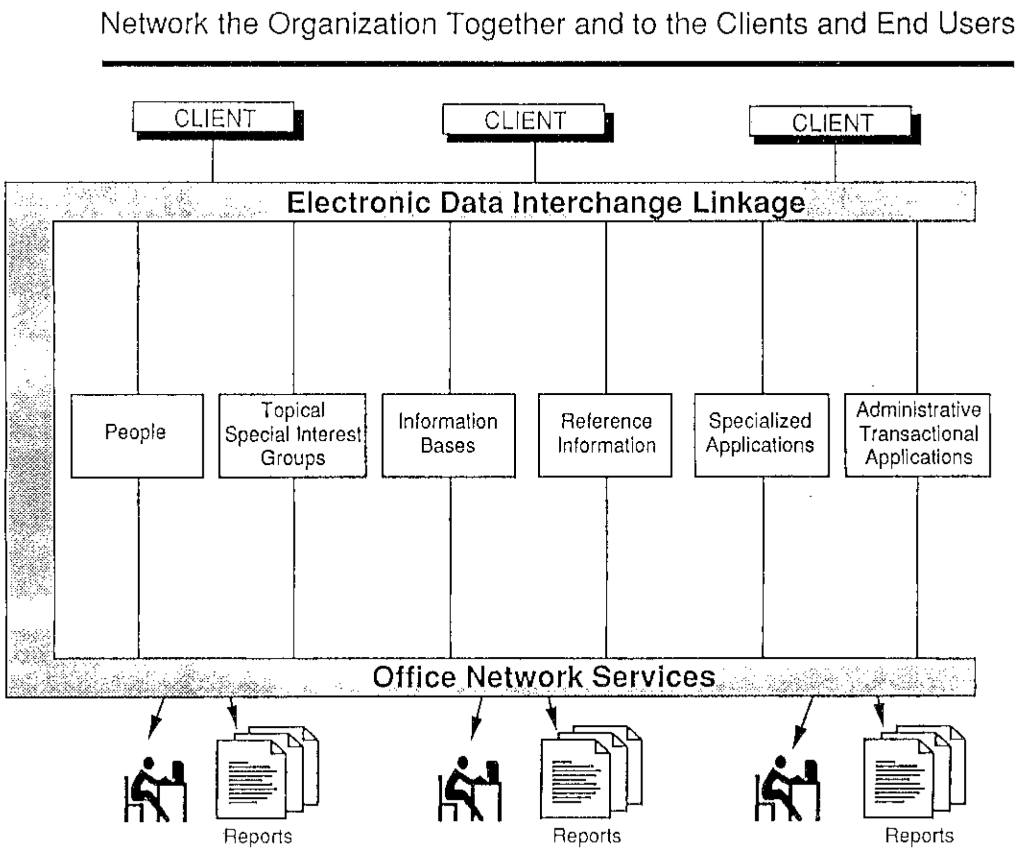

Network the Organization Together and to the Clients and End Users
CLIENT
CLIENT
CLIENT
Electronic Data Interchange Linkage
People
Topical Special Interest Groups
Information Bases
Reference Information
Specialized Applications
Administrative Transactional Applications
Office Network Services
Reports
Reports
Reports

Fig. 8

- The final view of NRIS shows an environment in which MNR's external clients and its own staff are communicating either through EDI linkages or other network services, with people they need to communicate with, with topical special interest groups, directly with information databases, having electronic availability of reference information, able to use specialized systems applications and tools, and having access to transactional systems.

Conclusion

All the lessons of the decade of the '80s will be used in the design development and implementation of an NRIS for the 1990s.

- It will be based on customer needs.
- It will be based on sound information management principles.
- It will be dependent on the development of data-driven, interactive, integrated natural resource information systems.
- It will use cost effective, technological solutions which will integrate GIS/MIS and other information technologies.

What will NRIS mean for you

The Public	- Faster and better answers to all natural resource information requested of MNR. - Greater and more informed public participation in planning and managing Ontario's natural resources.
The Government	- Improved and more timely information to Cabinet - Improved resource management practices - Improved credibility - Inter-Ministry information sharing
MNR Partners	- Ability to better share information and communicate with MNR, especially digitally - Strengthened partnerships
Industry	- Improved private/public sector cooperation - Could assist in improving profitability

Ontario's Municipalities	- Would assist in improving their services - Would speed up land use approval processes
Other Governments	- Provides data for cooperative programs and policies - Improves joint government initiatives in natural resources management.

---APPLAUSE

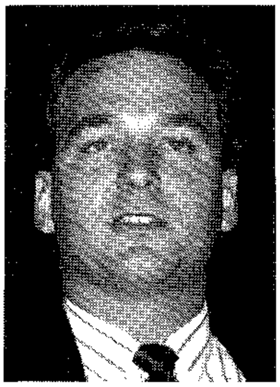
CHAIRMAN COSTELLO: Thank you, John.

Our next presentation is by John Houweling. John has degrees in Science and Environmental Planning as well as a diploma in Scientific Computer Programming. His educational background and multi-faceted career in GIS during the past decade has well suited him for his present position as Manager GIS Applications and Technology Transfer in the Surveys, Mapping and Remote Sensing Branch of the Ministry of Natural Resources where he has become a competent authority on GIS applications.

Amongst his many functions is the promotion of GIS technology and the use of the various GIS related standards the province has developed or adopted. In this capacity John is responsible for LOCUS FOCUS the GIS newsletter published by the Ministry, providing demonstrations to illustrate the capabilities of GIS and a host of other things including the co-ordination of this Seminar. Many organizations including municipalities come to John for advice with respect to GIS. He currently sits on several provincial and municipal committees and has just recently been seconded to devote his full time to the "MNR GIS Model Project".

During his experience with a large variety of different digital mapping and related data base applications John has come face to face with several such applications that require the third dimension "height". It is his experience in several such applications from which he will be drawing on in his presentation today "A 3-D Perspective". Ladies and gentlemen please welcome John Houweling.

A 3D PERSPECTIVE



JOHN HOUWELING
Manager - GIS Applications and Technology Transfer
Ministry of Natural Resources

DIGITAL ELEVATION DATA

The human race has long been fascinated with a need to represent the variability of the surface of the earth. A number of techniques have been developed in order to depict the terrain character. These techniques range from highly abstract, simple symbolic products such as topographic maps with contours to highly realistic, fully textured coloured images. Coupled with this desire to produce images which are indistinguishable from reality was a need to do various types of modelling and manipulation of the relief data[1].

The most common form of representing the earth's relief on a two dimensional surface is a contour. Traditional topographic maps include contours of varying width and colour to aid the map user in interpreting the "lie of the land". The contour, however, does not lend itself readily for applications such as cut and fill calculations, slope and aspect maps, watershed delineation and 3-D perspectives. Consequently, other methods were developed to meet these new user requirements.

SOURCES

The acquisition of terrain data is very important since it determines the ultimate application(s) for which the data can be utilized. As an example, spot heights taken from 1:50 000 aerial photography do not have the inherent accuracy for road design engineering type applications. It is therefore critical to have rigorous data capture standards to ensure the fidelity and accuracy of the topographic data. There are three main sources of terrain data (Figure 1):

---

[1] Raper, J. (1989). Three dimensional applications in Geographical Information Systems. Taylor & Francis, London.

1. land topographic surveys
2. stereoscopic aerial photographs, and
3. airborne/spaceborne remotely sensed imagery.

SAMPLING TYPES

Digital Elevation Data (DED) can be defined as a set of numerical spot heights which depict the topographic character of the earth's surface. The most realistic depiction of the earth's surface would require an infinitely large sample of DED. Various sampling techniques have been developed in order to obtain a representative sample; where a representative sample is defined as one that contains enough information to accurately define the elevation of surrounding points to within a specified level of accuracy.

There are three main types of sampling techniques: random, stratified, and systematic. Each of these techniques are further divided into aligned or unaligned (figure 2). Aligned simply entails either fixing the X or Y co-ordinate while the other is chosen randomly. Unaligned sampling occurs when each point is selected randomly. Briefly, random sampling involves capturing a subset of points randomly from the entire population. Stratified sampling is a process by which the population is broken into sub-populations called strata and then an independent subset is taken from each. Lastly, a systematic approach involves dividing the entire population into equally sized strata similar to grid cells and then taking a sample either at an exact location within each cell (aligned) or at a random location within each cell (unaligned).

DIGITAL TOPOGRAPHIC DATA BASE

In Ontario the Digital Topographic Data Base (DTDB) is the framework for all medium scale GIS applications. A brief history of the DTDB is included for reference purposes. In 1977 the Ontario Cabinet gave the Ministry of Natural Resources the mandate to: "describe the landmass of Ontario". The Ministry decided to implement its new mandate through the Ontario Basic Mapping Program. Changes in hardware and the maturing of Geographical Information Systems (GIS) software in the early 80s coupled with the demand for digital data provided the impetus for the 1986 decision to go entirely digital. The "Ontario Government Specifications for Digital Topographic Data and Cartographic Representation at Medium Scales" (Specs) outline the requirements to which the Mapping Contractors must adhere in data collection.

Common Standards

The DTDB is based on the Universal Transverse Mercator (UTM) Mapping Co-ordinate Grid System. NAD27 (May 1976 Adjustment) is the horizontal datum with an expected change to NAD83 shortly. Northern Ontario is mapped at an output scale of 1:20 000 from 1:50 000 aerial photography while southern Ontario is mapped at an output scale of 1:10 000 derived from 1:30 000 aerial photography. Positions of all topographic features are defined by a feature code and as two dimensional co-ordinates. The Specs also request a three-dimensional file of point features patterned over the entire map.

Hypsography - Collection of the Digital Elevation Data

The Specs require that two types of point elevations be collected. Points are to be digitized along scan lines in a static mode at a density of 2mm at photo scale. This translates to a point every 60 metres in southern Ontario and a point every 100 meters in northern Ontario. In addition to these regularly spaced points the following breaklines are to be collected at no less than three times the scan line density: crowns of hills, bottoms of depressions, water courses, lake edges, roads and railways. Figure 3 illustrates the scanline and breakline data for a DTDB mapsheet. For purposes of continuity between sheets elevation points are to be provided to two scan lines outside of the mapsheet boundary.

In terms of point elevation accuracy the specs state:

> "Point elevations will be assigned an accuracy code which is dependent on the method of collection (e.g., scale of photography) or on the physical conditions prevailing (e.g., obscured by bush, etc.)."

The Specs also state that ninety per cent of all cartographic spot elevations must be accurate to within one quarter of the contour interval. This computes to 1.25 metres for the 1:10 000 scale maps, and 2.5 metres for the 1:20 000 scale maps. The Specs outline three classes of accuracy codes XXXU - unknown (obscured), XXXS - a field survey elevation, XXXX - other points, where XXX indicates the scale of photography.

Assessment of DED Geometric Fidelity

In 1987, the Ministry of Natural Resources contracted the University of Toronto, Erindale Campus, to research the literature for alternate methods of DED capture applicable to the DTDB program. Part of the study was devoted to assessing the current accuracy of the

Digital Elevation Data in the DTDB. Three test areas were selected based on them being representative of the physiography of Ontario: the rural farming and urban areas of southern Ontario (moderate topography); the hilly forested areas of the Canadian Shield (rough topography); and the flat marshy areas of northern Ontario (flat topography)[2].

The results of the study found that the estimated accuracy (standard deviation) of the DTDB digital elevation data was: 0.73 m in southern Ontario and 0.81 m in northern Ontario[2].

Quality Control

The Monitoring area of the Digital Topographic Data Base Unit uses the DED to create contour plots for each mapsheet. A inspector checks the contour plot for any spikes which are readily identifiable by a whirlpool like structure. The contour plot also includes a point indicating the locations of each of the digital elevation points collected by the contractor (figure 4). Point locations are checked by the inspectors to ensure that the contractor has followed the Specs, i.e. triple the density along breaklines and a point every 2 mm at photo scale.

DEVELOPMENT APPLICATIONS

One of the goals of the GIS Applications & Technology Transfer Unit is to ensure the utility of the Digital Topographic Data Base. This goal is accomplished through joint GIS applications with groups at all levels of government. Usually the process entails familiarizing a user with GIS technology and then helping them automate applications previously performed manually. This type of arrangement creates a win/win situation. The user learns the technology and gains an understanding of the DTDB. The Geographical Information Services Section gains by further developing the DTDB market by ensuring it meets the needs of all users.

Digital elevation data can be used to generate a variety of products. These end products can be in the form of:

---

[2] Wassef, A.M. (1987). Toward an Accurate Reasonably-priced Digital Elevation Model for Ontario. Contract report to the Ministry of Natural Resources, Toronto, Ontario.

1) contour line maps;
2) cut-and-fill calculations;
3) three-dimensional display of landforms;
4) profiles and cross-sections;
5) visibility maps;
6) slope and aspect maps;
7) as a surface on which to drape other information;
8) shaded relief maps;
9) drainage network and drainage basin delineations; and
7) simulation models of landscapes and landscape processes [Burrough, 86]

The remainder of this paper discusses GATT applications in projects using the digital elevation data from the DTDB.

PAST

The early years of DED capture were devoted to the ability to generate contours from the resultant dataset - simply a case of automating the cartographic process. Many GIS software packages have the ability to generate contours from the DED. With most packages the user supplies the DED for the desired area and specifies the required contour interval. Although most packages are capable of producing contours at any specified interval, it is the user's responsibility to ascertain the source of the data.

Many of the early applications using DED were simply to produce contours as a background on thematic maps, e.g. soils, property parcels, or forest stands. The reasons for requesting contours were probably twofold:

1) contours are the traditional manner by which the topography was represented; and
2) at the time of the application most agencies did not have the hardware/software resources required to manipulate the digital data.

DED users began to recognize the need to break away from purely automating manual functions. This growing sophistication of users and the improvement in price/performance of computer hardware have been the driving force behind 3D software development. One significant development was the Triangulated Irregular Network (TIN).

TIN is a terrain model that creates a series of triangles from the DEM that are as close to equilateral as possible.

It has the ability to generate a terrain model from irregularly spaced points - enabling extra information to be collected in complex relief or alternately to have fewer points collected in areas of simple relief[3]. The TIN structure also provides the slope and aspect values for each triangle.

One of the first 3D applications which the GATT Unit undertook was on the Sleeping Giant landform. The application was a demonstration project to illustrate to users a number of products which could be produced from the DED and thereby possibly generate interest in the DED. The products generated were:

1) a contour map (Figure 5) - to ensure clients that these could be produced from the DED;
2) a perspective view (Figure 6) - a simplistic wire frame image;
3) a slope map classified into four slope categories (Figure 7);
4) an aspect map defining which parts of the landform faced north, south, east or west (Figure 8); and
5) a wildlife habitat scenario highlighting areas of moose habitat based on slope and aspect parameters (Figure 9).

It is important to note that many of the new applications require these basic tools in order to perform sophisticated analysis. Most GIS packages have incorporated these tools as commands in their software to enable users to generate these products easily.

PRESENT

Recent projects based on the digital elevation data are:

1. watershed delineation;
2. riparian rights buffer generation; and
3. incorporation of DED into remote sensing images.

A major difference between these new applications and those listed under the past is the

[3] Burrough, P.A. (1986). Principles of Geographical Information Systems for Land Resources Assessment. Clarendon Press, Oxford.

requirement of the user to develop software which interfaces with a GIS package. Most commercial GIS software packages enable users to interface external models to them readily.

Watershed Delineation

This project involved automatic generation of the watershed boundaries from the DED. The area selected was the Neebing watershed near Thunder Bay. Neebing was selected since it is a small watershed and the DED was available from the Digital Topographic data Base.

The watershed delineation programs were written by Darko Poletto, a Supervisor in GATT responsible for GIS Applications. The program is based on an algorithm developed in the U.S. by Sue Jensen. The software tools were obtained from the U.S.G.S. and are part of a generic toolbox developed for hydrologic analysis. A number of other programs have been written to create the appropriate data sets, control the processing, and incorporate the resultant data into the Ministry GIS. (A further discussion of the process is found in the 1990 FALL edition of LOCUS FOCUS Newsletter.)

The process begins by obtaining the DED for the desired area (figure 10) - in this case the Neebing Watershed. Next a TIN DEM is created (figure 11). Then a grid DEM is created using an interpolation function; the grid data structure is required for the watershed algorithm. The data is then exported out of the proprietary GIS software and manipulated by the watershed program.

The resultant watersheds are imported back into the GIS for analysis and display (figure 12); the heavy line represents a manual attempt at defining the watershed boundary from several topographic maps.

The watershed boundaries generated from the manual and automated processes fall very close to one another. With a GIS there is also the ability to drape the resultant information onto a perspective view. Figure 13 shows the subwatersheds as polygons and shades them. A next step in this process may include thematic overlays of soils and forestry to enable modelling the soil retention of effective forestry practices on a subwatershed basis.

Riparian Rights Buffers

The "Timber Management Guidelines for the Protection of Fish Habitat" produced by the Ministry of Natural Resources require that forestry practises in Ontario be restricted along lakes and streams to a width based on slope at the shoreline. The width of these buffers has been shown to have important effects on water temperature, stream flow, sedimentation, nutrients, and oxygen in streams and, to a lesser extent, in lakes (Moore 1983).

Each District Office in the Ministry of Natural Resources is responsible for determining the buffer widths around all lakes and streams within its District. Using present techniques such as field surveys are time consuming, expensive and questionable in terms of accuracy. LU-CARIS was contracted by the Ministry to develop a method to accurately define the variable width buffers, as specified in the fisheries guidelines, from the DED as stored in the Digital Topographic Data Base. The figures as well as the text for this application have been provided by Grant Mitchell[4] of LU-CARIS.

The guidelines specify the following buffer widths based on slope:

SLOPE (percent)	BUFFER WIDTH (meters)
0 to 15	30
16 to 30	50
31 to 50	70
46 to 60	90

The process begins by obtaining the DED data for the area of interest. Figure 14 has the drainage features over top of the DED to show the triple density of points collected along the drainage features. The points are TINed. Next the software determines which points in the DED coincide with the drainage feature layer of the DTDB (Figure 15). These points are then selected out and the slope is determined along each side of the stream. Based on the slope value a side dependent variable width buffer is generated for each stream and lake in the dataset. The resultant buffers (Figure 16) are then available and can be analyzed in the GIS e.g. overlay the digital Forest Resource Inventory to determine the amount and type of vegetation in the buffer. Figure 17 illustrates how the resultant buffers can also be displayed over a 3D image.

[4] Mitchell, G. (1990). Slope-Dependent Side-Specific Riparian Buffer Strips. Technical Papers of the 1990 ESRI Users Conference, Palm Springs, California.

It should also be noted that other firms are capable of generating variable width buffers from the DED e.g. Dendron.

Remote Sensing Applications
The Ontario Centre for Remote Sensing uses the DED from the Digital Topographic Data Base for a variety of applications. With the availability of digital elevation data and digital remote sensing imagery, it is possible to generate three dimensional perspective scenes of landscapes. These scenes generated by computer have the effect of simulating the view of an observer looking out over the landscape at an oblique angle.

Figure 18 is a perspective view of the Sleeping Giant landform near Thunder Bay. The LANDSAT Thematic Mapper spectral data was co-registered with the rasterized digital elevation data from the DTDB. The resulting three dimensional terrain and landscape information was then mapped into two dimensional space using a perspective projection based on the location of the viewer. Figures 19 and 20 illustrate perspective scenes of the Sleeping Giant taken from the same location with no vertical exaggeration and a vertical exaggeration of two times [Mussakowski, unpublised].

DEDUCTIONS AND RECOMMENDATIONS

What have we learned from the 80s
In terms of terrain data most users are no longer satisfied with contours since they do not lend themselves readily to analytical modelling and manipulation. Therefore, new methods have been developed in order to model the earth's surface. Digital Elevation Data (DED) are a set of numerical spot heights which depict the topographic character of the earth's surface. The DED lends itself readily to 3D applications such as cut and fill calculations, slope and aspect maps, watershed delineation and 3D perspectives.

The Ministry of Natural Resources through the Ontario Basic Mapping program collects digital elevation data at medium mapping scales. The DED forms a part of the Digital Topographic Data Base (DTDB). A study determined that the point accuracy of the DED is less than one metre.

The GATT Unit over the past several years has been involved in a number of 3D applications. Most of the initial applications were based on generic GIS tools. Recently,

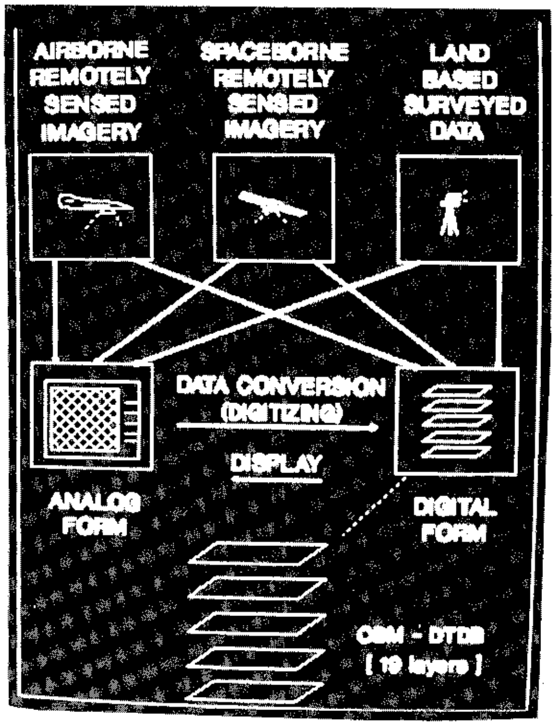


Fig. 1

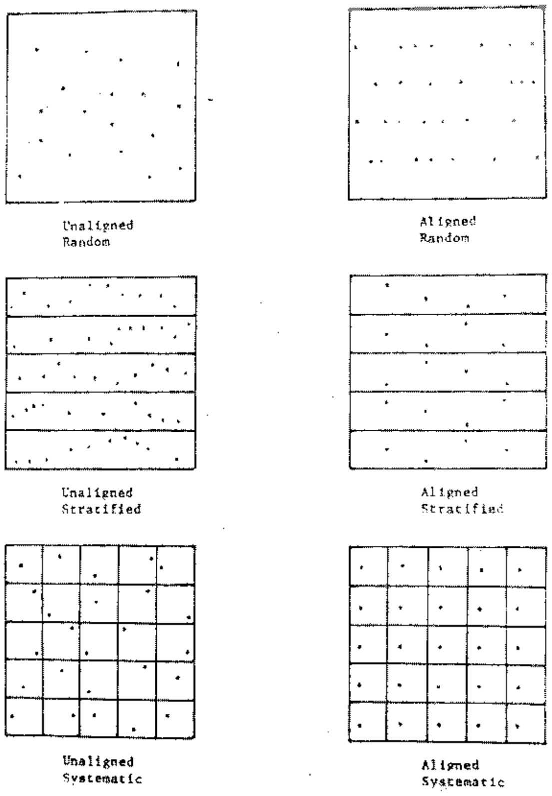


Fig. 2

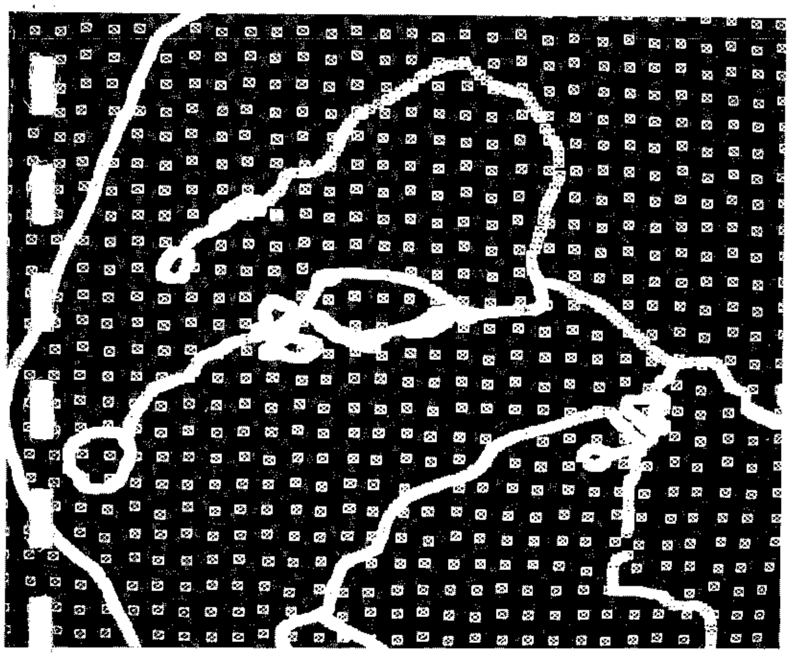


Fig. 3

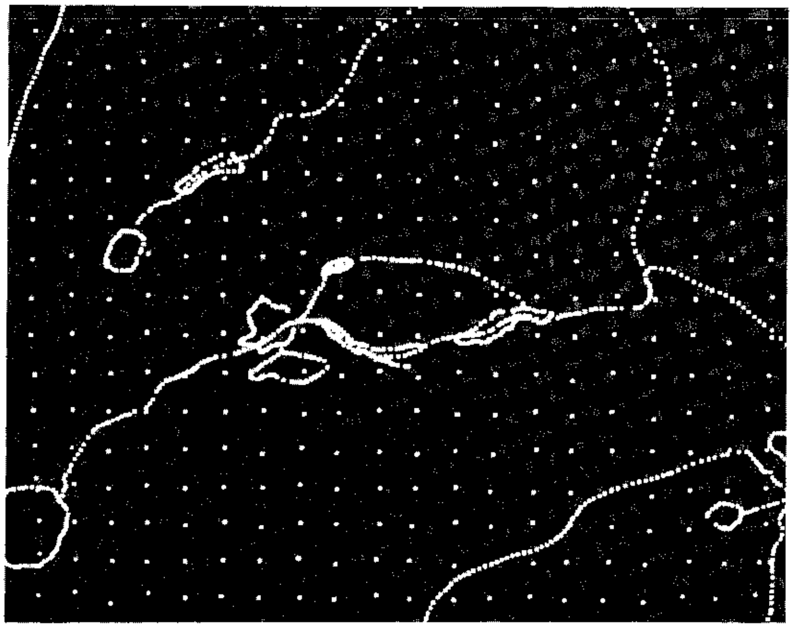


Fig. 4

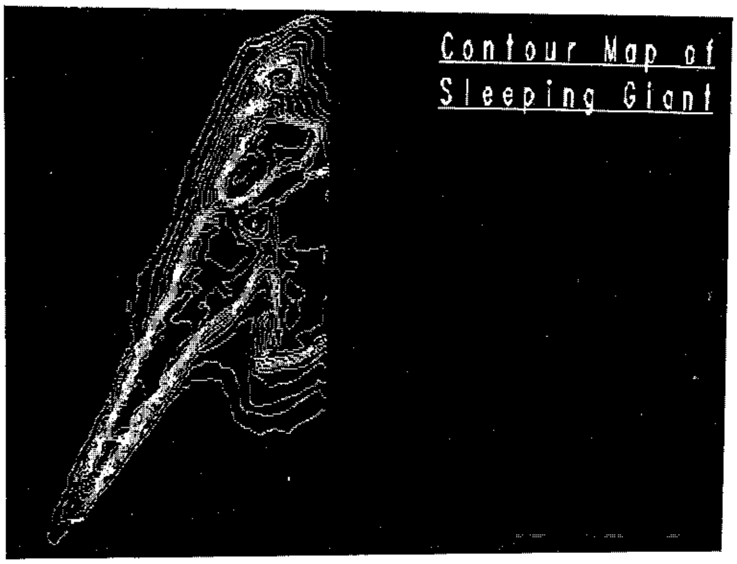


Fig. 5

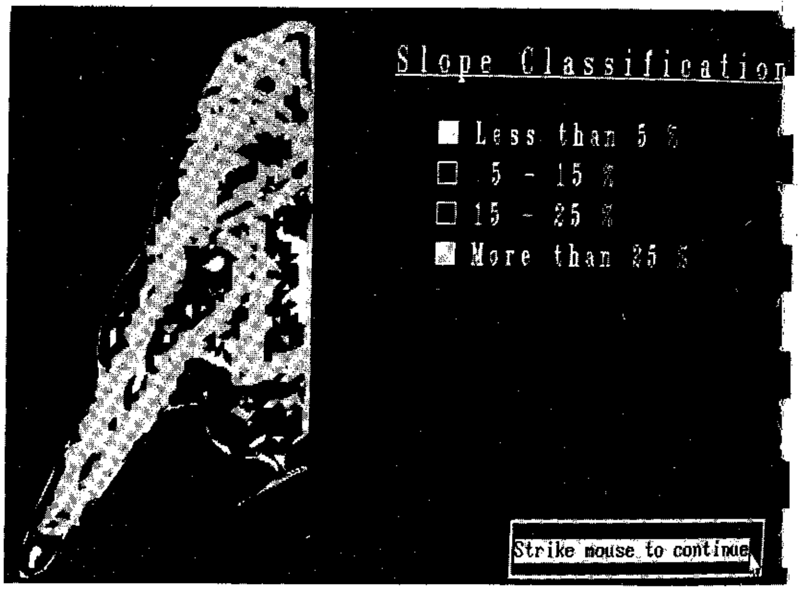


Fig. 7

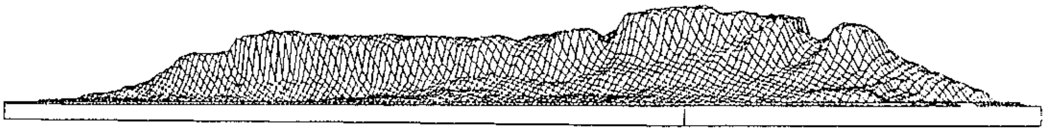
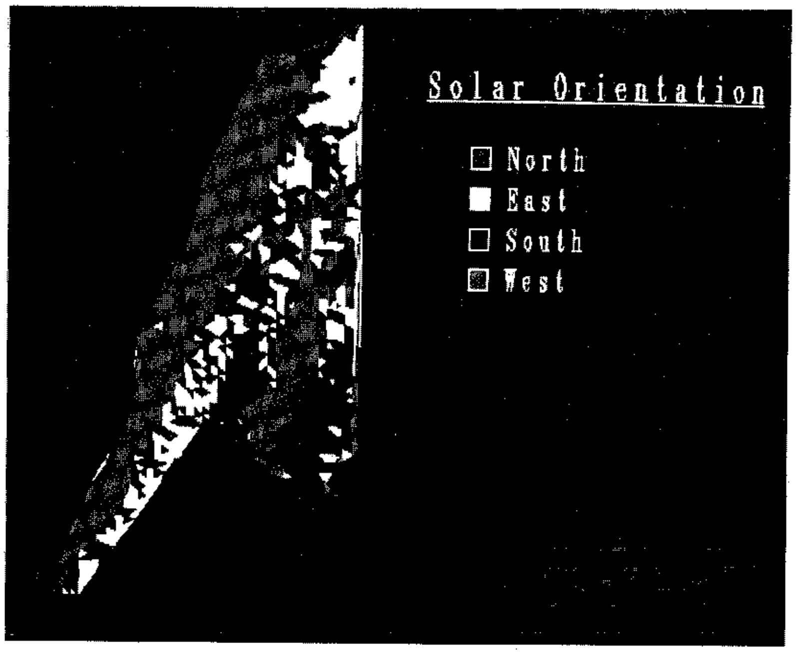


Fig. 6

Fig. 8



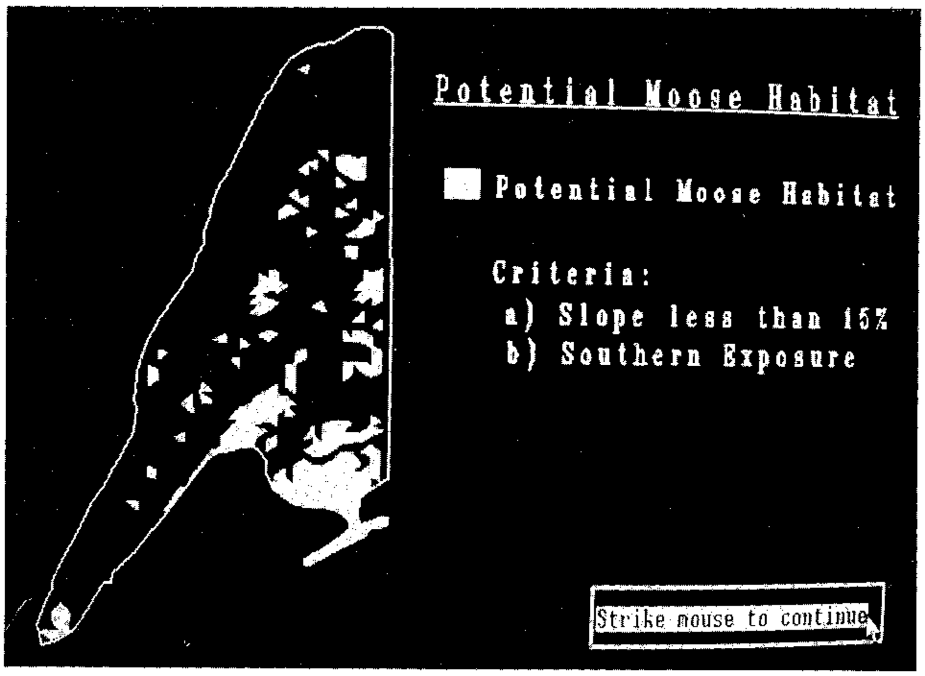


Fig. 9

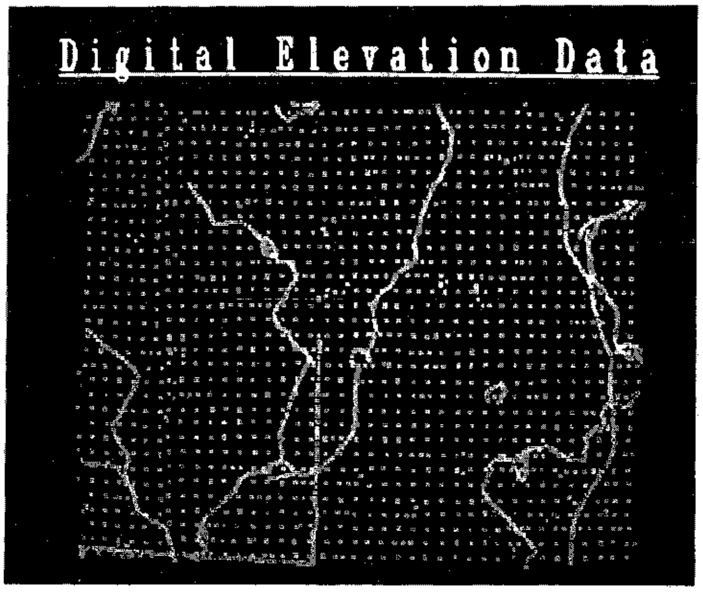


Fig. 10

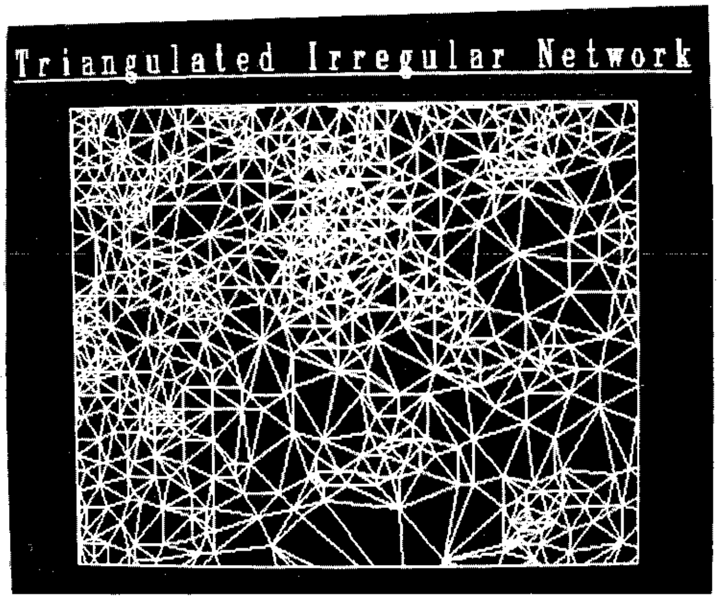


Fig. 11

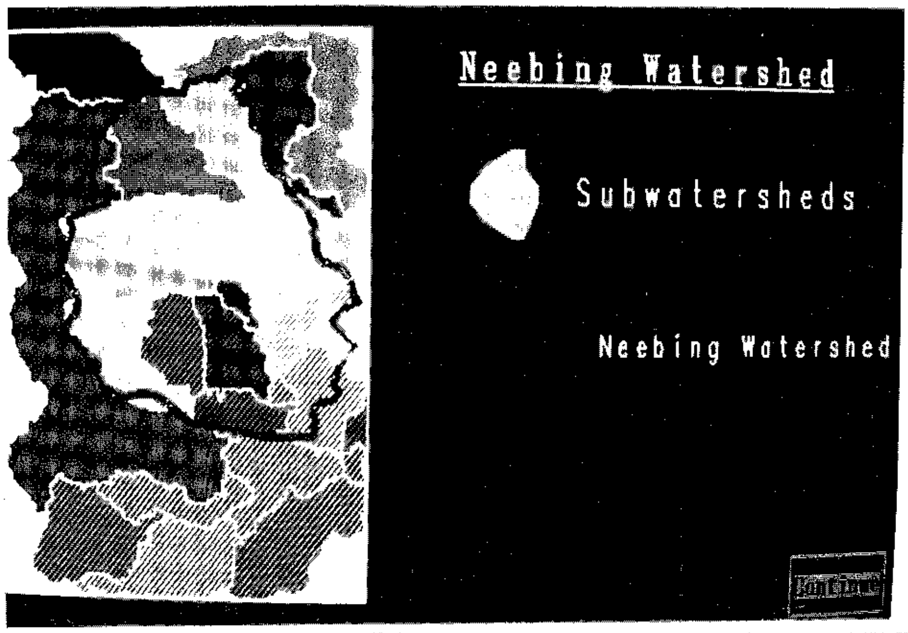


Fig. 12

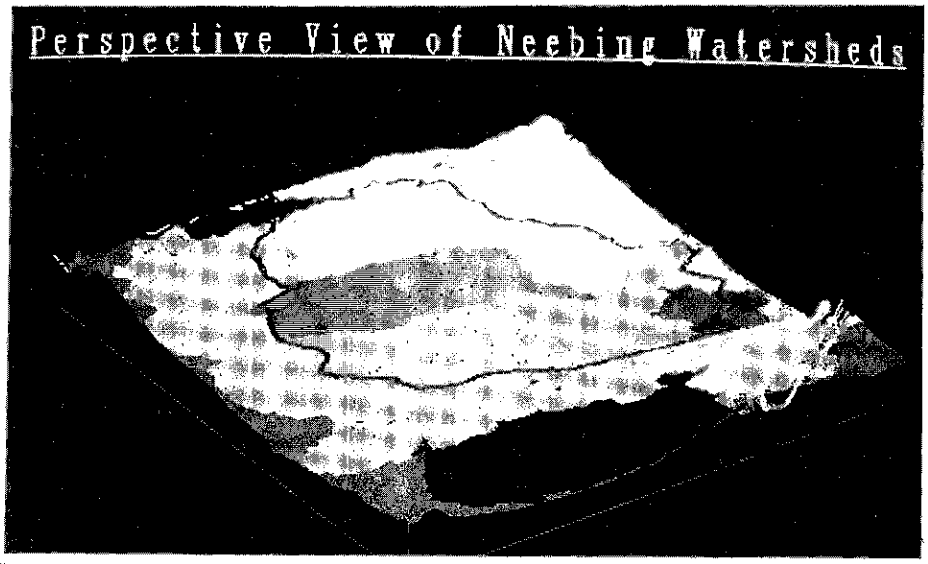


Fig. 13

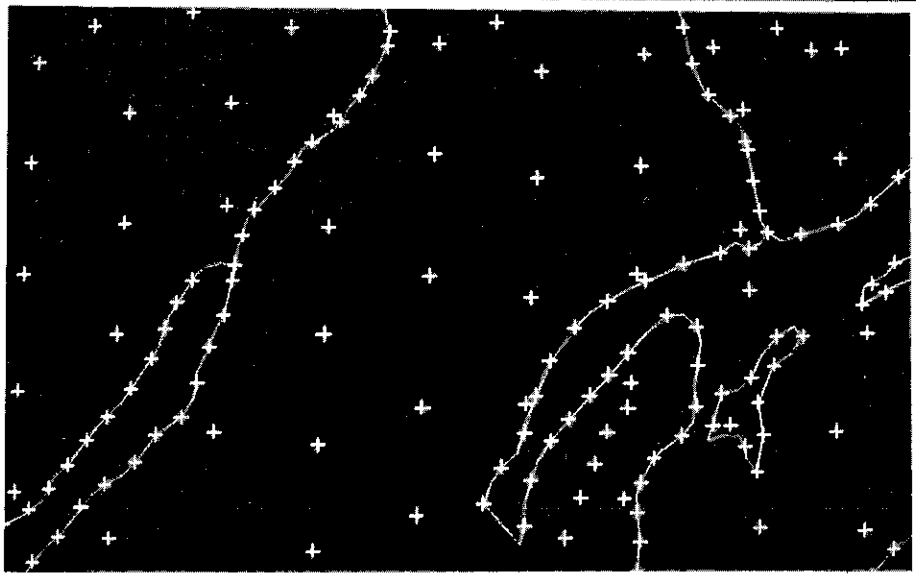


Fig. 14

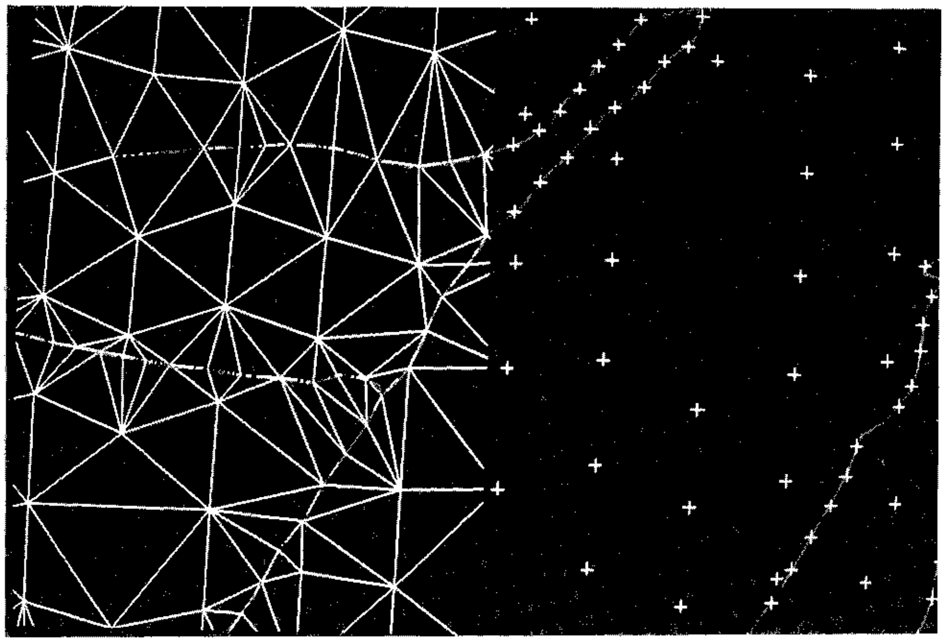


Fig. 15

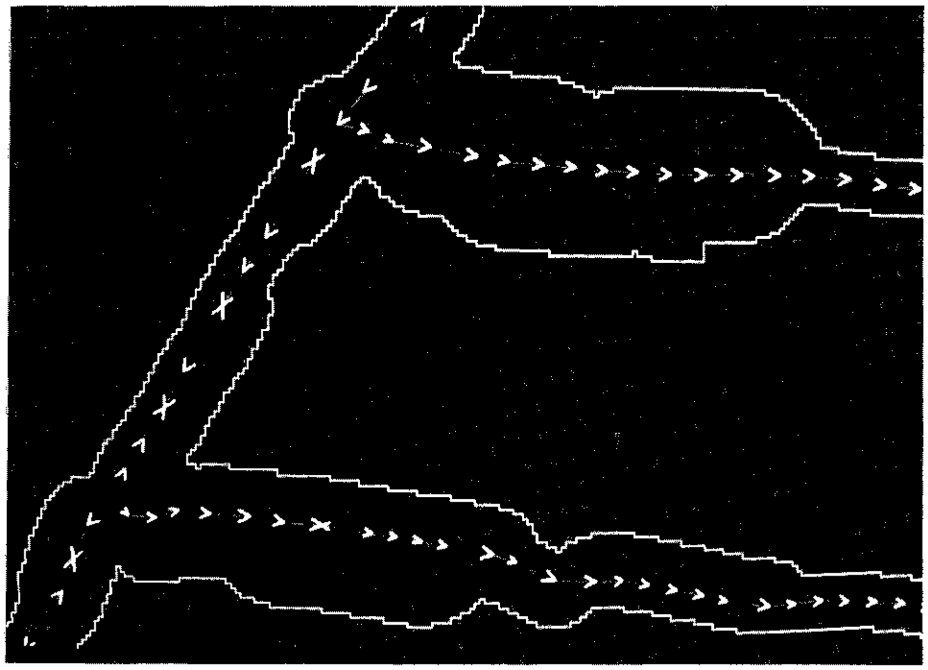
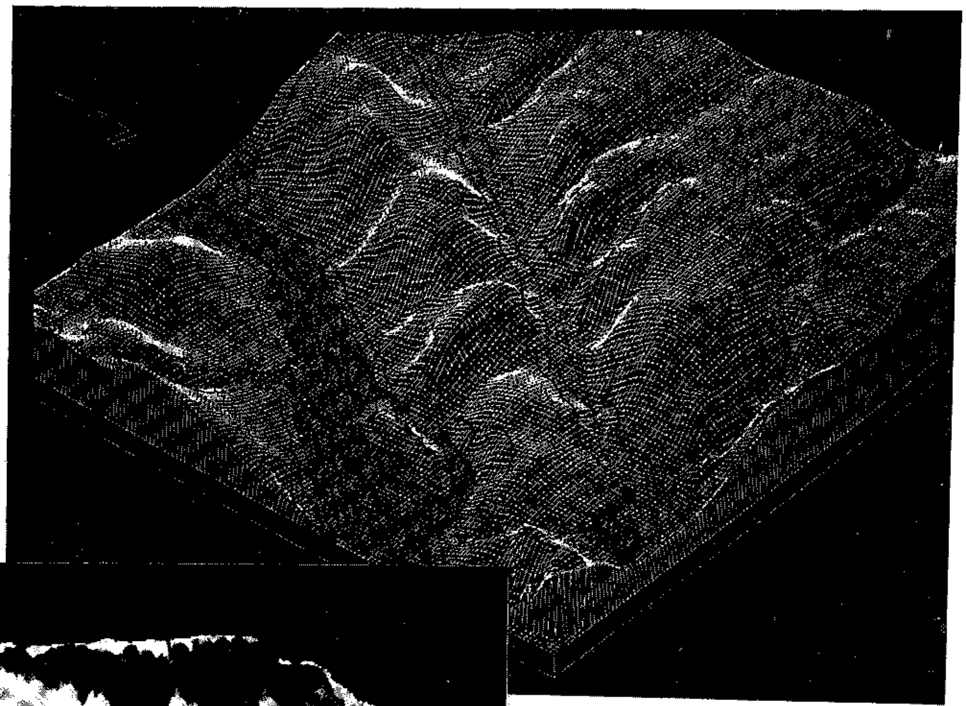


Fig. 16

Fig. 17



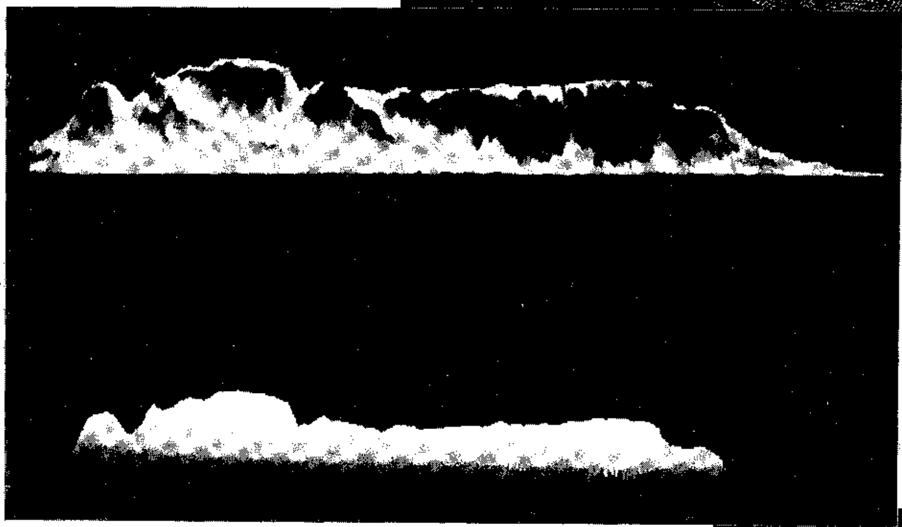
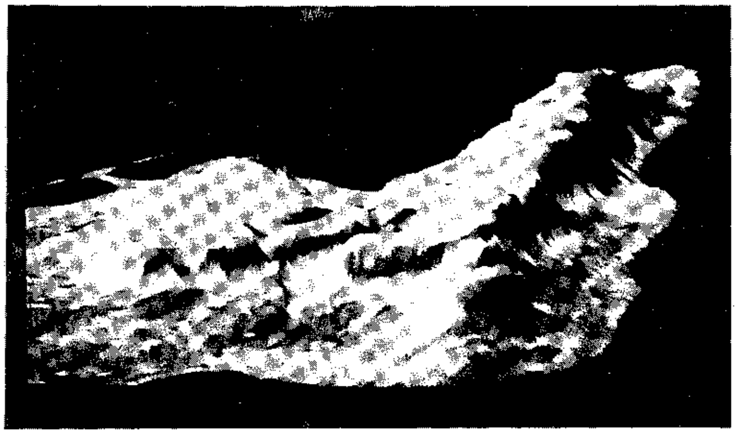
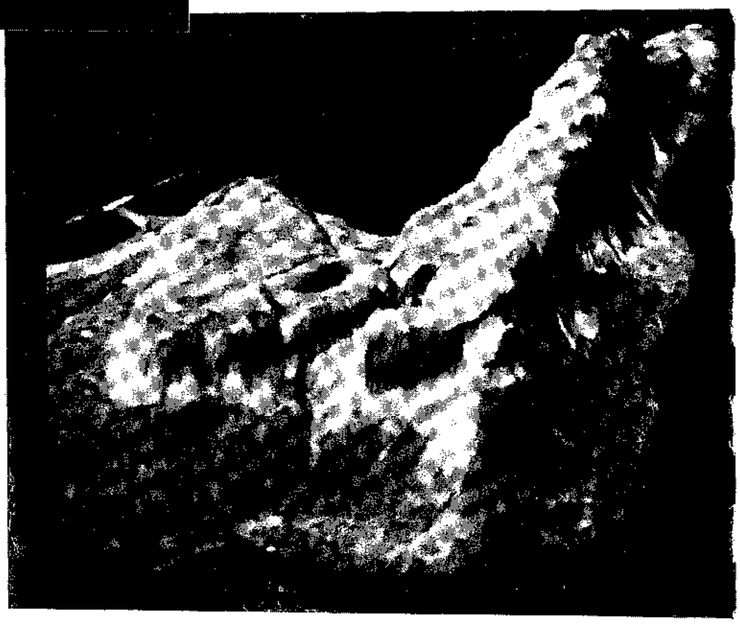


Fig. 18

Fig. 20

Fig. 19





users have become more sophisticated in their 3D application needs. These new applications usually involve writing of software to analyze the data and an interface with the commercial GIS software tools for further manipulation and display.

PROPOSED CHANGES FOR THE 90s

The 3D applications have provided the GATT Unit with many observations and consequently a number of recommendations. The first recommendation is that the digital elevation data feature coding for the DTDB be refined to categorize each of the DED points. Specifically, the Specs should be altered requiring that each digital elevation data point be feature coded as a:

1) mass point
2) obscured mass point
3) hydrographic breakline
4) transportation breakline
5) physical feature (top of break), or
6) physical feature (bottom of break).

The second recommendation is GIS software packages must provide new or additional tools for more versatile access to the DED stored in a system dependent data structure. Users are becoming more sophisticated in their 3D application requirements and GIS software packages are unable to satisfy these needs. The vendors therefore need to provide generic tools that will enable users to develop their own analysis and system interface tools that allow for uncomplicated DED access. Lastly, we have begun to see the integration of technologies such as GIS and Remote Sensing in 3D applications. Over the next few years there will be a greater demand by users to integrate various technologies in their quest to produce images or products that are indistinguishable from reality.

---APPLAUSE

CHAIRMAN COSTELLO: Thank you, John, for a very interesting and illustrative presentation.

Our next speaker on this afternoon's agenda is Nargis Ladha. Nargis is currently the supervising planner of the Computer Applications Section, Land Use and Environmental Planning Department, Ontario Hydro. That Department is responsible for conducting environmental assessments of transmission facilities. Nargis is in charge of all GIS and other computer applications for the Department.

She holds a Master's in Architecture degree from the University of Nairobi and a Masters in Environmental Studies from York University. Nargis has been with Ontario Hydro for the past ten years and has been involved in the setting up and implementation of several GIS systems. She is also currently involved in the development of the Ontario Hydro Corporate GIS.

Ladies and gentlemen, please welcome Nargis Ladha.

GIS APPLICATIONS FOR TRANSMISSION PLANNING

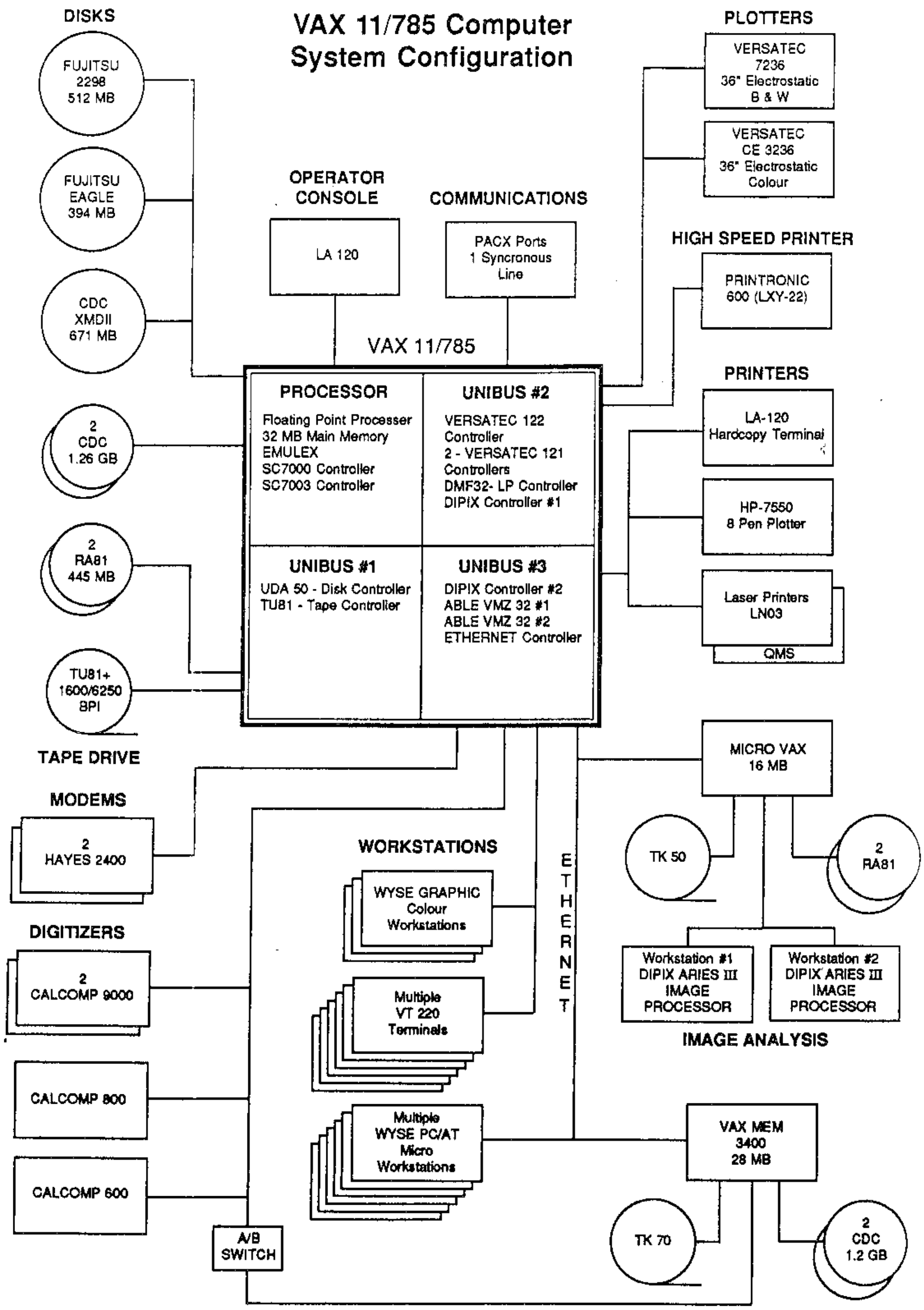
NARGIS LADHA
Supervising Planner, Computer Application Section
Ontario Hydro

At Ontario Hydro, we are constantly planning and building new generation and transmission facilities, all of which are subject to Government approval under the terms of the Environmental Assessment Act. The Land Use and Environmental Planning (LUEP) Department, which I represent, is responsible for conducting environmental assessments of proposed transmission facilities. In this paper I shall try to demonstrate how we have used GIS and its various components in the transmission planning process. I would like to share with you our experiences of the last 18 years in the use of this technology and would also like to share with you our thoughts on where we are going in the next couple of years.

And now for some background! The first law of computing is acronyms. The acronym for our system is CARSS. It stands for Computer Assistance for Route and Site Selection. It is a sum total of all the computing capabilities in the Department consisting of a variety of hardware and many kinds of application software. Although a major portion of CARSS is the GIS capabilities, we have integrated various business applications using the same hardware. The system has grown from its roots in GIS to becoming a tree that serves many functions and purposes. It provides computing facilities that support the entire environmental planning mandate of the Department.

CARSS was first developed in 1972 and we have moved from inputting data using card punching techniques and manually colouring output maps to what is considered today as a state-of-the-art integrated GIS system.

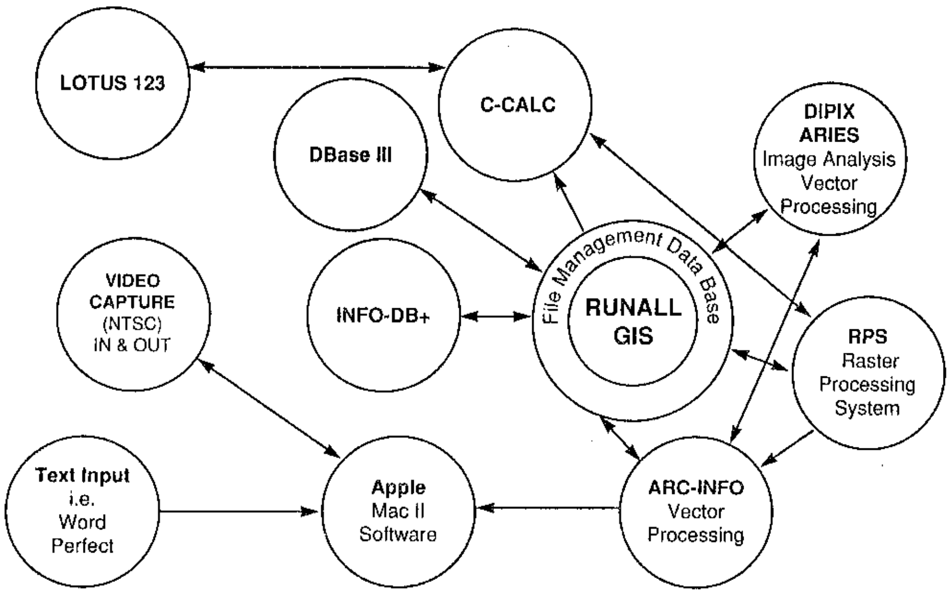
A system hardware configuration diagram follows on the next page. Briefly we have: a DEC VAX 11/785; VAX 3400; MicroVAX II; 6 PCs; 31 gigabytes of disk space; 4 tape drives; and 4 Apple Mac II microcomputers.


VAX 11/785 Computer System Configuration
DISKS
FUJITSU 2298 512 MB
FUJITSU EAGLE 394 MB
CDC XMDII 671 MB
2 CDC 1.26 GB
2 RA81 445 MB
TU81+ 1600/6250 BPI
TAPE DRIVE
OPERATOR CONSOLE
LA 120
COMMUNICATIONS
PACX Ports 1 Syncronous Line
VAX 11/785
PROCESSOR
Floating Point Processer
32 MB Main Memory
EMULEX
SC7000 Controller
SC7003 Controller
UNIBUS #2
VERSATEC 122 Controller
2 - VERSATEC 121 Controllers
DMF32- LP Controller
DIPIX Controller #1
UNIBUS #1
UDA 50 - Disk Controller
TU81 - Tape Controller
UNIBUS #3
DIPIX Controller #2
ABLE VMZ 32 #1
ABLE VMZ 32 #2
ETHERNET Controller
PLOTTERS
VERSATEC 7236 36" Electrostatic B & W
VERSATEC CE 3236 36" Electrostatic Colour
HIGH SPEED PRINTER
PRINTRONIC 600 (LXY-22)
PRINTERS
LA-120 Hardcopy Terminal
HP-7550 8 Pen Plotter
Laser Printers LN03
QMS
MODEMS
2 HAYES 2400
DIGITIZERS
2 CALCOMP 9000
CALCOMP 800
CALCOMP 600
A/B SWITCH
WORKSTATIONS
WYSE GRAPHIC Colour Workstations
Multiple VT 220 Terminals
Multiple WYSE PC/AT Micro Workstations
ETHERNET
MICRO VAX 16 MB
TK 50
2 RA81
Workstation #1 DIPIX ARIES III IMAGE PROCESSOR
Workstation #2 DIPIX ARIES III IMAGE PROCESSOR
IMAGE ANALYSIS
VAX MEM 3400 28 MB
TK 70
2 CDC 1.2 GB

In terms of software, we have our own in-house developed Raster Processing, data input, output and editing software; ESRI's ARC/INFO system; DIPIX image analysis software; and miscellaneous IBM PC and Apple related software packages.

The diagram below illustrates the various software components within CARSS including the data transfer capabilities.

Software Networking



Some of the software is developed in-house, some purchased as-is from external sources, some purchased and highly customized for our purposes; all are interconnected. Each component is designed to accommodate a different kind of spatial data, be it grid, image, or vector. CARSS is an integrated system in that data can be easily transferred between the different components. In addition, we also share data with other departments and external agencies. The essence is that we can record, store and output maps and produce new thematic maps and perform other non-mapped analysis for various planning activities.

The Planning Process

Let me now talk about how all of these computer facilities relate to transmission planning. The assessment process used by Departmental planners follows a constraint mapping approach and consists of two primary stages. During the first stage, planners collect, map and analyze environmental data at scales of between 1:250 000 and 1:50 000. The objective is to eliminate potentially high impact areas and to focus the study on those areas with a lower probability for impact. These lower impact areas are referred to as corridors, usually 2 to 5 kilometres in width.

The next stage of study is a more detailed one, usually using source data at a scale of 1:15 000 or 1:10 000. The objective of this stage is to locate alternative transmission line route alignments based on defining areas of minimal environmental constraint within the "corridors". It should also be noted here that the planning process is applied to linear facilities as opposed to specific sites. There is spatial variation in the environment being crossed and the system utilized must be flexible enough to account for these changes. After extensive evaluation and public involvement, a preferred alternative is selected and the study is presented to the public and to the government agency responsible for approving the proposed transmission facility.

The projects that we have handled using the CARSS system range between 10 km to 600 km of transmission line and the study areas involved often exceed 200 000 hectares of land. The volume of environmental data that must be mapped, analyzed and evaluated has lent itself to a successful GIS organization in which projects are completed and approved in a timely manner.

The following application examples demonstrate how the CARSS GIS has been used to assist within the transmission planning process. Examples have been chosen from projects that have been completed in the last 3 years.

Bulk Transmission West of London
The Bulk Transmission West of London project represents an upgrade of transmission facilities over approximately 300 km of transmission line. It covers a large part of southwestern Ontario from London to Sarnia and London to Chatham to Windsor.

The location of new transmission facilities requires that Ontario Hydro cross diverse environments, be it scenic countryside, productive agricultural lands, rich natural environments, or towns and cities. Consequently, the Study teams often include planners with an expertise in agriculture, forestry, biology, heritage, land use, mineral resources, recreation and socio-economic disciplines.

Under the EA Act, Ontario Hydro was committed to seeking public input and review of its planning process for this project. A key component of this public involvement process is centred around the notification of property owners that are directly or indirectly affected by proposed facilities. Hence, information such as owner name, mailing address and property location is required. For this purpose, the LUEP Department developed a GIS application using the general capabilities of the ARC/INFO system, called the Property Reporting Database.

The property fabric was digitized and an ARC/INFO database set up to accommodate the tabular digital data on addresses and ownership that was obtained from the Ministry of Revenue. The system has allowed planners to incorporate digital property information into their planning process by giving them the capability to generate lists of property owners who will be affected by construction of new transmission lines, to create up-to-date maps of existing property boundaries, to generate mailing lists and store comments related to various properties. Depending on the stage of the project, notification lists have ranged from within 100 m of a proposed facility alignment to all owners within an entire Study area. These lists have been generated using the buffering and neighbourhood analysis capabilities of the ARC/INFO system.

The ability to geographically locate oneself and then have data available for that location related to the environment, ownership, comments, etc. has made this application saleable. The PRDB application was successful and we decided to use the ARC/INFO system fully on the next project that came up. This was a proposal to increase the hydroelectric generating potential at Niagara Falls.

Sir Adam Beck Project

New and upgraded transmission facilities would have to be built to incorporate this additional power with the Bulk Electrical System. The Study area includes a large portion of the Niagara Peninsula between St. Catharines, Hamilton and Caledonia.

The Ontario Basic Mapping (OBM) digital data was not available at the outset of this project and so selected data layers were digitized from hard copy OBM base maps. The environmental data was collected, input and analyzed using the ARC/INFO system. Due to other project priorities, the input of all data for this project was consulted out and returned to us in an ARC/INFO proprietary export format. This is one of the first Hydro projects for which all data input work was contracted out.

The experience with Beck taught us that for successful GIS implementation, staff with project management/GIS experience is a must. As well, the terms of reference document for the contracting out work requires to be explicit in terms of digitization and setting up of the data base environment.

Another project that has recently been completed is the Supply to N.E. Ontario.

Supply to N.E. Ontario
The existing transmission facilities supplying northeastern Ontario will require reinforcement in 1990. Ontario Hydro is currently seeking approval to build a 230 kV transmission line, 550 km long from Crystal Falls (west of North Bay) to Kapuskasing.

For this project, approximately 50% of the Study area had OBM base maps available in digital format. With the assistance of Ontario Hydro's Surveys and Mapping Department and the Ministry of Natural Resources, we were able to obtain full base map coverage for this Study. This was the first time we had digitally transferred such a massive amount of data (175 OBM sheets). Of course there were some problems related to storage capacity, edge matching, data formats, transferability. However with the acquisition of more disk space and a better understanding from MNR of OBM data and its structuring, we were able to meet the project deadlines. This work of acquiring and transferring data took over 3 months.

Once the recommended route was selected, property-related information was digitized for the recommended route. We are now at the stage where approval is being sought. Once approved, the data is going to be utilized for developing rights-of-way selection plans and transfer documents at a scale of 1:5000 for use by construction staff.

The project was able to meet stringent time deadlines and there was no compromise on quality. As well, with the availability of OBM digital data, there was no need for photo mosaics or expensive orthophotography, resulting in further reductions in base mapping costs. For this project, we have used the capabilities of our in-house developed system for data input, output and analysis. The base map was imported via the ARC/INFO system and the full extent of capabilities of various systems was utilized.

Toronto Area Reinforcement Study

The CARSS system is currently being used for the Toronto Reinforcement Study. Between Sudbury and the Toronto Region there is a need for additional transmission facilities and the requirement for at least one new transformer station. In order to consider all routing and siting possibilities, a feasibility Study is being conducted at a map scale of 1:250 000 with the aim of reducing and refining the Study area. Upon completion of this stage a more traditional planning process will be followed wherein corridors and zones will be identified at a scale of 1:50 000. Afterwards the corridor stage routes and sites will be selected using a map scale of 1:10 000.

Again, we face the problem of acquiring a digital base. For this project we have used the scanned 1:250 000 National Topographic Series maps. As most of you are aware, this is simply graphic data and is not topologically structured. The data was acquired and loaded onto the CARSS system. The decision was made to structure the lake data only. Seven EMR sheets were acquired and used in this Study. The next stage is going to be done at 1:50 000 and we are currently reviewing our needs with the Ministry of Natural Resources about the possibility of using OBM data.

Combustion Turbine Unit

Besides doing projects for longer transmission lines, the CARSS system has also been used for smaller projects. We recently completed the Combustion Turbine Unit project using the ARC/INFO system. This study demonstrated the effectiveness of GIS for projects covering an area as small as included in a 10 km radius around generating station sites.

So what have we learned by being in this business?

Staff Resource Planning

With the increase in use and success of GIS applications for transmission projects, there is a tendency for unreasonable expectations on the part of planners. We are currently at the stage where we will be conducting four major projects on the system simultaneously. In our business, timely delivery of the product is a key productivity measure.

Two of the main problems we have faced are the lack of available experienced resources and underestimating of the work involved in the use of GIS. Staffing problems can possibly lead to failure in the implementation of GIS technology. While GIS production staff (digitizer operators) may not be hard to come by or train, experienced GIS project managers and application specialists are in short supply. Such people with GIS experience, generalized management/communication skills and strong interpersonal skills are a definite requirement.

If you are limited to one or two knowledgeable people who manage your entire system, you must develop contingency plans for the loss of that expertise. Disruptions caused by attritions, a leave of absence or a career change can have profound effects on your GIS project cycle.

The GIS industry has exploded to such an extent that we as a community have to develop a vision on dealing with this issue of resources.

System Useability

About five years ago, we were building user interfaces whereby our planners could conduct their own analysis and use the GIS in an interactive manner. With the increase in project workload and the introduction of new hardware and software on a periodic basis, we are finding that is not always possible to train all department staff to use GIS interactively. In our experience, a trained user must spend over 50% of their time on the GIS or they will forget much of what they have learned. Given the current project load of the LUEP Department, such a time commitment is not possible, hence the intention to give the system to the planners has changed.

We considered two alternatives:

- Retain dedicated operators who are responsible for all data input, management, and output activities but are hired at a clerical level and don't have the expertise to maximize applications development; or

- Train professional environmental planners in the use of this technology so that applications development is maximized at the expense of efficiency.

In reality, however, we have been forced to choose an in-between approach in which a Computer Applications Section has been created and staffed with people who have both GIS production experience and environmental planning experience. The sole responsibility of this section is computer applications. In addition, the section provides training and support to interested Departmental planners.

In general, we have learned that there are both technological and institutional barriers to successful GIS implementation. However, with management/organizational support, a few project champions, some solid project management experience and a well defined implementation strategy these barriers can be overcome.

Data Integration

As discussed earlier, the Land Use and Environmental Planning Department is an extensive user of mapped digital environmental data. We are therefore particularly interested in acquiring digital data directly from other sources where possible and have done so on many occasions. Such data is produced by Federal or Provincial agencies, by other Ontario Hydro Departments or by consultants and often must be converted for use on our CARSS system. Such data sharing is never an easy task because of the wide variety of GIS file formats, accuracy requirements, collection methods and quality control procedures. To this point we have used SIF as our interchange format of choice, however a provincial standard format is a definite requirement. Never take the data sharing process for granted; it can be expensive and time consuming. We have come across situations where our data did not match, or came in different projection systems or was referenced outside of Canada.

The area of digital data sharing offers a lot of opportunities but we have encountered several problems in doing so.

Futures

The future undoubtedly holds new developments for CARSS. Certainly there will continue to be on-going hardware and software upgrades and new applications development.

We are moving in directions that both respond to our collective wish lists and trends, both in the planning and computer industry. Development continues to modify the system and adapt it to changing requirements. Major areas of future development include:

- developing different ways and means of environmental modelling;
- improving user interaction with the system;
- refining the integration of the various components of the system;
- improving upon standards of data input, output and interchange;
- further exploring digital data sharing capabilities;
- developing alternative applications and uses;
- incorporating new technological innovations into the system;
- develop ability to use and create video images and integrate these with graphic and textual databases;
- installing workstation applications.

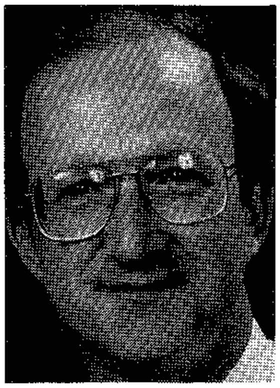
CARSS is an excellent example of a successful application of GIS in the planning process. It is being used to manipulate large volumes of data which would be impossible to manage or analyze manually. CARSS demonstrates how the integrated nature of a geographic, business and administrative system can be used successfully in the process of planning the location of high voltage transmission facilities.

CHAIRMAN COSTELLO: Thank you very much, Nargis.

Our last speaker for this afternoon is Brian Hart. Brian is the Manager of Surveys and Mapping with the Ontario Hydro. In this position, he is responsible for providing Survey and Mapping services to the Corporation. This includes amongst other things producing engineering data for the construction of new facilities and the development of a Corporate GIS. Brian is a professional engineer, having graduated from Queen's University in 1969. He is a member of the Canadian Institute of Surveying and Mapping and is currently the Chairman of the Spatial Information Management Committee of the Association of Ontario Land Surveyors.

Ladies and gentlemen, please welcome Brian Hart.

EXPLOITING THE THIRD DIMENSION IN THE DEVELOPMENT OF GEOGRAPHIC INFORMATION SYSTEMS - Taking the Next Step



BRIAN HART and JULIUS PALLADINO
Surveys and Mapping Department
Ontario Hydro

Introduction

The process of automation tends to take one of two forms. In one form, the products of an existing system are duplicated as closely as possible by replacing manual methods with computerized processes. In the other form, the existing process is totally redesigned to develop the best products to meet current and future needs. The first process tends to occur in mature or well-established organizations where there is often greater pressure to maintain the status quo. It represents the least risk to established profit patterns. The second process, that of re-engineering, is more often found in emerging areas and in younger organizations where there is less tradition on which to build. Re-engineering is also seen as a second iteration in those mature companies which are anxious to glean more than just an initial move toward automation.

The surveys and mapping industry unquestionably fell into the first category. It represented a mature industry which had been churning out essentially the same hardcopy products for hundreds of years. Throughout its history, incremental changes had been made to incorporate new procedures and technologies; however, the finished products changed very little. Computer automation represented one more improvement in this process. It has been going on for about twenty years now with the clear intent of replacing manually produced hard copy maps with computer generated products. Significant improvements in software and hardware over the years have brought the realization of this goal to some, while others are still struggling.

Because there had never been an effective way of integrating hardcopy map data directly into other technologies or areas of interest, there was little incentive to change the final map product during successive automation changes. Those setting base map standards did so primarily to satisfy their own technical and cartographic standards. The attention to standards for digital data has been driven from within the industry. Its focus is the map making process.

Today, the surveys and mapping industry is at a transitional point because the availability of geographic information systems has integrated the map maker with the map user to a degree which far exceeds anything seen in the past. It is essential that this is recognized as a point where re-engineering must take place if there is a genuine concern for continuity into the future. Rapid development of applications will place demands for data that have never been seen or met before. If the surveys and mapping industry does not adapt to the requirement and meet the challenge, the void will be filled either by some other group or by another technology.

One fundamental characteristic of an automated mapping system which illustrates this point is the manner in which geographical position is described. If the objective is to reproduce a standard hardcopy map, this can be accomplished with a two dimensional (2D) co-ordinate referencing system in X and Y . This is also a suitably adequate solution in terms of processing the data because it requires minimal memory and processing power. Although the possibility exists for including true three dimensional (3D) data, the option has often been rejected by many developers as being impractical for the job at hand. The database does not contain the vertical information. An addition to this basic structure or format allows the height component (Z-value) to be retained as a dependent variable at the basic data point. This allows easier production of isometric (terrain model) views of the topography and the graphical construction of any number of non-intersecting planes. This is often referred to as the 2.5D solution and it is intended to make the best of a limiting situation.

The prevailing concern is that systems built on these architectures cannot truly handle three-dimensional data where a surface could have more than one Z-value at any given location in XY. This is a physical situation which occurs commonly in nature and must be modeled in the new applications being designed today. For example, the topographic elevation, subsurface geology, magnetic field and gravity data may all be stored at the same XY co-ordinate. The problem does not end with the creation of three-dimensional graphic data, as the data base information related within the system must also be included in the analysis.

True three-dimensional co-ordinate references within an appropriate database construction offers the only lasting solution to this problem.

Expanding the GIS Vision

Up to the present time the majority of G.I.S. development has been channelled into several primary growth areas:

- municipal/LRIS,
- environmental assessment, and
- AM/FM.

Although each of these areas began development as separate entities, the use of common approaches and technologies has had the effect of bringing them together. Applications may be different, but the data base association and the basic graphical tools are largely the same. The definition boundaries have become blurred enough that it is often difficult to determine where one begins and the other stops. Even the professional organizations which represent these activities have merged or are finding it more and more difficult to remain totally distinct. This can be interpreted as a healthy sign for the G.I.S. industry as it communicates an integration of function, technology and purpose that will improve both efficiency and effectiveness. There is a danger, however, that G.I.S. could become too consolidated for this select set of users. Standards must be set with an eye on the future so that the family can grow to be as large as possible. The continued use of 2-D and 2.5-D systems is one factor that will limit universality of the tools.

The geoscientific community has always been a major user of maps, but not until recently has it started to develop ways of automating the analysis/interpretation and display of their data. The requirement is for a true three-dimensional analytical model where the typical height dimension of the model can be as large as the horizontal extent. There are few, if any, systems today which will allow full analysis of this type of data because of the complexities and discontinuities that can occur at boundaries. For example, representation of folded and faulted strata of rock require true three-dimensional capabilities. Without a true three-dimensional philosophy in both the data base and the graphic structure, this type of feature cannot be adequately analyzed. The term "Geo-scientific Information System", or GSIS has been coined to differentiate this approach from the more common two-dimensional GIS products.

In time, this 2D-3D distinction may disappear if the tools become universal. It is clearly indicated that the need for the fundamental map data to be truly three-dimensional is one of compatibility. The addition of the geoscience community to the GIS family, including geology, geophysics, hydrology and climate, etc., will represent a large increase to and a strengthening of the user base.

The engineering community has been involved in automation from the inception of computers. Engineering calculations were a natural starting point and it was not long before computer automated drafting (CAD) began to appear and to make graphics generation more productive. The necessity for handling three-dimensional objects was met early on, allowing the complete automation of some mechanical designs from drawing board to lathe. Later developments in three-dimensional design include aspects of materials management, routing and interference resolution, etc., which are parallel to GIS applications we are already familiar with.

Much has been said about the differences between CAD and GIS approaches. There have been differences, although not as great as most have suggested. What is important to recognize is that the end goal of both systems is almost identical and that the similarities are greater than the differences. Given the close ties which should exist between GIS and computer assisted design and drafting (CADD) systems, this is encouraging. The strength of three-dimensional analysis in the engineering environment should not be ignored however. If GIS is to grow in its ability to interact with the planning/design/construction or "engineering" market, it must strengthen its ability to use and manipulate three-dimensional data.

The extended GIS world includes users with requirements which may be outside the recognized bounds of the original user needs. Purveyors of GIS technology must show that it is flexible and accommodating to their needs. To do this, it must build on structures that are as open-ended and generic as possible. Full 3D capability, with powerful software applications, should be one of the cornerstones of such a system.

Visualization

In GIS, an underlying reason for adding graphics to geo-graphical information is the concept that a picture is worth a thousand words. It follows that a 3D picture must be worth a lot more than a flat one. Without first hand experience of visualizing your own specific data or application, it is difficult to fully realize the decision making power and speed of a 3D system.

Accurate scalar visualization frequently spawns new observations, approaches and ideas. How would familiar thematic data appear when analyzed and viewed in an appropriate 3D terrain model? Utility corridors become threads in space. Large surfaces of the earth (thousands of square kilometres or more) become flat dimpled objects. Our preconceived perception of their representation is often quite different from reality. This can awaken a new sense of creativity in finding new solutions to old problems.

Plan/profile drawings have long been the standard for the engineering of railways, roads and utilities. They became the standard despite drawbacks because they represented the best way in which data can be illustrated in two dimensions. With 3D, a truer representation of the landform can be constructed that offers new flexibility in analyzing, creating and displaying the design.

Walkthroughs (3D facility models) take on a new significance with geometrically corrected, life-like images. They can provide a significant design tool whether walking along the bottom of a lake or river bed or through a major generating plant. The information conveyed through this type of spatial model has even more significance when dealing with time dependent datasets. The skills of when and where to apply this technique will have to be acquired because they represent a significant change in the way we have been accustomed to approach problems.

The 3D environment hatches many special purpose tools. Easy to use interfaces are required to select and create model viewpoints which most appropriately complement specific data or images. In models, the most appropriate surface materials and lighting sources must also be easily created and sampled. The creation of the model itself should be a simple and repeatable task. In addition to visualization, this allows the broadest range of users to access instantaneous generation of custom selected contours, profiles and other volumetrics.

Thematic data should also be considered with respect to its 3D attributes. Better tools are required for network analysis where nodes such as roads, rivers and utilities have complex spatial relationships. Application solutions for vertical culture (overhead, underground) must be 3D in thinking, if not in design.

Support Tools

A limiting factor in the use of true three-dimensional analytical tools has been the availability of software and hardware which can accommodate both the volume of data and the processing speeds required. The machine dependency of many early GIS packages did not allow the user the flexibility to "mix and match" requirements to achieve optimum performance. Instead, it was the compromise solution which made the best of what one had. For the purchasers of new systems, and for those in emerging disciplines, this is no longer the case.

There are a number of mini-computers and workstations available in the marketplace which are capable of doing real-time processing on practical amounts of three- dimensional data. The number will increase rapidly because of competition and improving technology. Recent releases by major manufacturers have created new performance benchmarks that cannot be ignored by the traditional GIS suppliers. A typical 40 MIP processor will manipulate digital terrain models of 20 000 three dimensional points, in real-time; creating surfaces, rotating images, doing volume calculations and contouring on the screen as quickly as the image can be painted. Models of up to 50 000 three dimensional points can be handled in near real-time. The memory sizes and operating speeds are increasing at such a rate that the computer can no longer be looked on as a constraint to GIS processing capability. Increased care and attention will have to be taken to thoroughly evaluate the increased quantity of throughput and the improved quality of analysis when performing cost/benefit studies undertaken for the purchase of this equipment.

Viewing, manipulating and thinking in 3D will for most people require additional skills. The demands on software are just as great. Three-dimensional applications must be easy to operate and must include the flexibility to custom tailor output results. Off the shelf products may be suitable as interactive environments but they will not satisfy all user needs. UNIX operating systems and window environments have made life easier in this sense for both the programmer and the user.

The willingness of the existing GIS market to move quickly to exploit this capability of working in true 3D remains to be seen. On the surface, it may involve the upgrading or replacement of both hardware and software. It will certainly require enhancements to the fundamental structure of the database.

Summary

GIS is at a crossroads. The technology can remain focused on current applications or it can become a major player in the information technology field. If it is to fulfil this latter roll, it will only happen by design and not by accident. There are many factors that need to be addressed in terms of building this vision for the future and in terms of the tools that will be required to get it there. The capability to collect, store and analyze true 3D data is one of those issues. Because the common approach to GIS today is centred on the 2D solution, a change will be required.

The demand is real and the basic tools exist. Will you rise to meet the 3D challenge and make GIS stronger as a result?

--- APPLAUSE

CHAIRMAN COSTELLO: Thank you, Brian, that was an exceptional video.

Ladies and Gentlemen. That concludes today's session. Refreshments will be served in the exhibits room, starting at 4:45 pm, this evening.

FRIDAY MORNING SECOND SESSION, 21st SEPTEMBER 1990

SESSION CHAIRMAN

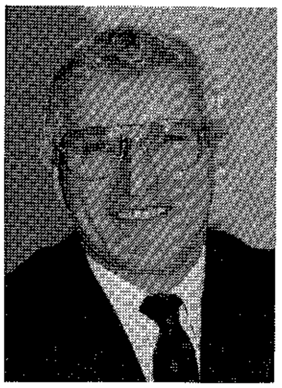
GABRIELLA ZILLMER
General Manager - Geographic Information Serivces
Ministry of Natural Resources

If you thought yesterday was a marathon, I'm sure you'll agree - looking at the agenda - we're headed for another one this morning. We have some excellent speakers and I'm sure you're looking forward to them as much as I am. On an administrative note, when you registered - anybody who pre-registered - received luncheon tickets. Those luncheon tickets are going to be required to get into the luncheon this afternoon, so if you've left your packet in the car or somewhere else, please pick up your ticket. If for some reason, your ticket has disappeared or you didn't get one, see Tom Malone at the registration desk during at coffee break, and he may be able to accommodate you.

Moving on, our first speaker on the agenda this morning is Ron Logan who is the Executive Director of Automated Information Systems for the Ministry of Consumer and Commercial Relations. Ron is, by profession, an Ontario Land Surveyor. He has worked in a variety of positions in the provincial government, in a career spanning many years. During his career, Ron has played a key role in the re-structuring and modernization of the Land Registry System in Ontario. From 1976 to 1980, Ron directed the research, design and development activity which resulted in an approved program for conversion to automation of the Land Registry System which is one of the oldest information systems in Ontario. In 1984, he assumed the role of Director of Land Registration and took on responsibility for implementing computerized land registration operations across the province. More recently, Ron has provided leadership for the Ministry of Consumer and Commercial Relations team which is negotiating to establish a strategic partnership with the private sector with respect to some aspects of the Land Registry System and that's what he's going to be talking to us about today.

Please join me in welcoming Ron Logan.

POLARIS UPDATE



RON LOGAN
Executive Director, Strategic Alliance Office
Ministry of Consumer and Commercial Relations

Introduction

The paper I will be delivering today is essentially the same as one delivered to the FIG 90 congress in Helsinki in June of this year. It includes early background material and commentary on the intervening events since the Report of the Law Reform Commission on the arrangements for land registration in Ontario in 1971. It does however focus on the make up of the POLARIS databases and how they will form the nucleus of a broader based land-related data distribution network in Ontario. In addition the concept of strategic partnership is reviewed and the status of activities to date to form a alliance between government and the private sector is highlighted. It is this concept that we believe highlights GIS/LRIS activity in the 90s.

Ontario, the second largest province in Canada, covers approximately 1 million square kilometres of which about 50% is undeveloped crown land. It is the most populated Province in Canada with about 9.6 [1] million people with the majority located in the most southerly 30% of the territory. This southerly area contains more than 75% of the 4 million patented land ownership, parcels recorded in the 65 Provincial land registry offices. Each county and district in Ontario has at least one land registry office within the jurisdictional area. Patented land may be registered under the Registry Act [2] or recorded under the Land Titles Act [3] depending on which statute is available in the given location. Currently there remains 31 offices which offer only Registry Act services, providing an index of registered

---

[1] Statistics Canada, *Quarterly Demographic Statistics for Canada, Provinces and Territories,* 1989.

[2] Ministry of the Attorney General, *Registry Act,* Ontario: Queen's Printer for Ontario, February 1988.

[3] Ministry of Attorney General, *Land Titles Act,* Ontario: Queen's Printer for Ontario, October 1988.

interests in chronological order but making no definitive statement regarding the validity of ownership interests claimed.

Both systems of land registration, the Registry Act since 1795 and the Land Titles Act since 1885, operated for more than one hundred years without substantial changes in context or practice. Both were labour intensive, paper driven recording systems which required storage and retrieval of indexes, parcel registers and original documents and plans. Use of the system required personal attendance at the land registry offices and usually resulted in repetitive searching through multiple books, documents and plans to complete a single property transaction. Minor changes or fixes in system procedures were initiated from time to time but it was the report [4] of the Ontario Law Reform Commission (1971) that triggered major reform of land registration in Ontario.

Background

The 1971 Law Reform Commission Report made far-reaching recommendations for change in the Land Registration System in the Province of Ontario. The recommendations of the Commission showed a great deal of foresight and three of these recommendations in particular were of major significance to the current involvement of the private sector in the arrangements for land registration. These were:

- "A computer system should be used for land registrations". [5]
- "An index that is derived from co-ordinates and designed in co-operation with other prospective users should be used". [6]
- "An improved land titles system should be the sole system for land registration in Ontario,....." [7]

[4] Department of Justice, *Report on Land Registration*: Ontario Law Reform Commission, Toronto: The Queen's Printer and Publisher, 1971.

[5] Ibid, chapter VII, p.64.

[6] Ibid, chapter VII, p.65.

[7] Ibid, chapter III, p.23

It will become clear later in this paper how these particular recommendations led to a design concept and implementation plan which became attractive to the private sector as the basis for a broader land-related information system industry.

In response to the Law Reform Commissions Report, studies by the Ministry of Consumer and Commercial Relations led to the completion of the Province of Ontario Land Registration And Information System (POLARIS) Concepts Report[8] in 1978 which received Cabinet approval in 1979. Work commenced in 1980 to develop these concepts into a series of improvements including:

- Changes and improvements to the legislation
- Introduction of a microfilm system for documents
- A system initiated certification of title for plans of subdivision registered since 1955
- The automation of the title records and the creation of digital property maps; and
- Aggregate information reporting.

This paper will report primarily on the automation aspects of the improvements which are being implemented and the relationship between this automation and the creation of a broader based system of land-related information services.

It was recognized at the start that the two POLARIS digital data bases required to automate the land registration system, also form basic components of a provincial automated land information system. To address the broader based requirements it was essential that a common frame of reference be built into this data base. This common frame of reference is geographic location on the earth's surface and is provided by relating all elements in the property mapping data base to the Provincial horizontal control network. In turn the property mapping data base serves as the unique land ownership parcel index that links ownership data and description data together.

[8] Ministry of Consumer and Commercial Relations, *An Improved Land Registration System for Ontario: An Executive Summary of the Design Concepts and Recommendations*, Volume #1 & #2, August 1979.

The Ministry chose to commence the testing and implementation of improvements by prototyping. The office chosen for the prototype was the land registry office in Woodstock which contains the records for the County of Oxford. The automation of the title files and the digital mapping files for the 40 000 properties in the County were completed in 1987. The public is now searching title at computer terminals and is able to make reference to a series of hard copy property maps which are plotted from the digital map base. In addition to piloting the registration system automation in Oxford County the Ministry, in partnership with the County Planning Department and two other Ministries, participated in building a complete land-related information system which provides the County with a fully automated decision making tool. In 1988 this system won an international award for small municipal land-related information systems.

The success of the Oxford prototype lead the Ministry to prepare and gain Cabinet approval for a POLARIS business case and operational plan which scheduled implementation of full automation preceded by several interim improvements in all 65 Provincial land registry office. POLARIS and the interim improvement would be implemented across the Province, over a 15 years timeframe, including the building of digital title files and digital property mapping files. The funds for this project would be recovered by an increase in the registration fees charged in the 65 Land Registry Offices. The offices which would be completed in the first five years included the 3 offices in Metropolitan Toronto, the 2 offices in Ottawa, 1 office in Sudbury and the office in Chatham. In total about 35% of the total number of land ownership parcels. Implementation in accordance with the plan commenced in Toronto and Chatham in 1988 and is continuing.

Prototyping in the Woodstock office did not include consideration of combining the two existing land registration statutes into one hybrid statute. Originally the Concept Report concluded that both the Registry and Land Titles system should be automated before the decision on what the final legal system should be was made. By 1987 POLARIS automation had rendered the operations under each statute to an almost identical practice and it was therefore appropriate to review the possibility of converting the legal base as earlier as recommended.

An important pilot project was established in the City of London. Ministry staff conducted property searches for properties in the northern part of the City and adjacent areas in Middlesex County. The purpose of this exercise is to test conversion of properties recorded under the Registry Act to the Land Titles System as part of automation. Approximately 37 000 properties have been converted, loaded onto the POLARIS data bases and used as the production system starting in November 1989. To date the results have been quite positive and extension of conversion to a land titles based legal system simultaneous with automation has been approved Province wide. The importance of this decision is best understood in the context of a broader based land-related information system discussed later in this paper.

This background precis sets the stage for a review of the main elements of POLARIS and the role they play in a land-related information system for use as a decision support system.

The Structure and Content of the Digital Files

As noted earlier two digital databases make up POLARIS: a digital property map file and an on-line automated title record. Currently these two databases operate independently but the necessary linkages to aggregate information from both have been developed as part of the unique parcel identification approach.

Digital Property Map Files

The property mapping database contains information on all surveyed township fabric, all recorded plans, ownership boundaries, water boundaries, municipal boundaries and the unique identifiers (PINs) created during the mapping process. Basically, the property mapping database is created by:

- Entering all of the six degree UTM co-ordinates of the horizontal control stations existing in the area to be mapped.
- Entering bearings and distances of surveyed limits which are connected to the horizontal control stations. Simplified information from connected co-ordinate geometry files is extracted and put into a least squares adjustment.
- Entering the bearings and distances from all other recorded plans of survey using co-ordinate geometry, and adjusting the data to fit the network obtained in the two steps documented above; and
- Adding ownership boundaries obtained from land registry office searches of each property.

In rural areas, the network obtained from the process just described can leave much of the area to be mapped undefined. It is then necessary to obtain the township lot fabric from the 1:10 000 topographic maps prepared by the Ministry of Natural Resources either directly from digital map files or through digitizing.

Automated Title Files

The two land registration statutes operating in Ontario impact on the structure of the title files. The automated title index database is by necessity a combination of a computerized version of the Abstract Index (Registry Act) and Parcel Register (Land Titles Act) with the records organized on a property ownership basis.

In terms of the amount of data loaded into the automated title files several alternatives were used. Some Registry Act records were loaded into the system with a full 40 year title file for each ownership interest, while others were loaded with only the title history from the last registered owner forward (last registered owner). For Land Titles, the entire title file for each parcel was loaded.

Due to data loading and storage cost considerations, Registry Act records for the rest of the province excluding Kent County, will be loaded on the basis of last registered owner if land titles conversion is not carried out as part of the automation process. The main features of the automated title system are:

- All updating to, and inquiry from the system is on-line in real time at a computer terminal;
- Registration of documents and plans is done at a terminal while the customer is present;
- An automatic sub-search of the title may be done as the document is being registered;
- Abstracting and certifying is done at a terminal;
- Property record maintenance due to consolidation and subdivision is fully automated;
- A push-button language change feature for English to French, French to English exists;
- Properties can be searched using a person's name, the municipal address of the property or the document number;
- Fully automated auditing and statistical reporting is available; and

- Searches can be customized, both on the screen or in a print out, to include, or exclude certain instruments which are no longer effective.

In practice access to the automated information continues to require considerable manual activity. The property map files are used to produce paper copies of the property index maps, as shown in Figure 1, for use in the land registry offices where the automated system is operating. These paper maps are used by clients to help locate properties and identify the PIN's of properties of interest and the adjoining properties. These PIN's are then used to access title information related to these properties from the automated title files. Access ranges from on-line direct access by users in the automated offices to staff produced information print-outs on request.

An example of a typical electronic abstract printout and the information available to clients is shown in Figure 2. Direct access title searching from a remote location has been tested but will not be feasible until the entire database, including documents, can be made available on-line.

Developing Provincial Land-related Information Systems

Computers have altered the way in which geographically referenced information about land is managed. For example, municipalities all over the world are beginning to make use of computerized Geographic Information Systems (GIS) to automate everything from mapping to complex land use analysis.

As Figure 3 illustrates Ontario's geographically related land information system rests on a base which consists of the Provincial horizontal control network, the Provincial topographic mapping and the Provincial property mapping. The Provincial property mapping base contains a unique property identifier number (PIN) for every property. This PIN, which is created during the POLARIS property mapping process, makes it possible to create cross reference indexes such as the assessment roll number/PIN index. These cross reference indexes allow other digital land-related databases to be referenced to ownership parcels. Land registration title data relating property ownership to property boundaries (PIN) has been shown to provide the vital information necessary for many land-related information systems applications.

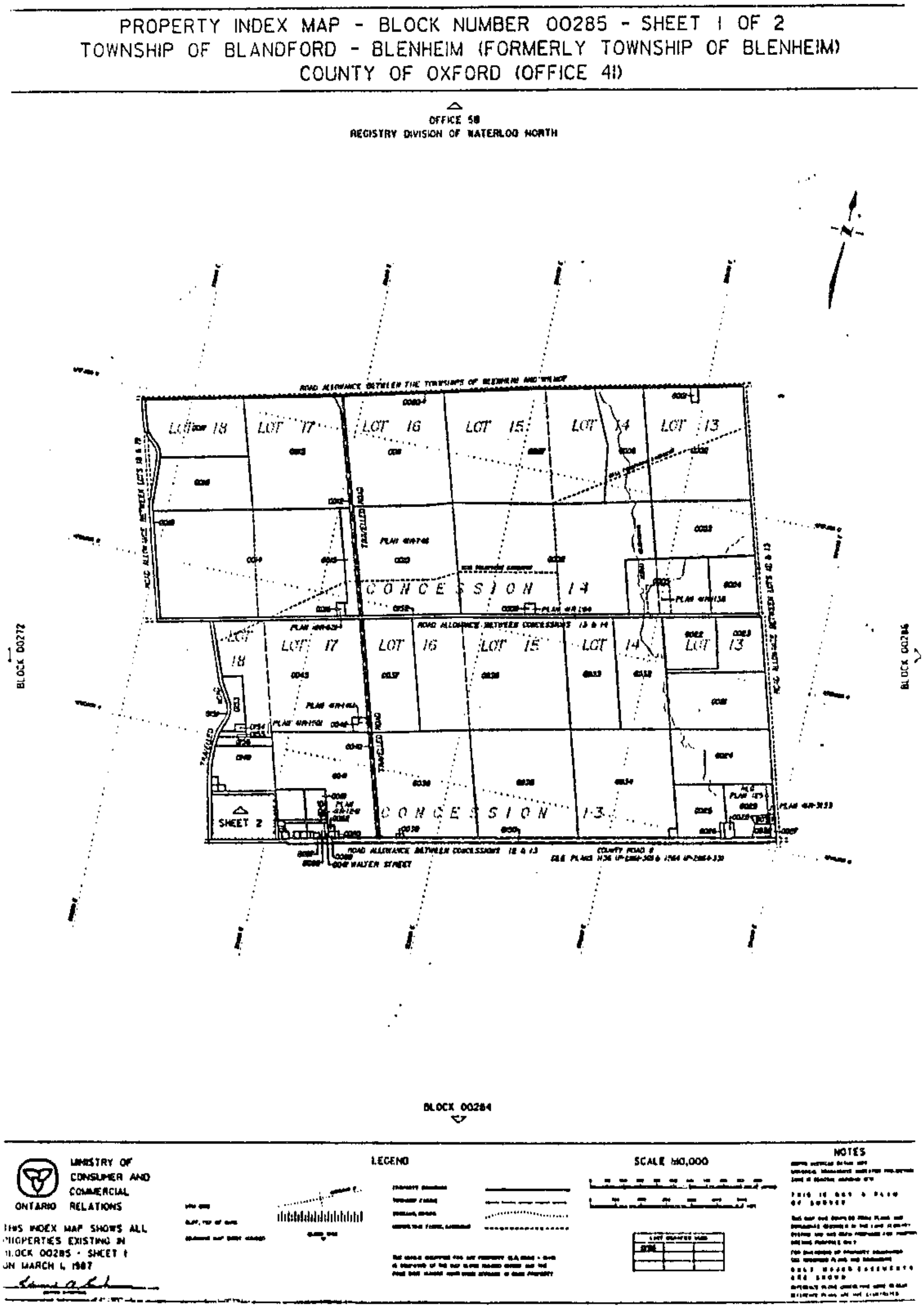

PROPERTY INDEX MAP - BLOCK NUMBER 00285 - SHEET 1 OF 2
TOWNSHIP OF BLANDFORD - BLENHEIM (FORMERLY TOWNSHIP OF BLENHEIM)
COUNTY OF OXFORD (OFFICE 41)
OFFICE 58
REGISTRY DIVISION OF WATERLOO NORTH
LOT 18
LOT 17
LOT 16
LOT 15
LOT 14
LOT 13
CONCESSION 14
CONCESSION 13
TRAVELLED ROAD
SHEET 2
BLOCK 00272
BLOCK 00286
BLOCK 00284
MINISTRY OF CONSUMER AND COMMERCIAL RELATIONS
ONTARIO
LEGEND
NOTES

Figure 1

Ontario COMMERCIAL RELATIONS REGISTRY OFFICE #41

00211-0028 (R)

PREPARED FOR: MR. RON LOGAN
ON 1990/05/29 AT 13:07

Figure 2

PROPERTY DESCRIPTION: PART LOT 11, CONCESSION 2 ZORRA/WEST ZORRA

PROPERTY REMARKS:

ESTATE/QUALIFIER RECENTLY FIRST CONVERSION FROM BOOK 225

REG. NUM.	DATE	INSTRUMENT TYPE	AMOUNT	PARTIES FROM	PARTIES TO	CERT/ CHKD	FILM
* PRINTOUT INCLUDES ALL DOCUMENT TYPES (DELETED INSTRUMENTS SINCE 1986/09/01 INCLUDED) *							
* DATE OF EARLIEST REGISTRATION LOADED: 1963/11/01 *							
A58084	1963/11/01	TRANSFER	$ 7800		HAGGERTY, WOODROW A.	C	
B6115	1970/07/15	NTCE OF CLAIM			THE BELL TELEPHONE CO. OF CANADA	C	
B8967	1970/08/24	NTCE OF CLAIM			THE BELL TELEPHONE CO. OF CANADA	C	
321428	1987/04/24	TRANSFER	$ 174000	HAGGERTY, WOODROW ALAN	DONBURG FARM LIMITED	C	
321429	1987/04/24	CHARGE	$ 15000	DONBURG FARM LIMITED	THE ROYAL BANK OF CANADA	C	

Figure 2

consultants and system integrators. As a result of the response a Request for Proposal was released to twenty-one firms on December 7, 1988 with a Spring 1989 closing date.

Three responses were received by February 28, 1989. One did not meet specifications and was disqualified. The remaining two, both quite extensive and entrepreneurial in nature, were submitted by consortia of the majority of the firms invited to respond. These two proposals were subjected to a stringent evaluation over the period extending from March 15 to June 26, 1989.

The evaluation included detailed analysis by a government team composed of experts from several ministries and an equally detailed review by a private sector evaluating team made up of individuals specializing in the various aspects of the geomatics industry and at arms-length from government. In addition an independent financial review was carried out. The results of all reviews were presented to an Executive Review Committee made up of government and municipal executives whose role was to recommend a preferred private sector partner to a steering committee of Deputy Ministers and ultimately to Management Board of Cabinet.

The proposals received were conceptually similar albeit using different approaches and technologies. Both were very broad in respect to the land-related industry and a concept of data distribution in Ontario, with POLARIS as the core element. As a result both proposals went somewhat beyond the model originally envisaged and therefore did not fall within the mandatory requirements. Each however, created sufficient interest that it was deemed reasonable to continue to work toward a partnership but by a process of negotiation rather than proposal selection. In January 1990 government approved an approach and a negotiating mandate such that the Ministry could enter into negotiations with both consortia in order to arrive at a partnership selection.

Negotiations took place between February 15th and April 23rd, 1990, beginning with an optimal government position and resulting ultimately in a signed Letters of Intent from each of the Consortia as a commitment to enter into partnership agreements with government within committed limits. By comparison of the "Letters of Intent" to the optimal government position and negotiating mandate it was determined that the consortium known as Real/Data Ontario Inc. would be the preferred partner. They were notified on May 16, 1990 and accepted the challenge of working with the Ministry to put the partnership in place.

The Partnership

This alliance of government and the private sector will be an unique arrangement in Ontario. It is expected to be a equal partnership in the form of a private sector corporation under the laws of Ontario with government being a shareholder and equal partner in returns from the corporation's endeavours. Both partners will contribute equity and share in returns. The corporation will be staffed with proven expertise from both sectors in a way most likely to achieve a strong working blend of technical expertise, business awareness and proven marketing experience. The Board of Directors will be reflective of the equal partnership in both make-up and representative skills and experience. The partnership will be responsible to government for POLARIS implementation and operation and to the shareholders for good business arrangement.

The Expectations

The businesses of the Strategic Alliance and the expectations of both government and the private sector are as illustrated in Figure 4.

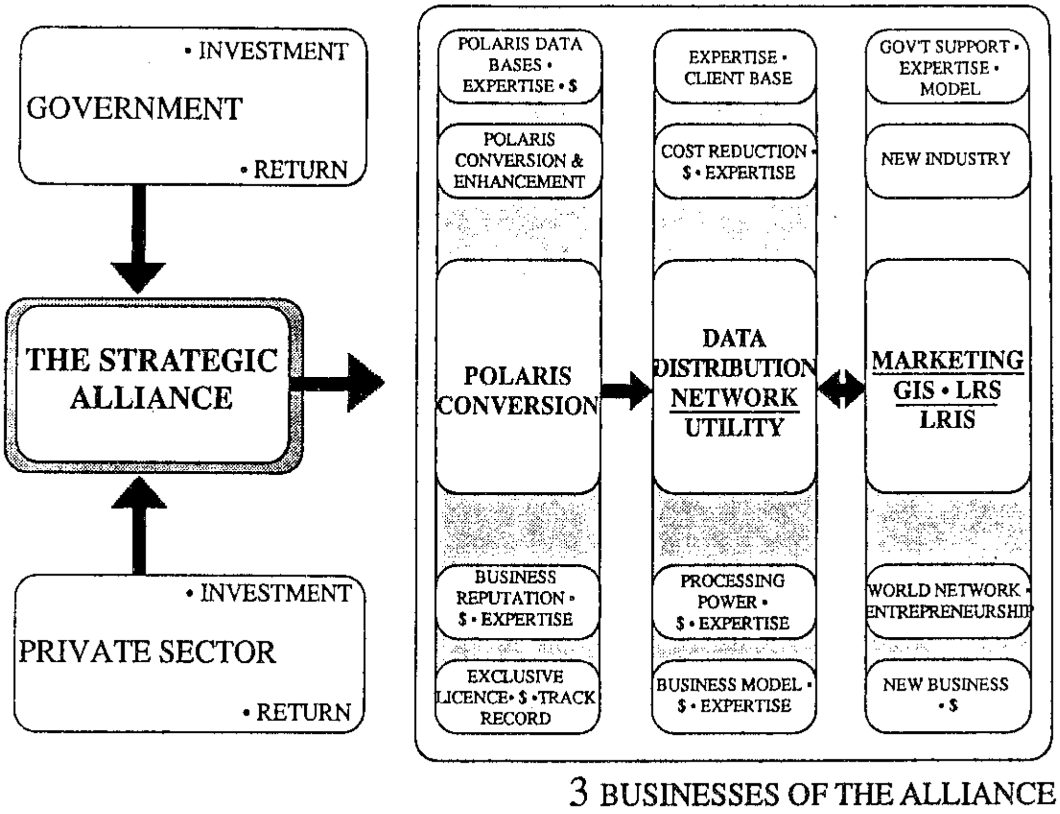
For government there exists the expectations of:

- Expeditious implementation of a greatly enhanced POLARIS province wide;
- The development of a data distribution network providing direct remote access to all land registration data and other land-related data in an open and timely way;
- Development of a world class industry centred in Ontario; and
- Reduced costs to the Province for implementation and operation while continuing good land registration services

For the private sector there exists the expectation of:

- A transfer of government experience and expertise gained from building and implementing POLARIS;
- The opportunity to operate a data utility in Ontario providing not only land registration information but a wide variety of value added products and services;
- A working model including joint government participation to use in competing in the world market for similar land-related information service projects; and
- An established industry opportunity in Ontario which will bring stability to what has typically been a project oriented activity in the past.

Figure 4
BUSINESS OF THE STRATEGIC ALLIANCE



Both partners expect to realize the benefits of joint participation to expedite the implementation of the POLARIS model and to experience a continued synergy through operation in Ontario and marketing abroad. The partnership provides an opportunity for extensive research and development and eventually world recognition and a market share which should prove profitable to Ontario generally.

Concerns/Issues

Both potential partners were not without some concerns. The Ministry team had concerns about:

- A potential for monopoly in the private sector;
- The continuation of a high level of public service at reasonable costs;
- Data sharing and use issues focusing on, but not limited to, freedom of information and rights to privacy; and,

- Completion of POLARIS implementation in remote areas.

The Real/Data Ontario team had concerns about:

- Continued government commitment to the partnership given that elections take place every five years at a minimum;
- Staffing issues, particularly those which exist in successor rights legislation;
- Major market changes which could limit sales opportunities; and
- Technological complexity of the marketing model being unachieveable in a short time frame.

Both teams shared concerns related to:

- Failing markets, both domestic and international;
- Failure of the alliance for various reasons such as resource shortages, complex technologies and changes in requirements;
- Public reaction to the critical mass philosophy which could exclude some firms from competing; and,
- Demands of on-going maintenance with such a varied client group.

Timing

Work is continuing now, involving Ministry and Real Data Ontario teams to finalize the detailed agreements necessary to establish the alliance and to develop a sound business plan to implement the new partnership. It is expected that the agreements will be complete including vetting with the new government later this fall and subject to Management Board of Cabinet approval the partnership will begin operations in 1991.

Initially the focus will be on accelerating POLARIS implementation and enhancement but it is expected that initial activity to penetrate other markets will begin early in the Corporation's operating plan.

The Future

The concerns mentioned can be overcome through careful planning and research at this early stage and the building of an element of trust founded on experience and good business practises.

Jointly we believe that the partnership will result in the provision of a greater range of timely land-related information products and services at reduced costs to government and with fair pricing arrangements for land registration service users and the general public.

Remote access will remove time restrictions and make information readily available to clients in there own business location as well as at the land registry offices for walk-in service.

The venture should prove profitable to the Province generally as we build a globally competitive service industry. In addition the opportunity for supporting research and development in the land-related information services industry will result in many opportunities for spin off business to grow in Ontario.

This is an exciting new initiative, unique in Ontario today. The strategic alliance promises to implement POLARIS across the province more efficiently and effectively and in less time than the current 14-year schedule. Equally important, this new venture, through government/private sector partnership, will foster the growth of an industry in Ontario, dedicated to the development, marketing and implementation of Land-related Information Systems both domestically and internationally.

---APPLAUSE

CHAIRMAN ZILLMER: Thank you very much, Ron, for providing an excellent presentation about a very innovative initiative in Ontario. I would also like to take this opportunity to thank Ron for the incredible amount of work that he and his staff have put towards this effort over the last several months.

Our next speaker, Elizabeth Ottaway, should be credited - at least in part - for helping to put Oxford County and the City of Woodstock on the map of the world. Elizabeth is the Deputy Planning Commissioner in the County of Oxford, and has been with the County since 1973. She has her Batchelor of Environmental Studies degree, University of Waterloo, School of Urban and Regional Planning and has partially completed her Masters Degree in

Regional and Resource Planning at University of Waterloo in Municipal Land-Related Information Systems. I find this a little surprising because I think that Liz could probably teach that course!

Elizabeth is a member of the Professional Planners' Institute, the Canadian Institute of Planners, the American Planning Association, the Urban and Regional Information Systems Association and the Municipal Information Systems Association.

Ladies and gentlemen, please welcome, Elizabeth Ottaway who will talk to us today about a County Municipal Integrated GIS.

A COUNTY/MUNICIPAL INTEGRATED GIS

ELIZABETH J. OTTAWAY, M.C.I.P.
Deputy Planning Commissioner
Oxford County, Ontario

Oxford County's goal in 1986, when we installed the equipment for the Land-Related information System, was to develop an efficient and economical integrated municipal database that utilized geographic information technology. We believed that the implementation of very straight-forward organizational principles would allow us to maximize this goal and, while the Oxford Land-Related Information System has grown and changed considerably since 1986, we still believe that the basic principles that we based the system on, and have worked towards since 1986, are successful.

Our basic premise was to re-evaluate the data requirements of the municipality and define the key data elements that would form the core of municipal information. It was important to identify the source of the data and to achieve punctual and accurate updates at the data source in order to achieve a reliable and accurate system that users could have confidence in. The source may vary between provincial ministries or local or county departments. We have spent much of the period since 1986 addressing the massive administrative issues that arise from integration of data and the technical difficulties of data exchange on a constant ongoing basis.

Our second basic premise was to develop user-friendly applications for municipal departments that relied on our basic data and also to provide transactional updates to an expanding range of municipal data. We discovered very quickly that our user community of eight local municipalities demanded accurate and current information in order to utilize the Land-Related Information System.

I believe that Oxford County has learned a great deal from the 80s. As we met with municipalities across Canada we concluded that the basic information required for municipal information systems and the procedures for update are not dependent on the size of the municipality. The basic task in all municipalities is to manage land, structures and facilities whether for taxation, development control or road construction.

The system we developed in 1986 was based on an ARC/INFO database system and primarily allowed for an integration of four provincial mapping and tabular information systems: the Ontario Basic Maps from the Ministry of Natural Resources at 1:10 000 and 1:2000, the Ministry of Consumer and Commercial Relations POLARIS Property Mapping, the POLARIS Title Files on land transactions, and the Ministry of Revenue Master Assessment Tapes. We were able to establish that the four Provincial systems could be integrated and could be used effectively for municipal applications. We produced an on-line query system for municipal departments that gave them both visual and written information about properties that was not available to them before and considerably expanded both the mapping capabilities of the municipalities as well as provide a level of geographic analysis for many municipal problems. Some early examples of studies that utilized the system included a residential infilling study for the City of Woodstock which provided a very complex and successful analysis of housing patterns in the older area of the City. The study clearly showed us there was an opportunity to improve the quality of decision making with a visual analysis that was clear and understandable to the public and the City Council. We did, however, have many problems integrating the data we had received from different sources.

Our initial conversion of the POLARIS Property Mapping was a fairly simple data exchange that created topology in the property layer of the POLARIS Database only and added information such as subdivisions, reference plans and easements as graphic overlays. Our initial conversion of the property mapping took approximately six months and three staff. The Property mapping was updated by the Ministry of Consumer and Commercial Relations with a time delay of sometimes three to six months and we had no simple procedure to incorporate revised or updated property maps into our system without losing some of our own information.

The Ministry of Natural Resources OBM Mapping represented a more stable map base. The 1:2000 mapping was only available in the City of Woodstock however and it was a much more effective base than the 1:10 000 for our other urban areas. The aerial photography was flown in the early 80s and the updates to buildings was a problem that needed to be addressed. The update features required new aerial photography and the Ministry was not able to provide it in a time frame satisfactory to our users. We are proposing to the Ministry of Natural Resources to utilize the building permitting system as an update mechanism between Provincial updates. Besides, the building footprint as input from as-build construction surveys is more useful for municipal applications than aerial rooflines.

The Ministry of Revenue Master Assessment Tape provides a very functional range of information about structures and land. Our initial linkage between the Assessment data and the POLARIS data was a tabular cross-reference file between the PIN of POLARIS and the Assessment Roll Number which was established at the time of the initial data load by POLARIS. It rapidly became apparent that the cross-reference file between assessed parcels and ownership properties on a continuing basis was the major problem that we faced in implementation of the Oxford Land-Related Information System. The POLARIS system did not have a mandatory requirement for capture of an Assessment Roll Number at the time of registration and in the creation of new properties through plans of subdivision and consent, the Assessment Roll Number is not assigned at the time of registration,. The results are not a simple relationship between assessed parcels and ownership properties. For example, a church that leases their parking lot during the week will have different Assessment Roll Numbers for the church building and the parking lot for municipal taxation purposes, although the properties are under one ownership. Relying on a tabular cross-reference file meant that we were losing the geographic relationship that enabled us to determine which building on the ground is attached to which Assessment Roll Number.

As we received weekly on-line updates of the POLARIS Title Files of land transactions, we acquired new properties and PIN's and an even greater discrepancy between the PIN and the Assessment Roll Number. Today, after three years of operating without regular and consistent updates to the property mapping and cross-reference file, we have approximately 20 percent of the 40 000 parcels in the County with unknown Assessment Roll Numbers. This means that 20 percent of our properties have lost their connection to the data files or may have questionable data linkages and while we recognized this problem as a critical component in maintaining data relationships, it is a difficult issue for the County of Oxford to resolve in isolation. We have spent the last year and a half working with the Provincial Ministries of Consumer and Commercial Relations and Revenue to solve the data integration problems.

We are currently in the middle of a six-month test with the Ministry of Consumer and

Commercial Relations to convert the 65 levels of the POLARIS Property Mapping as of June 1st, 1990 and to simultaneously be responsible for all updates to the POLARIS maps from June 1st forward. This includes the insertion of reference plans, easements and plans of subdivisions. For this purpose we engaged an Ontario Land Surveyor as a consultant to the County to assist our staff in making survey decisions on the update of the POLARIS mapping. This test has been an excellent experiment in the total exchange capabilities between two separate computer systems and has pointed out mutual problems and procedures that need to be evaluated and changed on both systems. As we worked through the update procedures we are convinced that municipalities have more access to local survey data to assist them in this process. It has also been an important learning exercise for the local survey community who begin to appreciate the efforts of municipalities to improve ground control, and to improve the ties in the property fabric. Most importantly for Oxford County, we are able to achieve the currency of property mapping and survey information updates that we require to address our users' requirements. From the Provincial perspective we hope that we can establish the role of municipalities as being a valid partner in data exchange for land information systems. As the Province developes new relationships to take advantage of this technology, I believe that it is critical to recognize municipalities as a valid data source and to move towards implementing the required modifications in both Provincial and Municipal systems to maximize data exchange.

As part of our ongoing issue of data integration we have explored with the Ministry of Revenue the mutual benefits to municipalities and the Assessment system of the satisfactory resolution of the PIN/Assessment Roll Number cross-reference problem. Some avenues that are being explored include: the Ministry of Revenue becoming responsible for the Assessment Roll Number in the POLARIS fields or the user of the Land Registration System being responsible for the accurate input of Assessment Roll Numbers. From the experience in Oxford we have concluded that the tabular cross-reference is not the long-term solution to the integration of the key identifiers of geographic features. We are creating a master graphic file that overlays the properties of POLARIS and Assessment parcels to generate the lowest common denominator of land that carries unique identifiers between the two systems. We have realized that this system cannot exist without a geographic representation of Assessment parcels. As long as a separate system exists in Ontario to define the spatial relationship of assessed parcels, then as municipalities we need to store data against this administrative unit and generate assessed parcels in relationship to buildings and structures, both graphically as well as in the database. So we are now exploring with the Ministry of

Revenue methods by which we can achieve a graphic representation in digital form of Assessment parcels that recognizes the Ministry of Revenue as the source of the definition of assessed parcels. We are finding enthusiasm and encouragement and a gradual perception of the mutual benefits of knowing those relationships. For example, Oxford County is facing a reassessment project which could have the potential to reduce assessed values across the County. By utilizing our existing database we are able to provide analysis of the relationship between property values and geographic features in our communities. This may result in a more accurate reassessment project. Both the County and the Ministry of Revenue benefit from our joint activities. On an ongoing basis we are proposing to feed the data from the County Building Permitting System back to the Ministry of Revenue for more rapid assessment on new structures and renovations. These types of linkages are possible because the Building permitting system can be linked back to the assessed parcel as well as property ownership.

It should be clear that our efforts in the past two years have primarily evolved around trying to solve the very real problems we have encountered with data integration since 1986. Without the co-operation from provincial ministries, and without the provincial review of the mandate of individual Ministries, the restructuring of organizational and computer procedures, the County of Oxford Land-Related Information System cannot succeed. Over the past year we have come very close to giving up our goals in frustration. We have tackled many exciting and worthwhile applications in the past two years. But we are practical enough to realize that all of our applications depend on an ongoing accurate source of data update procedures to the basic provincial data sources. For example, we have created a development monitoring system which has the potential to evaluate the capacity of vacant lands within our urban municipalities for development and weigh that against the physical capabilities of sewer and water systems to handle the development. This requires the development activities in the County, and the changes in property ownership to accurately maintained, as well as rapid updates to the property mapping systems.

In Oxford County we are excited in spite of our frustrations as we head into the 90s. Our users have been patient as we attempted to resolve a linkage of Provincial and Municipal mandates. By the end of 1990 we believe that we will have established effective update procedures for the POLARIS property mapping. We have already perfected on-line updates of POLARIS Title Files and update procedures for Ministry of Revenue Assessment Data. We are at present working the with Ministry of Revenue on the creation of Assessment parcels in graphic form, and on an update to the cross-reference between PIN and Assessment Roll Number. Also we are actively pursuing with the Ministry of Natural Resources, update procedures to the topographic mapping for at least the building and structure levels. The new integration of data should be released to our users by January 1991 and then we can proceed with our own on-line transactional activities such as Building Permitting and monitoring of development activity.

What have we learned from the 80s? We have learned that it is possible to develop an efficient and accurate municipal information system that is exciting and has a far reaching potential to improve day-to-day municipal operations as well as improve the level of decision making in municipalities. However, the success of that integration is totally dependent on an effective integration with Provincial systems and procedures, and that without that daily integration and accurate update mechanisms - the Oxford County Project will not succeed.

---APPLAUSE

CHAIRMAN ZILLMER: Thank you, Elizabeth. You've provided an excellent example of how well the integrated approach can work using a GIS. You also brought home the point that these types of systems continue to grow and evolve over time, they don't just end at some point in time.

Before I introduce our next speaker, I've been asked to get a show of hands from our delegates as to who intends to visit the exhibit area after lunch today. You will notice on your program that the closing remarks will be made after lunch in Room 107. We shall not be returning to the theatre for any sessions this afternoon. How many will be attending the exhibits after 3:00 pm? Not very many, then we will suggest the exhibitors close up during lunch.

Our next speaker Valerie Higgin is the Project Manager in Geosystems Development, Metropolitan Toronto.

Valerie has a science degree in Mathematics. She has been involved with the land-information community since 1968 when she first joined ProConsul Ltd to work on survey adjustment techniques. Her interest in GIS began to grow in 1982 while working for the Municipality of Metropolitan Toronto, where she currently has major responsibility for the development of the Metro Toronto Information System.

Ladies and gentlemen please welcome Valerie Higgin.

THE MUNICIPALITY OF METROPOLITAN TORONTO ACCOMPLISHMENTS OF THE 80s - THE CHALLENGES OF THE 90s

VALERIE I. HIGGIN
Project Manager, Geosystems Development
Municipality of Metropolitan Toronto

The Municipality of Metropolitan Toronto is a regional government and a corporate federation, its members include six local municipalities and various Agencies, Boards and Commissions such as the Metro School Board, the Metro Police Force and the Toronto Transit Commission. The area administered covers 640 sq km, has a population of 2.2 million and over 800 000 assessed properties.

Metro was incorporated by Provincial legislation in 1953 in recognition of a need for common shared services which at that time were development of arterial roads, trunk sewer systems etc. This resulted in a coordinated approach to planning and construction with shared costs and avoidance of duplication. During the 80s, and in fact since its inception, Metro has emphasised the advantages of regional solutions to municipal planning and administration.

Regional solutions have been found to work in Metro provided three prerequisites are in place:

- A **common** need is identified,
- A **joint** action is taken, and
- A **common** benefit is realized.

These prerequisites for regional solutions were fundamental to the formation of Metro and, since that time, have been in place to varying extents for the development of regional mapping capabilities and sharing of various subsets of corporate information.

Corporate Information

In the 1970s and 80s several regional solutions were developed and applied to common mapping and information management requirements for the Metro Federation:

Control Surveys

Joint programs, established in the 1950s, continued for densification and maintenance of the control survey network in Metro. Costs were shared between Metro and the municipalities, standards, quality control and administration were supplied by Metro.

Mapping

The common need for up-to-date and accurate base maps with a "one-stop-shopping" approach was identified in the 70s. To meet this need the Central Mapping Agency (CMA) was created, it is now named the Geographic Information Centre (GIC). The Agency assumed a coordinating role as a central repository for common base mapping for Metro.

In the 1980s a common need for replacement of their large scale, traditional mapping products was identified by many of the local and the regional works departments. This need was caused, in part, by general wear and tear of the traditional products and also by the changeover from the imperial to the metric systems of units. Replacement by traditional means was very expensive. A joint recommendation to Metro Council resulted in the purchase of a combined Mapping and GIS system for use by all members of the Metro Federation. Cost sharing programs between Metro and the local municipalities allow for assembly of large scale digital mapping data. CMA has the responsibility for administration, quality control, the development and enforcement of standards and provision of storage and exchange facilities. To date 40% of Metro is covered by large scale, 1:500, mapping and 100% is expected to be covered within the next three years.

A need for medium scale mapping existed to allow Metro departments to view the region as a whole. A digital medium scale mapping product has been assembled by Metro with 100% area coverage. It is combined with complete street centreline mapping data with all names and addresses, also available with full Metro coverage. These medium scale products are available for use by all members of the Metro Federation.

Tabular Information

In the 80s information was recognized as a valuable corporate resource. The Metro area amasses vast amounts of information regarding demographics, property values, businesses, employment, travel patterns and new development. Metro Planning, in particular, has taken a lead role in improving the utility of this tabular information by tagging it with various geographies such as school districts, police districts and providing aggregation capabilities. This information is used by many departments across the Metro Federation and the private sector.

Applications
Many mapping, GIS and information applications were developed. Examples included transportation studies, address matching and subsequent displays of Parks and Recreation facilities, school bus routing.

Corporate Information Access
Major requirements which contribute to the success of sharing and exchange of mapping and tabular information are availability and adherence to enforceable standards and the existence of communications networks. Communications networks in this context include both people networks and computer networks.

Standards
CMA, in conjunction with its users, has established standards for capture of data, storage of data and exchange of data. The standards are periodically reviewed.

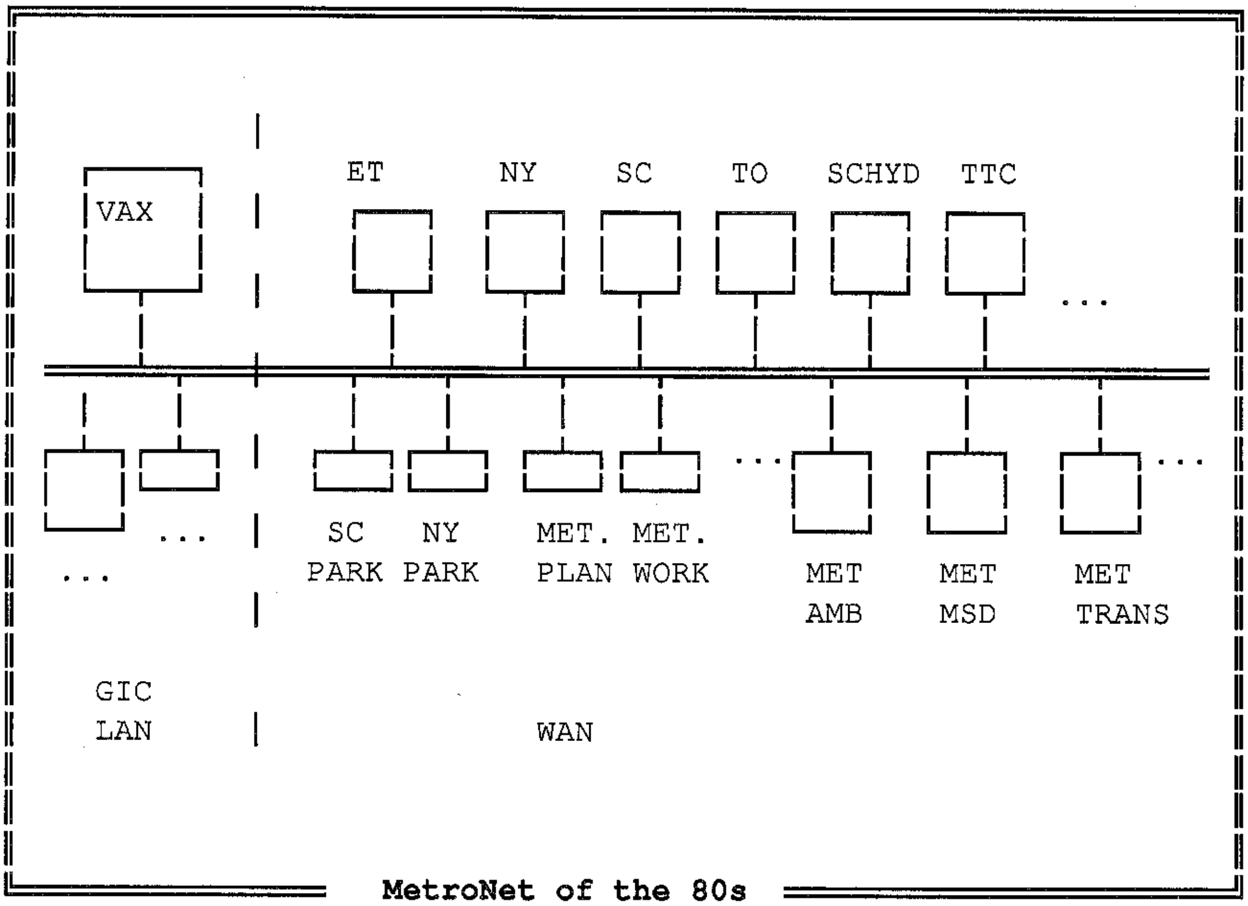
People - Communications Networks
Various Committees are in place for the sharing of knowledge and planning of direction.

The Mapping Liaison Committee involves as its members the Commissioners of Works of all Metro and local municipalities and representatives of Public Utilities and also the Ministry of Natural Resources receives copies of all minutes. The Mapping Liaison Committee was instrumental in the acquisition of the Mapping and GIS Systems for a regional solution.

The Metro Toronto Public Utilities Coordinating Committee includes representatives from Ontario Hydro, the local Hydro Commissions, Bell Canada, local Public Utility Commissions and Consumers Gas. This Committee reviews the advantages and mechanisms of sharing well maintained mapping data.

Computer - Communications Networks
The MetroNet was established in 1985 with a central Vax system on a local area ethernet network. The local area network now includes Intergraph Servers, Sun workstations, Intergraph workstations, microcomputers emulating both Tektronix terminals and Intergraph workstations and various terminals. Initially only the Cities of Etobicoke and Toronto were part of the wide area network. It has since been extended to include the Cities of North York and Scarborough,

Scarborough Hydro, The Toronto Transit Commission, Metro Ambulance, Metro Management Services and Metro Transportation. Many of these wide area network nodes are themselves part of established local area networks. Terminal connections also access the wide area network from Scarborough Parks and Recreation, North York Parks and Recreation, Metro Planning, and Metro Works. The wide area network is linked by Centrex III communications lines at 56KB.



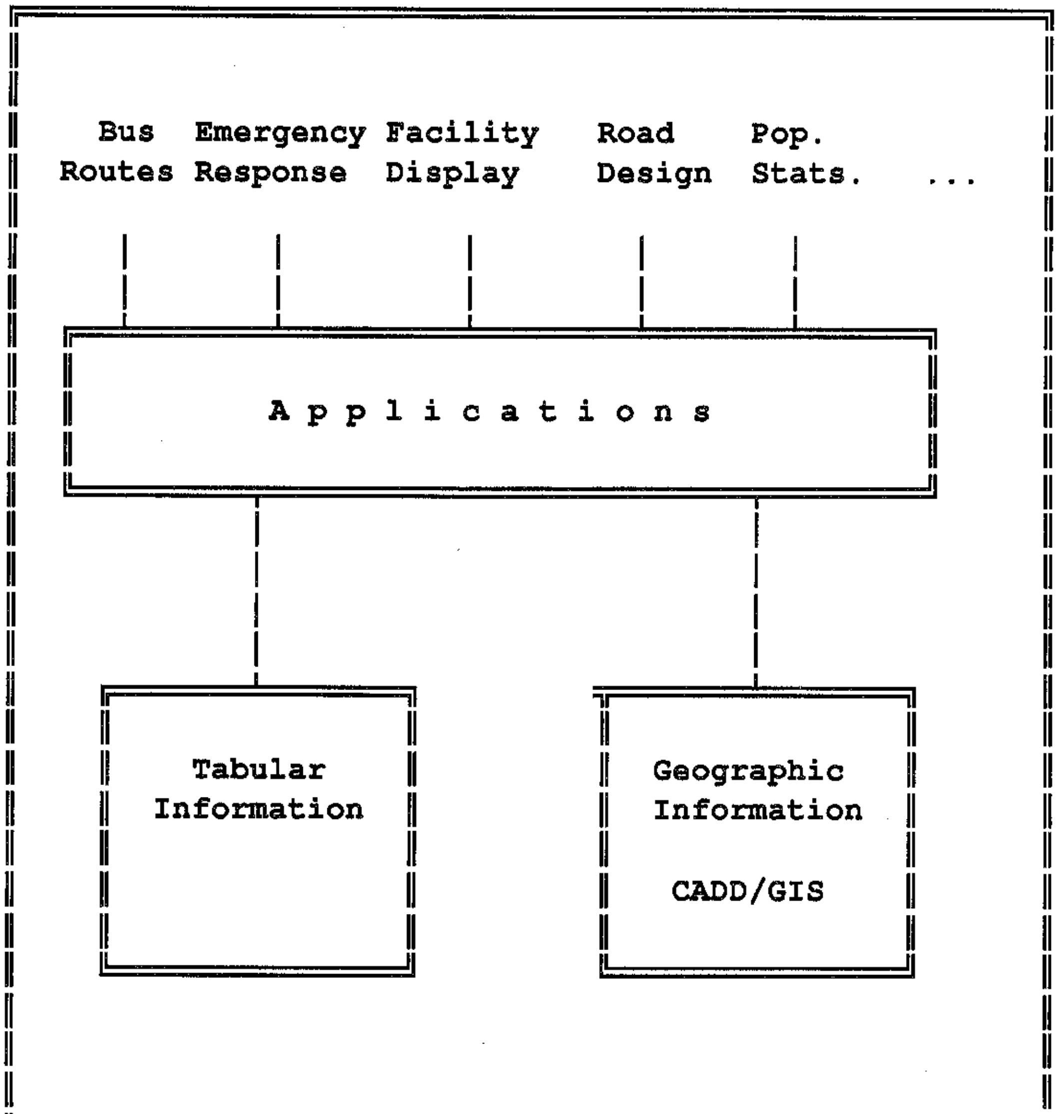
MetroNet of the 80s

Corporate Information Architecture

The system architectures of the 80s stressed two characteristics:

Firstly, centralization, as detailed above in the MetroNet, where data are centrally stored and manipulated on the VAX.

Secondly, the information model, as diagrammed below, for the most part separated the tabular information storage and the geographic information storage. The two were only combined on an as needed bases for specific applications.



Information Model of the 80s

The Challenges

By the end of the 80s, significant progress had certainly been made towards the sharing and utilization of geographic and tabular information. However challenges were identified and remain to be faced if the sharing and utilization of intermunicipal and corporate information is to be fully effective and meet user needs of the 90s.

As the user community has become more experienced in managing digital mapping data, the central storage architecture is no longer satisfactory. The issues of data ownership have to be faced. The benefits of ownership carry with them the responsibilities for timely maintenance of the data, the provision of data storage, the provision of access to the data and the responsibility to maintain storage and access standards.

Another issue to be faced is the structuring of the geographic and tabular information, so that these are maintained in an application independent manner and not locked into specific applications.

The New Decade - facing the challenges of the 90s

The Central Mapping Agency begins the new decade with a new name - The Geographic Information Centre (GIC). The new name reflects, in part, the approaches we are taking in the new decade. The two specific challenges identified for the 1990s are being addressed by two major projects at the GIC. The first is the distribution of large scale mapping data bases, the second is the development of the Metro Toronto Information System (MTIS).

Decentralization of large scale mapping data bases

Large scale digital mapping data are currently stored on the central VAX under the Intergraph System. Testing is underway to confirm the feasibility of decentralizing these data to the parties who maintain and make most use of the data. In the case of roads, it is the works departments of the local municipalities and the Metro Transportation department. In the case of underground and above ground utilities, it is the local and regional works departments, Consumers Gas, the various Hydro Commissions, Bell Canada or local Cable companies.

The decentralization involves storage of the data on an Intergraph server at the locations of the data owners, who then assume full ownership of the data and are responsible for keeping their segments of the data up-to-date and for making it available for access over the wide area network in a manner which adheres to the established standards. Users of the data over the wide area network are neither concerned with, nor aware of the location of the data.

Prior to distribution, the storage of municipal attribute data associated with the large scale mapping system is being transferred to the ORACLE relational data base management system.

Communication speed will become an issue with the move to decentralization. In the future it is anticipated that fibre optic links will provide a viable solution. Metro is moving towards this standard and conduits are being installed on the major arteries.

Metro's responsibility will be to coordinate the setting of standards for storage, maintenance, access and communication. Metro will audit servers on the network to ensure the adherence to standards and to ensure the availability of the data. GIC is currently in the process of finalizing agreements with users to move in this direction. Focus documents which detail the planned transition to a distributed system are available.

Metro Toronto information system

The Metro Toronto Information System (MTIS) was instigated because the existing combined systems which separately maintained tabular information and geographic information could not answer in a timely manner the questions which will be asked by managers and planners of the 90s. In reviewing these requirements it became apparent that much more flexibility was required and that it could only be provided if the tabular information was maintained fully integrated with the geographic information in a manner totally independent from applications. Further, the maintenance of the geographic information by a geographic information system will provide geographical relationships to the tabular information which had not been previously available.

A review of municipal tabular information in general and its relationship to geography provided a high level corporate information model on which the design of MTIS could be based.

The corporate information model for the 90s

The characterization of municipal tabular information is simplified by classifying it into the four main generic categories of land divisions, structures, people/businesses and objects.

Land Divisions: The class of land divisions includes information related to such divisions as ownership parcels, assessment parcels and administrative areas such as police divisions or ambulance districts. This class may be extended to include information about air and water.

Structures: The structures class of information includes information with its major association to man-made features which include buildings, roadways, bridges, etc.

People: Information with a major association with people and businesses falls into this classification. It includes employment records, social information and employee counts.

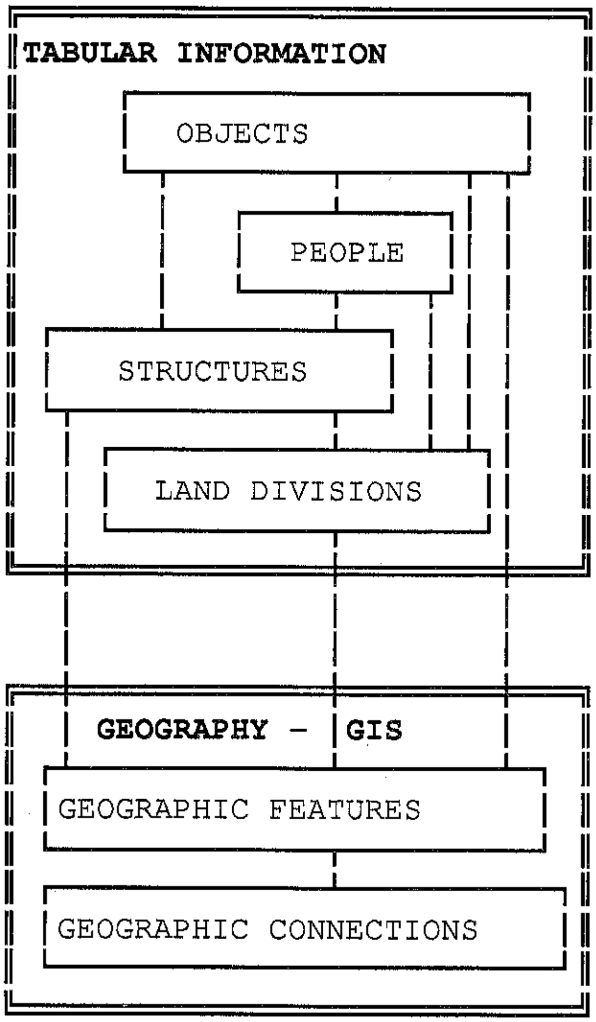
Objects: Information about personal/corporate property such as cars, computers, information about work orders, purchase orders, reports and information about incidents all fall into the Objects classification.

The four classifications are generically related. For instance objects belong to people or businesses, objects are housed in a particular structure, incidents occur in structures or in a land division, people live and work in structures they also own land. Structures are always built on particular land parcels.

Reviews of municipal tabular information show that more than 80% is directly or indirectly geographically based. Typical municipal operations are to plan, maintain, regulate, licence, permit, manage, administer, tender and invoice. The related geography may be an address or it may be an administrative area such as a zone or a right-of-way. For example invoices are sent to people at municipal addresses, licences are issued to people at municipal addresses, permits are issued to allow parades along certain routes, library books are loaned from a particular branch to a person, each with a specific municipal address. Planning functions consider zoning, redevelopment etc for various areas.

Each of the classifications of municipal tabular information can therefore directly or indirectly be represented by one or more geographies. For example land divisions are represented by areas, structures can be represented by areas, lines or points.

Maintenance of the geographic representations in a Geographic Information System (GIS) provides all relationships of connectivity, adjacency and nesting between all geographic features. When tabular information is referenced to such geography, the relationships transfer to this information and it is then possible to correlate previously unrelated tabular information via the geography. Often municipal tabular information retains an inherent geography, such as the direction of flow of water pipes, the direction of increasing addresses. Maintenance of the information integrated with a GIS allows the validation of such data. It is on this Corporate Information Model that MTIS is based.



Corporate Information Model of the 90s

MTIS - User requirements

Representatives from those departments who use the Information models of the 80s have formed the MTIS Advisory Committee. Its purpose is to provide identified requirements for MTIS and provide ongoing validation of the design and direction.

Committee representation includes

- Management Services Departments from Metro, Etobicoke, North York and Scarborough
- Planning Departments from Metro, Toronto and Scarborough
- Community Services Department, Metro
- Works Department, North York
- Parks and Property, Metro
- Fire Department, Toronto
- Metro Ambulance
- Metro Police
- Toronto Transit Commission

Reviews of requirements with members of the Advisory Committee, revealed a high cross-departmental need for geographic data. The degree of common interest allowed priorities to be assigned to the various geographic features and lead to a phased development.

Geography Phase 1

- Single line representation of the topographic fabric of streets, railways, rivers, highways, bridges, shorelines and hydro right-of-ways. Such representations are to be named and, where appropriate, to have address points linked to them.
- The address points allow aggregations to various sets of blockfaces for those users only interested in address ranges.
- Convenience addresses to be included and linked to the official address point and also to contribute to address ranges. Building names and site names are also to be linked to the official address point.
- Extension of the single line representation to a 15 km swath abutting the Metro border.
- Jurisdictional, administrative and statistical boundaries.

Geography Phase 2

- Area representations for assessment parcels, also for ownership parcels and cadastral fabric.
- Topographic representations of curb lines, building symbols and building footprints of large buildings.

Reviews of tabular information requirements showed a cross-departmental need for a common core of information with additional requirements to tie user specific departmental data to the geography. Again, a phased approach was possible for the integration of tabular information.

Information Phase 1

- Assessment data which provide age, sex, ethnic origin, social units, housing, land use and assessed values.
- Business and employment statistics
- Postal code information.

Information Phase 2

- Census information
- Building permit information

Information Phase 3

- User driven

MTIS - A corporate information model for the 90s

Over the last year the GIC has reviewed the user requirements in light of the Corporate Information Model outlined above. The following general prerequisites where identified as necessary for the MTIS model:

- Integration of geographic and tabular information
- Maintenance of geographic information by a GIS
- Maintenance of tabular information in an RDBMS
- Maintenance of historical data
- Maintenance of all information in an application independent manner
- Frequent update cycle, suited to all needs
- Ability to pose ad-hoc queries
- Provision of some predetermined queries
- Ability to qualify queries (ad-hoc and predetermined) with geography, time, information and presentation (such as reports, graphic display) requirements.
- Maintenance of standards
- Full access over MetroNet

- Provision of data in formats acceptable by various front end proprietary and custom packages - PC ARC/INFO, MAPINFO, ATLAS GRAPHICS, SAS, SASGRAPH, RESPONDER, EMERGENCY CUSTOM RESPONSE PACKAGES

Metro's existing GIS, ARC/INFO by ESRI, provides the GIS capability. ORACLE was chosen as the RDBMS because of existing interfaces to ARC/INFO and to Intergraph, its position as one of the RDBMS leaders and its multi-platform philosophy.

MTIS logically presents to the user at the functional level, an information system which is totally integrated with a geographic foundation. However the physical reality has the full geographic foundation maintained under ARC/INFO and the tabular information maintained under the ORACLE RDBMS. These two systems are of necessity closely linked.

In keeping with the prerequisite for integration of geographic and tabular information, MTIS requires that the geographic foundation be in place before any information can be built on it. In other words, representations of the road and property point must be in place before an assessment for that property can be loaded.

Geographic foundation design concepts

The geographic foundation is maintained under the ARC/INFO librarian system. The data are stored in "tiles" which are transparent to the user. Requests for an area covering a group of tiles are handled by the Librarian, which assembles the appropriate 'tiles' and presents them to the user as one area. The Librarian will flag tiles which are out for update thus avoiding two users attempting simultaneous update in the same area. The "tile" size is optimally determined, large enough to reduce "tile" amalgamations for average retrievals, while small enough to allow reasonable execution times for maintenance or geographic analysis on one "tile". For the PHASE 1 geographic foundation, concession blocks are used as the basis for the tile structure.

Other key features incorporated into the geographic foundation design are:

- Maintenance of all linework for feature centrelines and boundaries of administrative, jurisdictional, etc. areas in one composite coverage. This maintains the collinear integrity of the features, thus allowing the same linear feature to be part of boundaries of various application areas.
- All geographic features are maintained to double precision accuracy.

- Maintenance of unique identification and geometric details on all features. For example, each node has an identification, a northing and an easting. Each linear feature has a unique identification as well as the geometric description and the identifications of the beginning and ending nodes.
- Full maintenance of topology between all features. For example between node features and linear features and between linear features and area features.
- Full maintenance of municipally-required relations between features. For example, the relationships of blockfaces to included address points and to involved linear features; relationships of address points to linear features and relationships of linear features chained in order of increasing address.
- Maintenance of thematic layers of application areas derived from the composite coverage for the convenience of users.
- Maintenance of all nonactive features in historic layers providing the ability to recreate geographic features at any point in time
- Maintenance of effective and expired dates on all features.

Tabular information design concepts

- Maintenance of the tabular information in an application independent structure
- Maintenance of the tabular information in a denormalized structure to ease maintenance and facilitate expandability of information storage and functionality.
- Maintenance of effective and expired dates on all records to allow historical tracing.
- Reliance on GIS to provide all references and cross-references to the geographic foundation.
- Provision of predetermined queries, which aggregate information according to flexible and user defined criteria.
- Provision of detailed access to base tables.

MTIS - Development

Development of MTIS is following a formal life cycle methodology: CASE*Methodology by ORACLE Corporation. It involves a top down design with bottom up checking and a heavy reliance on user reviews.

As part of the conceptual design, a full Entity/Relation information model has been developed. Entities are things of significance about which information is maintained and between which relationships with appropriate cardinality are maintained. The entities are grouped according to their major associations to the information classifications of land, structures, people and objects. This simplifies the reading and modification of the model. The model currently uses 70 entities. A functional hierarchy has been completed for the system along with data flow diagrams for the more complicated aspects of the design.

The project team includes consultants from ESRI Canada and from ORACLE in addition to our own staff at GIC.

The development platform consists of two SUN 4/110 workstations, one with the ORACLE data base, ORACLE software and used primarily by the ORACLE developers. The second SUN has the ARC/INFO database, ARC/INFO software and is used primarily by the ARC/INFO developers. The two machines are on the local area ethernet. Communication between the two uses TCP/IP, SQL*TCP/IP, SQL*NET and ARC/INFO RDBO.

A request for quotation for the MTIS production platform will be issued shortly. The production platform is anticipated to be a central system initially with the possibility of decentralization later. The final system architecture of the central system however is not prejudged at this time and may involve one or more data base servers and one or more processing nodes.

The Phase 1 geography is estimated at 2.2GB, the Phase 1 information is estimated at 5 GB. However at the 5 year mark, assuming Phase 2 is implemented for each of the geographic foundation and information the volumes are anticipated to increase to 26GB for the geography and 14GB for information.

Corporate information system philosophy

The Metro philosophy emphasises decentralization of information beginning with the large scale mapping data.

Metro is stressing an integrated and shared corporate information system philosophy. MTIS provides a full geographic foundation on which to build an intermunicipal corporate information system. It provides a framework to store municipal information and link it to the geographic foundation. The design is open ended, to accommodate additional information and additional applications. It emphasises the philosophy of universal, flexible access to corporate tabular information integrated with a geographic foundation.

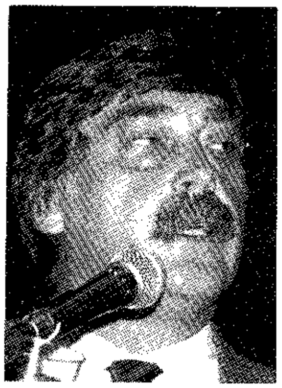
The common RDBMS of ORACLE for both the attributes Intergraph maintained large scale mapping and the tabular information integrated to the ARC/INFO maintained geographic foundation allows the possibility for cross access in the future.

---APPLAUSE

CHAIRMAN ZILLMER: Thank you very much, Valerie, for a most enlightening discourse.

Our next speaker is Dr. Joerg Schaller. He is an Assistant Professor, Chair of Landscape Ecology at the Technical University of Munich in Germany, specializing in GIS Applications for Environmental Planning. Dr. Schaller is both a Landscape Ecologist and a Landscape Architect. He has been involved in scientific work on ecosystem research, environmental impact assessment, environmental modelling and protection of natural resources. We had the pleasure of hearing Dr Schaller speak at a seminar in the spring, based on that talk, we invited him to come here today. I am looking forward to hearing what he has to say. Ladies and gentlemen, please welcome Dr. Joerg Schaller.

GIS-APPLICATIONS IN ENVIRONMENTAL PLANNING AND ASSESSMENT



Dr JOERG SCHALLER
Chair of Landscape Ecology
University of Technology Munich

THE MAB-6 PROJECT ECOSYSTEM RESEARCH BERCHTESGADEN (REGIONAL CONSIDERATION OF THE MAN-ENVIRONMENT SYSTEM)

Human Influence on Ecosystems

Ecological theory, in particular ecosystem theory, is nowadays distinguished by a new and better understanding of ecosystem dynamics. Conventional emphasis on relatively descriptive considerations of ecosystems and landscape have here been replaced by an emphasis on process and feedback effects. A consideration of people and their socio-economic systems is also incorporated into the ecosystem research.

The resource dependency of individual ecosystems is predominantly vertically orientated in the catchment areas of mountain ranges. In steep terrain, surface and sub-surface water flows carrying materials from ecosystems at higher levels to those at lower levels. Through these flows, low lying ecosystems tend to accumulate soil material and dissolved nutrients from higher levels, thus increasing their overall productivity (ref. Fig. 1.1).

Any human use of an environment results in the removal of the materials (and their embodied energy) which may later not be broken down and returned to the same site. This means that processes of removal and supply of materials characteristic of human use replace the natural processes to a greater or lesser degree. Here, one may speak of "removal ecosystems" and "supply ecosystems" as dictated by the material transports, analogous to the ecosystems in the mountains. Thus, the typical natural relationships between production, use and decomposition in producer-consumer-decomposer cycles are disturbed.

Anthropogenic imbalance may then predominate, bringing with it instability[11].

The Model Approach

The model approach developed for the German MAB Project 6 has been developed with the help of the experience and results of the Austrian and Swiss MAB-6 Projects. In these projects, integrated investigations of human-environment ecosystems were incorporated as part of the research for the first time, featuring also the delineation of important impact factors and their interrelationships. The scheme from MESSERLI and MESSERLI ([12], [13], Fig. 1.2) shows a schematic representation of a regional economic-ecological system, which is essentially composed of three main components (a natural system with abiotic and biotic resources, a land use and a socio-economic system). All the individual components of such a model are interrelated and react together as a whole under external influences. An example of an external ecological influence might be the uncontrolled entry to the system of air pollutants from a distant source. An external socio-economic influence might be a political programme resulting in changed or increased agriculture and forestry use.

The model from MESSERLI and MESSERLI (Fig. 1.2) has, in the Berchtesgaden MAB-6 Project, been applied at different levels of consideration determined by a number of biologically and sociologically orientated specialists (ref. [14], [15]). The observed ecosystem pattern, with its material, energy and economic cycles and interrelationships is considered

[11] Haber, W., 1986: Über die menschliche Nutzung von Ökosystemen - unter besonderer Berücksichtigung von Agrarökosystemen. In: Verhandlungen der Gesellschft für Ökologie (Hohenheim 1984), Band XIV, 1986, S. 13-24.

[12] Messerli, P., et al., 1979: Wirtschaftliche Entwicklung und ökologische Belastbarkeit im Berggebiet. Fachbericht zur Schweiz, MAB-Information Nr. 1, Bern.

[13] Messerli, P., 1986: Modelle und Methoden zur Analyse der Mensch-Umwelt-Beziehungen im alpinen Lebens- und Erholungsraum, Erkenntnisse und Folgherungen aus dem Schweizerischen MAB-Programm 1979-1985, Nationale Forschungsgruppen MAB des Schwerizerischen Nationalfonds Nr. 25, Bern.

[14] Grossmann, W.D., 1983: Systems approaches towards complex systems. Fachbeiträge Schweiz. MAB-Information (Bern) 19: 25-57.

[15] Grossmann, W.D., 1988: Das Regionalmodell Regio: Grundlagen, Aufbau und Einsatz. In: HABER, W. (Hrsg.), 1988: MAB Projekt 6: Ökosystemforschung Berchtesgaden. Methodenentwicklung für die integrierte Ökosystemforschung.

on the lowest level. This lower level of the model consideration is called the process observation level. Here the existing spatial and temporal data are processed in the form of an input-output consideration with the aid of a geographic information system.

Quantitative relationships in the real world can however only be determined by detailed investigation of relatively small samples of the environment. Larger areas of reality are more difficult to measure and quantify, and must be modelled and judged by other methods. It was necessary in the Berchtesgaden Project to illustrate various regional dynamic effects at different spatial and temporal scales (ref. Fig. 1.1, 1.3,[16], [17]).

The essential links between the theoretical levels are those of intellectual interpretation processes. Given a problem, it is necessary, to determine which is the best level to begin at and whether to advance higher or lower. One may begin with the fine details and aggregate the data in an analysis to come to an understanding over the context and connections within the system - an inductive or "bottom up" process. Or, one may begin with overall concepts at a higher level, and work down to the determine the meaning on the ground at a detailed level - a deductive or "top down" process. In practice, both processes operate together, depending on the nature of the problems to be solved.

The Geographic Information System

The Geographic Information System (GIS) applied for the Berchtesgaden Ecosystem Research is a computer system which is used to store and process geographic information. All the data from the study area has been stored in the form of thematic maps and related attributes. From here they can easily be retrieved as required, overlaid and presented in map or table form for a particular purpose.

[16] Grossman *ibid*

[17] Haber, W., Schaller, J., 1988: Ecosystem Research Berchtesgaden - Spatial relations among landscape elements quantified by ecological balance methods. Proceedings of the VIIIth International Symposium on Problems of Landscape Ecological Research Oct. 3-7, 1988, Kamenec resort-Zemplinska Sirava, CSFR.

Fig. 1.1

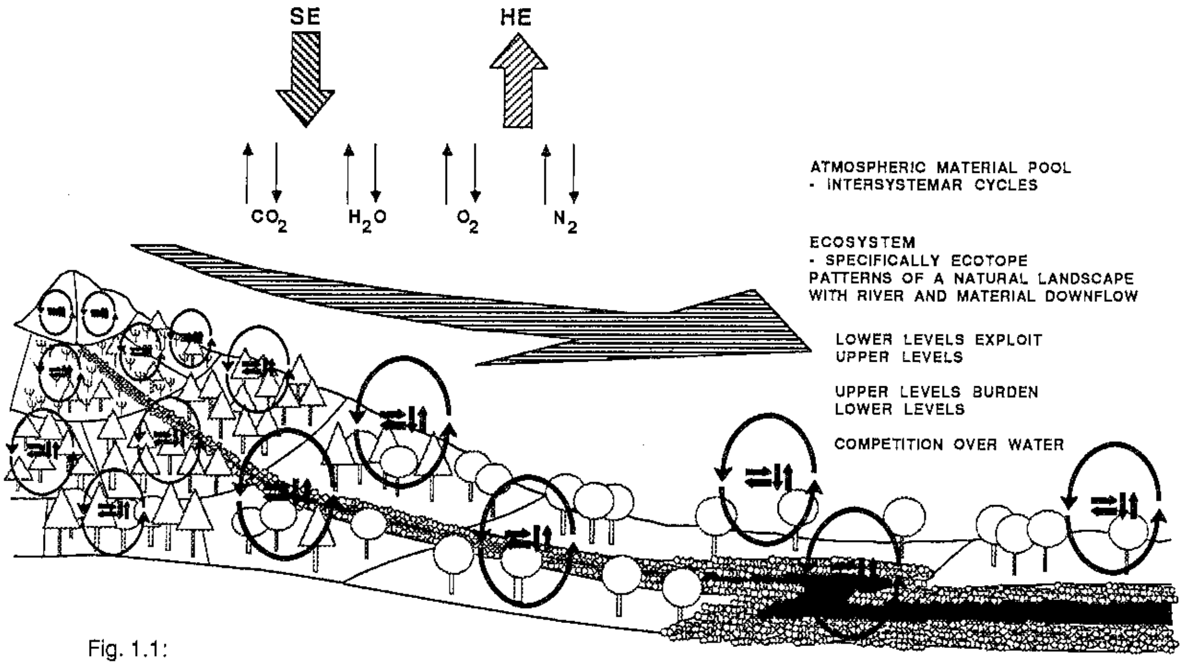


Fig. 1.1:
Pattern of natural ecosystems on a mountain slope.

Surface runoff, streams and rivers carry materials down to lower levels. The site-bound (intrasystemar) ecosystem cycling becomes poorer at higher levels and richer at lower levels. Thus there is a dependency (intersystemar) between the levels. (modified after HABER, W., 1986)

Fig. 1.2

Fig. 1.2: Schematic Representation of a Regional Ecological/Economic System (MESSERLI et al, 1978 adaption)

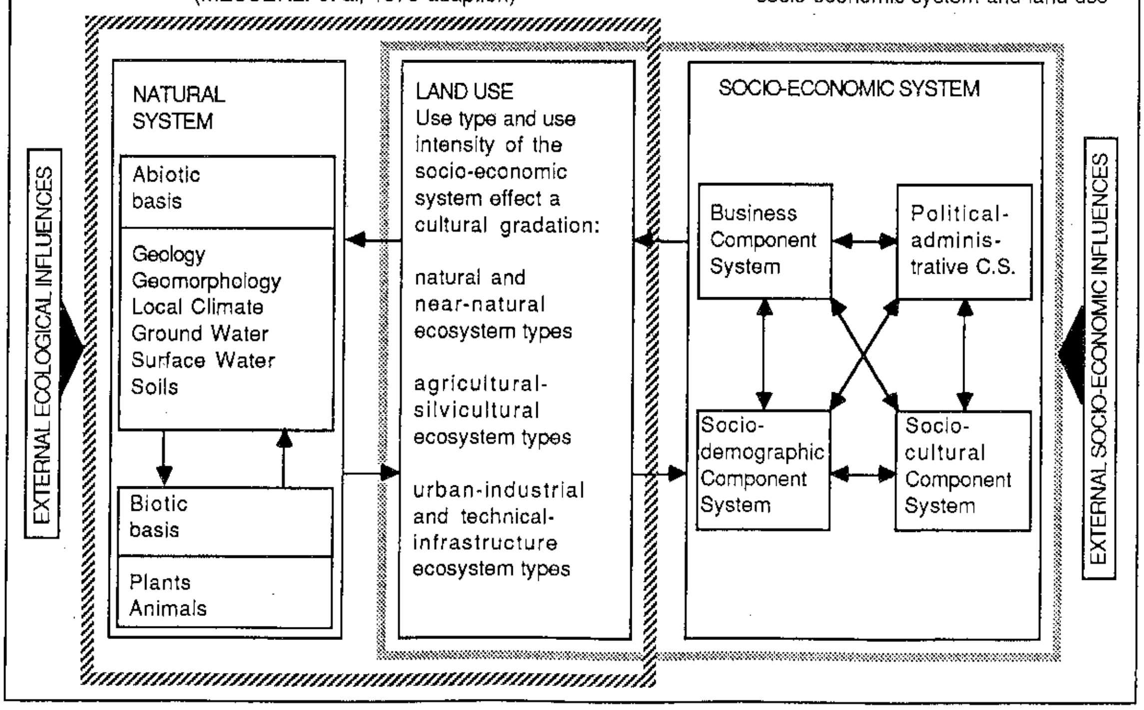


Fig. 1.3: Information Processing at several levels of consideration

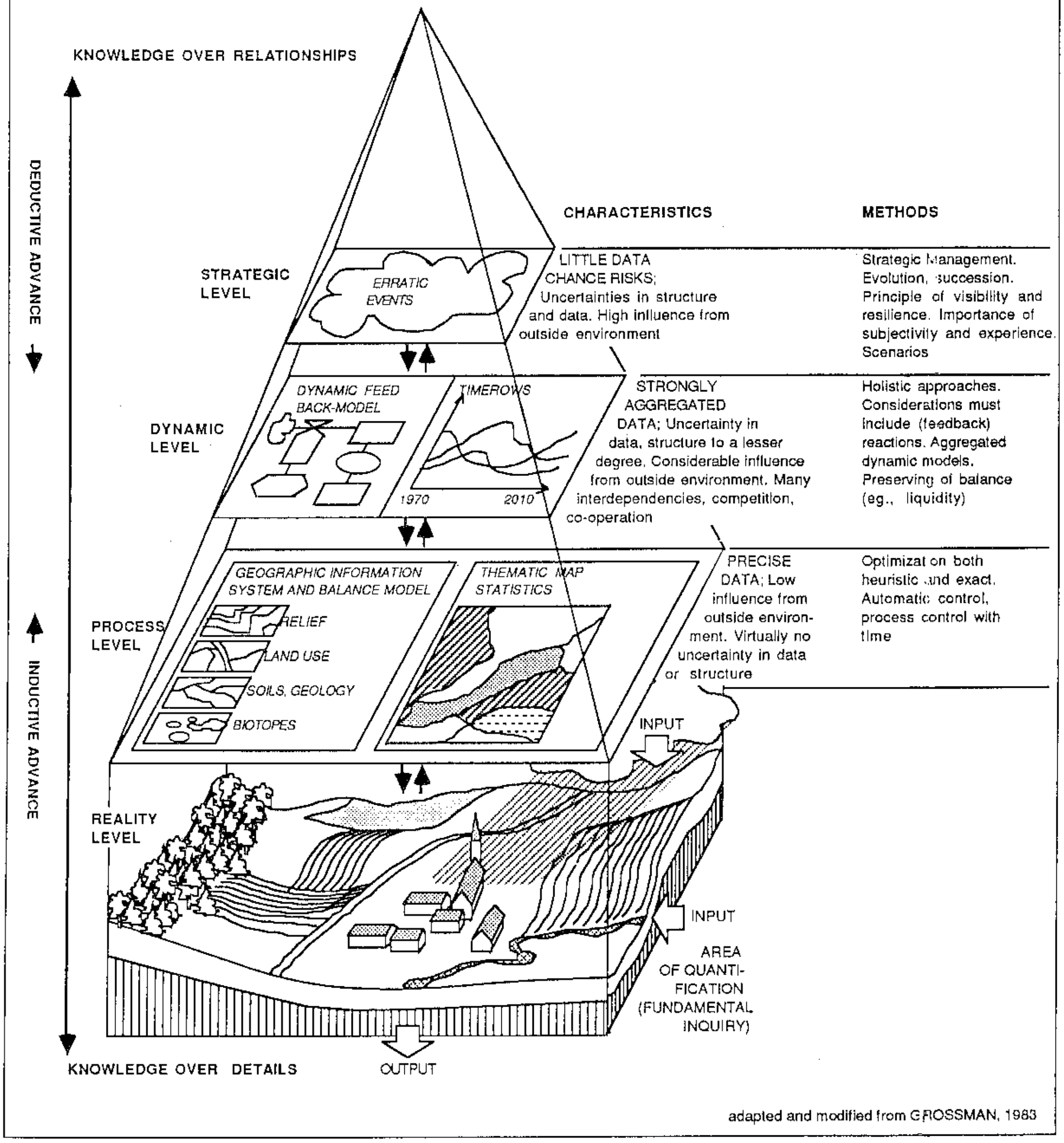


Fig. 1.3

Fig. 1.3: Graphic representation of the hierarchical systems method applied to an ecosystem complex as process domai (bottom). The regulation and control domain is pictured as a three-storied pyramid composed of subdomains which are conceived as different levels of observation. From bottom to top, external control of the system increases. See text for further explanation.

The GIS structure was built up as illustrated in Fig. 1.4[18]. The data from the various sources is processed and combined to give firstly three main spatial data classes, from which maps may be produced.

- site data, from maps, survey results and literature, including information on rock types, soils and soil fertility, erosion and specific site habitat information.
- topographic data, typically slope, drainage, exposure and altitude as determined from photogrammetric measurements.
- land use data, representing the spatial expression of human activities in the environment: data of agriculture, forestry, water bodies, settlements, technical infrastructure, roads etc. are all included. The data is derived from an interpretation of false colour infra-red aerial photographs and orthophotographs. An interpretation key developed for the whole study area is derived from information collected from the intensive test areas. A total of 196 land use types have been identified for Berchtesgaden.

While the mapping scale of 1:10 000 is sufficient to show most land use types, it is not so easy to show linear or point features such as stream courses, walking tracks, hedgerows or individual trees. The same problem exists for details of technical infrastructure, such as mountain cableways. Therefore extra maps of linear and point features have had to be prepared. Discrete mapping co-ordinates were applied for the latter.

The three spatial maps were overlaid for form a combined map, which is thus composed of smaller, delimited areas of common characteristics. This new file contains the "smallest common geometry" (SCG file), the finest spatial breakdown of the study area's characteristics. Each area or "polygon" from the file has a particular and complete set of characteristics. This file is the one used for further computer evaluation, along with the linear and point files. Mapping, statistical procedures and modelling techniques may in any case be applied on all the files. Specific data may be combined or "aggregated" as required for a particular evaluation.

[18] Schaller, J., Spandau, L., 1985: Der Einfluß des Menschen auf Hochgebirgsökosysteme. Integrierte Methoden und Auswertungsansätze zu den Ergebnissen der Ökosystemforschung Berchtesgaden. In: Verhandlungen der Gesellschaft für Ökologie, Band XV, 15. Jahrestagung Graz, 1985.

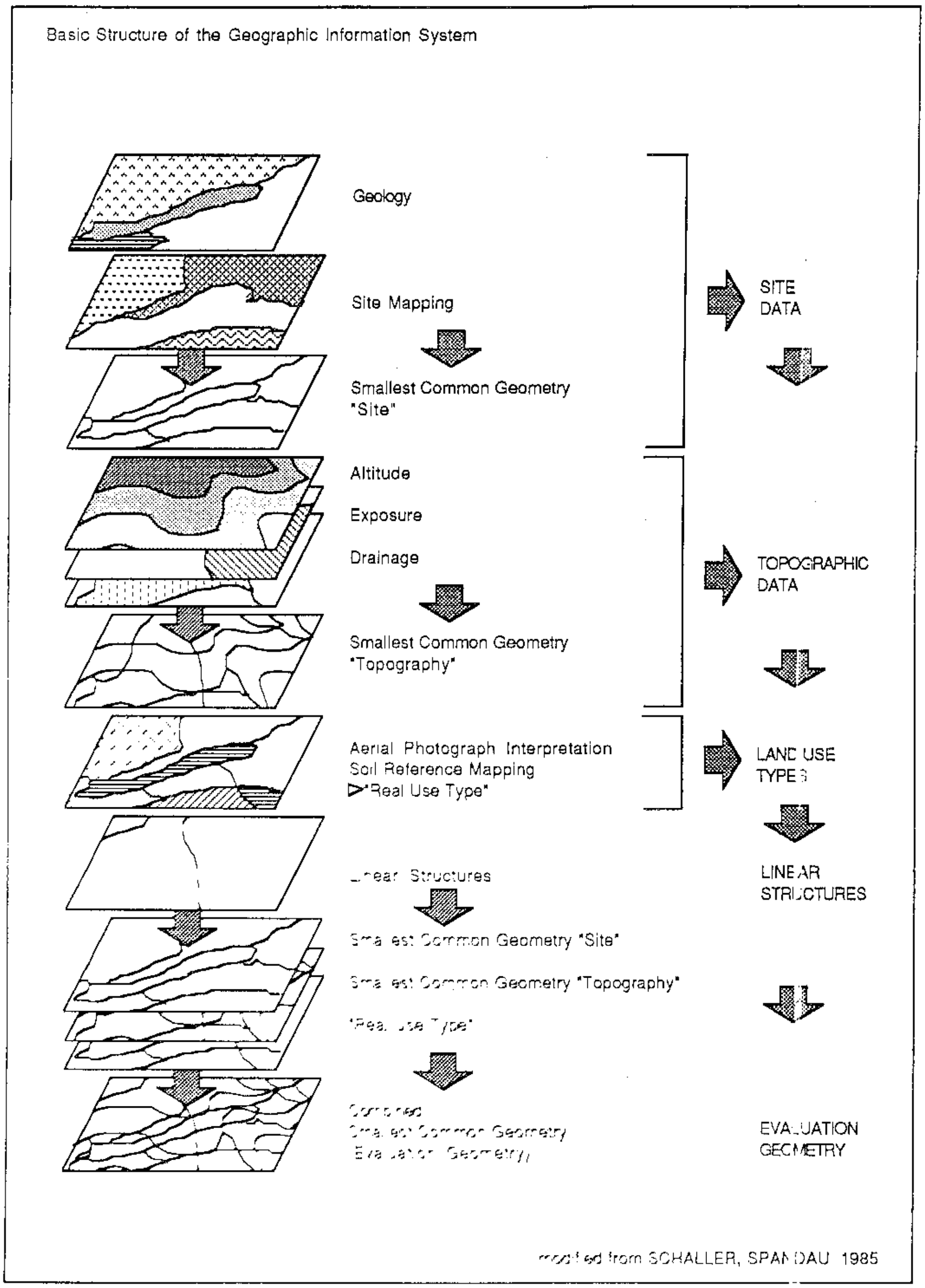

Basic Structure of the Geographic Information System
Geology
Site Mapping
Smallest Common Geometry
"Site"
SITE
DATA
Altitude
Exposure
Drainage
Smallest Common Geometry
"Topography"
TOPOGRAPHIC
DATA
Aerial Photograph Interpretation
Soil Reference Mapping
"Real Use Type"
LAND USE
Structures
Geometry "Site"
Geometry "Topography"
LINEAR
STRUCTURES
EVALUATION
GEOMETRY
from SCHALLER, SPANDAU 1985

Fig. 1.4

Three thematic tables are prepared from all the data within the SCG-polygons to tabulate the individual characteristics or variables:

- a use table (called "NUTZTAB") which lists all the different land use types encountered. This includes detail of various environmental factors such as vegetation type, transpiration, unproductive evaporation, root depth, sensitivity to operations in the water budget and sensitivity to fertilizer materials. There is also information on the ecological functions of each land use type, as well as socio-economic factors.

- a soil table ("BODTAB") which lists soil characteristics interpreted from national mapping sources, and

- a waterform table ("GEWTAB") which shows water source types (rivers, lakes, groundwater etc.) and water quality.

The construction of the GIS thus makes it possible to define spatially more or less unified land use types related to particular abiotic sites within the study area. From the initial data base, modelling and representations can be made by altering the characteristics related to hypothetical changes. The coding system applied allows a whole range of changes in any one polygon to be represented by simply changing from one code number to another. It is also possible in a modelling scenario to develop "new" land use categories not already present in the study area. All these features allow the Ecological Balance Model to be run, which is able to calculate matter and energy input and outputs for a given study region.

The Ecological Balance Model

As described in Section 1.1, the difference between natural and human-influenced ecosystems may be related to the cycling of materials. Differences between inputs and outputs may be related to anthropogenic influences of supply and removal of materials.

As a consequence of this, a data structure has been developed for the catchment area of the Königsee Lake in Berchtesgaden, whereby for all land use types, so-called use tables have been compiled, containing the essential balance data for each ecosystem type[19].

[19] Cejka, M., Kerner, H., 1988: Das ökologische Bilanzmodell. In: HABER, W. (Hrsg.), 1988: MAB Projekt 6: Ökosystemforschung Berchtesgaden. methodenentwicklung für die integrierte Ökosystemforschung, Chair of Landscape Ecology TUM.

As shown in Fig. 1.5, the balance model calculates the origins of materials for each defined ecosystem type, that is emissions, and controlled and uncontrolled inputs. It considers the internal structure, control, processes and alterations to supply and calculates the respective emissions, and controlled or uncontrolled outputs of the respective system. The exchange conditions for the ecosystem complexes are described by the preliminary processing steps of the geographic information system and the spatially-related data model in the GIS software. Thus, the GIS delivers a quantitative calculation of the material and energy flows between "origin" and "receptor" ecosystems

The basic equation for the ecological balance model is therefore:

OUTPUT + EMISSIONS = INPUT + IMMISSIONS - INTERNAL USE + SUPPLY CHANGES

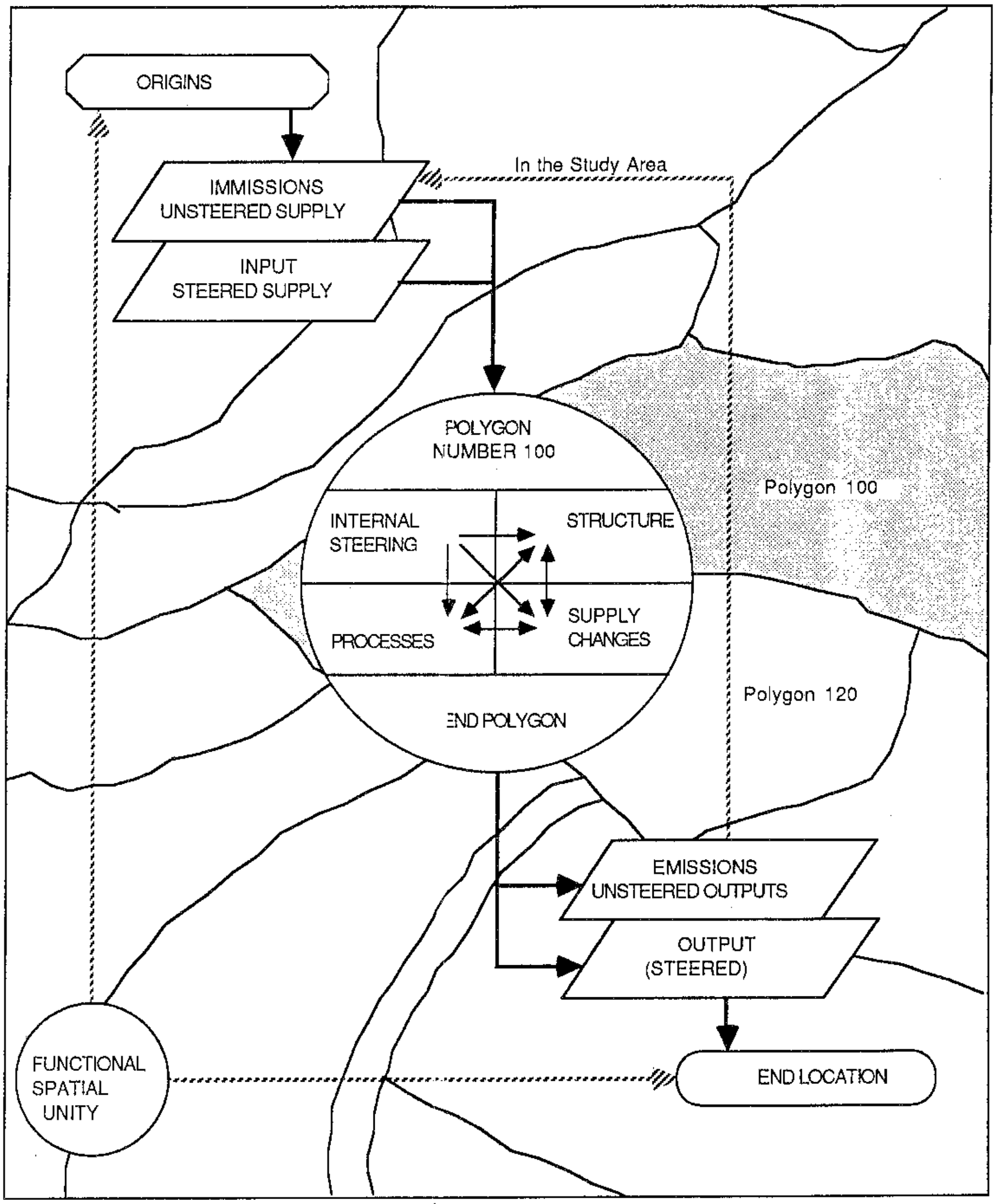
The focal point of the balance model evaluation is the calculation of the ways and extent of material transports. These include transports otherwise unnoticed, as well as those tolerated by normative regulation, or those which are unavoidable. Typical output variables include infiltration, sediment loads in water bodies, total emissions, nutrient content loss through erosion, run-off, and effects on water bodies from eutrophication, terrestrial primary production etc.[20].

The simplest application of the balance model is to consider the change of a land use type. This occurs anyway in reality through natural or human influences, such as windthrow or clearance of trees within a forest, or in a quite different example, the loss of a meadow or field to hard surface construction. These land use changes can now be incorporated in the database with the aid of simple transition matrix, whereby calculated values for the old land use type in the GIS geometry are replaced by values for the new land use type. This approach enables planning simulations to be carried out to determine ecological effects within the land use pattern. This means that for each balance calculation, it is only necessary to assign a new land use type code to each individual polygon in the GIS geometry.

[20] Kerner, H., 1988: Das ökologische Bilanzmodell. In: Haber, W. (Hrsg.), 1988: MAB Projekt 6: Ökosystemforschung Berchtesgaden. Methodenentwicklung für die integrierte Ökosystemforschung; working paper Chair of Landscape Ecology TUM, unpublished.

Fig. 1.5: Basic Equations of the Ecological Balance Model

Fig 1.5



KERNER, 1988, in preparation

A meaningful step in the ecological balance within a water catchment area is the calculation of surface water run-off with the aid of the ecological balance model. Fig.1.6 shows the result of TIN (TRIANGULAR IRREGULAR NETWORK) cascading with the various flow directions and the general connections between catchment areas and stream sources[21]. It is thereby possible to represent water transport processes in terrestrial catchment areas. Such a balancing and simulations instrument saves effort not only for documentation but also for prognosis as a decision basis for the future land uses in catchment areas of water body ecosystems [22].

Environmental Impact Assessment Study for the Danube River Channel between Straubing and Vilshofen

The aim of this study is to investigate possible effects of different river works variants on the natural resources of the Danube River and the floodplain. A null hypothesis is also considered. Potential risks and deleterious effects are shown in time to bring ecological considerations to the fore before the building works begin. The study area for the Danube section between Straubing and Vilshofen is about 50 km long with an average width of about 5 km. The total area covered is 257 sq.km..

Conception

For this ecological study, which is to be finished in 1990, a concept for the project implementation has been developed in co-ordination with the Bavarian State Agency for Environmental Conservation. This concept breaks up the project into five main phases, which in part run simultaneously [23], [24], [25]:

---

[21] Flacke, W., Schaller, J., 1988: GIS and a balance model - technical solutions for the application programming in the MAB-rsearch. In: Proceedings of the IIIrd. ESRI European User Conference. Environmental Systems Research Institute - D-8051 Kranzberg-Freising.

[22] Koeppel, J.G., Schaller, J., 1989: Environmental Monitoring as a Contribution to Nature Conservation in the Federal Republic of Germany, Planning Office Dr. Schaller, unpublished.

[23] Koeppel, J.G., Mayer, F., Schaller, J., Steib, W., 1988: Konzept der Ökologischen Rahmenuntersuchung zum geplanten Donauausbau zwischen Straubing und Vilshofen (BRD). Wissenschaftl. Kurzreferat zur Arbeitstagung der IAD in Mamaia/Rumänien, in preparation.

Phase 1: Data Collection
Flyovers and aerial photograph evaluation; field mapping, creation of ecologically relevant data; literature evaluation

Phase 2: GIS-creation and Data Processing
Development of maps, tables, diagrams and statistics as a basis for the subsequent assessments

Phase 3: Model Application and Resource Assessment
Professional modelling and statements from various disciplines; development of assessed spatial units

Phase 4: Prognosis and Balancing Methods of Impacts
Combination of ecologically assessed spatial units with the affected areas for the different variants; variant-orientated impacts balance

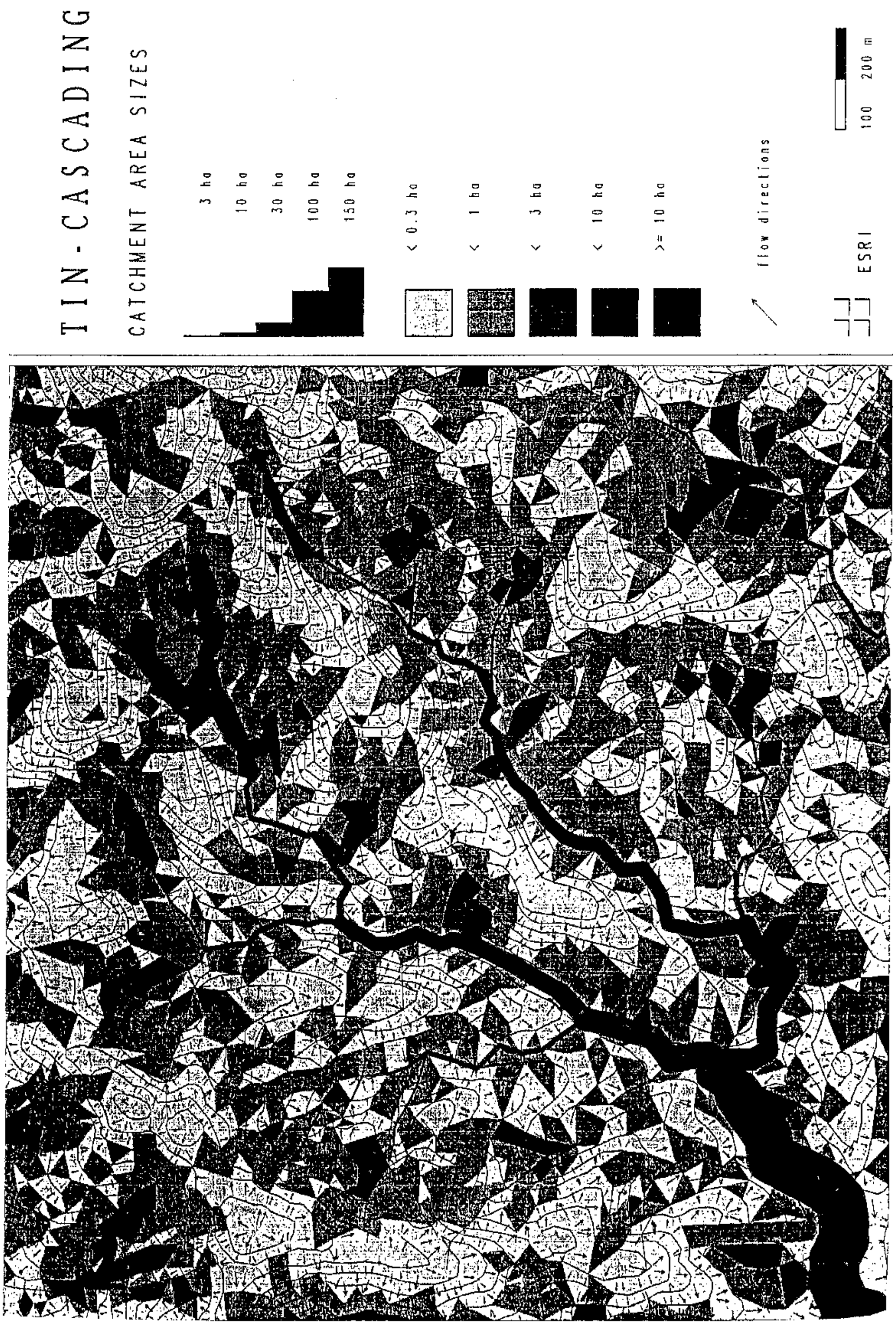
Phase 5: Total Evaluation and Presentation of Results
Summarized expert statement

Data Collection
After the initial project definition phase with the client and the Bavarian State Agency for Environmental Protection and Conservation, several disciplines from different sources (consulting offices, universities and own resources) were invited to a workshop where the main issues, the data needs and principles of assessment were discussed. A work programme was developed in which all questions of data collection and processing were considered.

[24] Planungsbüro Dr. Schaller, 1988: "Neue Schritte beim Donauausbau - Die ökologische Rahmenuntersuchung". In: RMD-Intern 3/88 und 1/89. Rhein-Main-Donau AG (Hrsg.), München.

[25] Schaller, J., 1989a: Environmental Impact Assessment Study for the planned Rhine-Main-Danube River Channel (Federal Republic of Germany). In: Proceedings ARC/INFO User Conference 1989, ESRI Redlands, Cal.

Fig 1.6


TIN-CASCADING
CATCHMENT AREA SIZES
3 ha
10 ha
30 ha
100 ha
150 ha
< 0.3 ha
< 1 ha
< 3 ha
< 10 ha
>= 10 ha
flow directions
ESRI
100 200 m

GIS Structure and Data Processing

Fig. 2.1 illustrates the area-related basis information of the GIS. For the entire study area, a map library of eighty-one maps (scale 1:5.000) was prepared, containing all necessary information for the area-related Environmental Impact Assessment. The data were either taken up directly in digital form, or manually digitized using aerial photographs interpretation maps and resources maps showing filed boundaries. The corresponding attributes were stored in the INFO data bank.

Statistical analysis of basic data has been carried out parallel to data processing, e.g. evaluation of ground water time series data, to create results which have been assigned as single attributes to the GIS-Database. Fig. 2.2 shows the integration process of the different single GIS databases required to conduct the area-related assessments. Integrated resource assessment maps are created by using GIS procedures such as overlay, buffer and network techniques. The different alternatives of construction become subsequently overlaid with the resource data, resulting in geographic and statistical data for interpretation to conduct the evaluation of the variants of construction.

Model application

In addition to pure area-related more or less static evaluations, dynamic effects of the respective impacts on ground and surface water conditions must also be considered (eg., ground water level changes, changes in water quality, changes of vegetation in time, etc.).

Here, for example for the ground water conditions, a two-dimensional stationary groundwater model was used, and coupled with the GIS database[26]. The basis for the model calculation is a grid with a meshwidth of 500x250 m. For every grid element, aquifer parameters (kF value, dam or gravel overlaid, etc.) and hydrological parameters (ground water table, new formations thereof, etc.) are coupled with other resource data (eg., vegetation, soils) and valued.

Similarly, the water quality conditions before and after the works are compared for each variant. For an example of a biotic evaluation in the form of a spatial model, the GIS

---

[26] Fürst, J., Nachtnebel, H.P., Remmel, I., 1989: Ökologische Rahmenuntersuchung Straubing-Vilshofen/Grundwassermodell. Vorbericht Variantenstudie. Universität für Bodenkultur, Wien, unpublished.

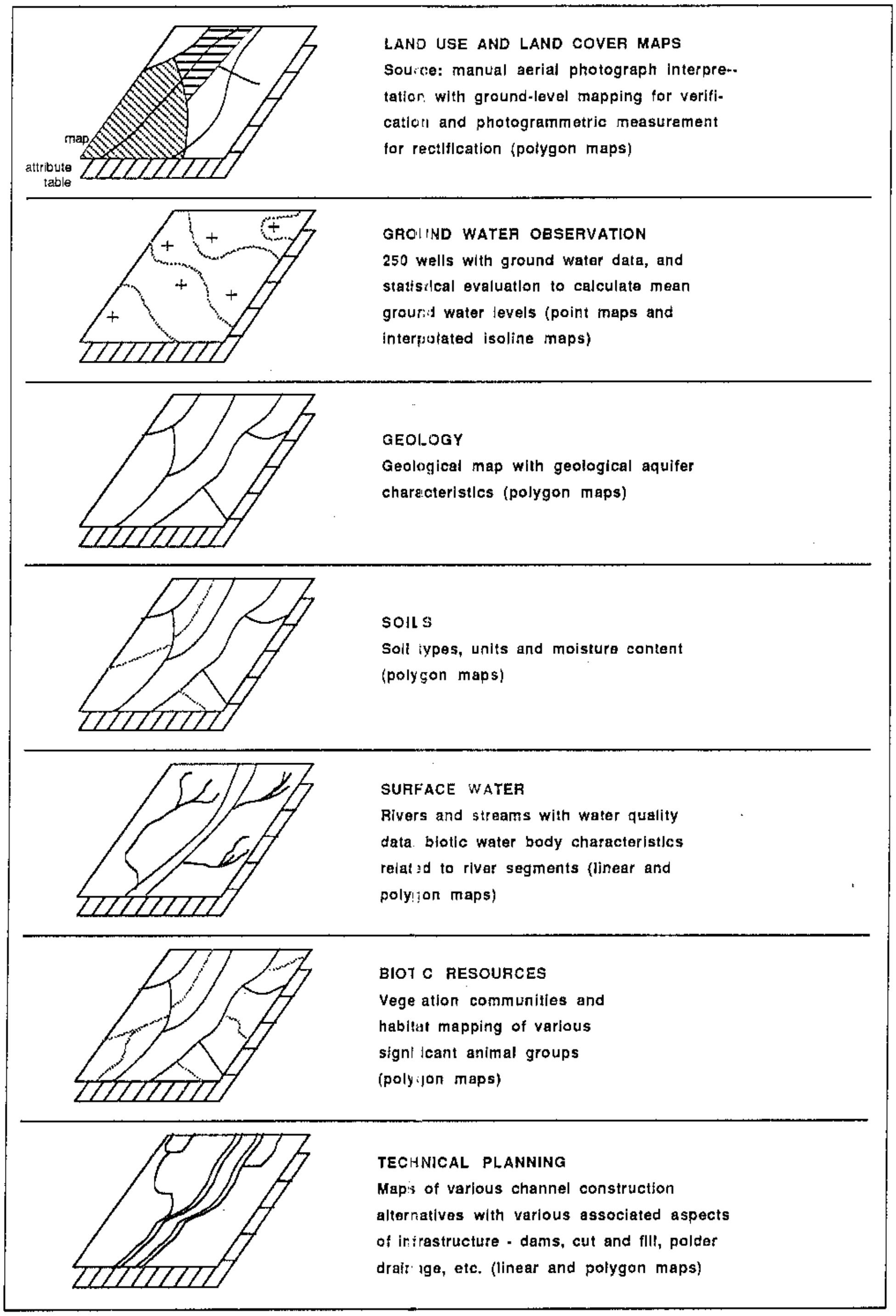

map
attribute table
LAND USE AND LAND COVER MAPS
Source: manual aerial photograph interpre-tation with ground-level mapping for verifi-cation and photogrammetric measurement for rectification (polygon maps)
GROUND WATER OBSERVATION
250 wells with ground water data, and statistical evaluation to calculate mean ground water levels (point maps and interpolated isoline maps)
GEOLOGY
Geological map with geological aquifer characteristics (polygon maps)
SOILS
Soil types, units and moisture content (polygon maps)
SURFACE WATER
Rivers and streams with water quality data, biotic water body characteristics related to river segments (linear and polygon maps)
BIOTIC RESOURCES
Vegetation communities and habitat mapping of various significant animal groups (polygon maps)
TECHNICAL PLANNING
Maps of various channel construction alternatives with various associated aspects of infrastructure - dams, cut and fill, polder drainage, etc. (linear and polygon maps)

Fig 2.1

application for the derivation of values of the biotope natural should be mentioned. From the biological disciplines came calculation procedures for the "stepping stone" function of different habitats for various animal and plant species[27], [28].

Prognosis and Evaluation of Impacts
In the study, the following impacts must be considered:

1. Status quo - null hypothesis
2. Effects of construction
3. Effects from the form of the works (variant comparison)
4. Effects from channel river operation (wave action)

The fundamental procedure is illustrated in Fig. 2.3. Depending on the type of valuation, the various effects are described in the form of transition matrices (eg., landuse changes) or risk profiles. In this way, it is possible to compare the effects of impacts both for the status quo as well as the variants with one another, and thereby develop an "ideal" model [29], [30], [31].

---

[27] Manegold, J., 1989: NETNET, Programm zur Trittsteinbewertung. ESRI, Germany, Kranzberg, unpublished AML procedure.

[28] Schreiner, J., 1989: Fachliche Vorgaben zur Trittsteinbewertung. In: Zwischenbericht der Projektleitung. In: Planungsbüro Dr. Schaller, Arbeitsgruppe Ornithologische Arbeitsgemeinschaft Ostbayern. Projektbericht "Ökologische Rahmenuntersuchung zum geplanten Donauausbau zwischen Straubing und Vilshofen - Bewertungsprogramm", unpublished.(Parts of this paper have been published by the GIS-Summer Institute, Amsterdam, Schaller, 1989b ([20]))

[29] Koeppel, J.G., Mayer, F., Schaller, J., Steib, W., 1988: Konzept der Ökologischen Rahmenuntersuchung zum geplanten Donauausbau zwischen Straubing und Vilshofen (BRD). Wissenschaftl. Kurzreferat zur Arbeitstagung der IAD in Mamaia/Rumänien, in preparation.

[30] Planungsbüro Dr. Schaller, 1988: "Neue Schritte beim Donauausbau - Die ökologische Rahmenuntersuchung". In: RMD-Intern 3/88 und 1/89. Rhein-Main-Donau AG (Hrsg.), München.

[31] Schaller, J., 1989a: Environmental Impact Assessment Study for the planned Rhine-Main-Danube River Channel (Federal Republic of Germany). In: Proceedings ARC/INFO User Conference 1989, ESRI Redlands, Cal.

Ecological Balancing in Land Consolidation

The increasing ecological sensibility of recent years has also had effects on land consolidation. Not only primary economic questions must be considered - ecological aspects such as biotope protection, resource protection and endurance of agricultural production by minimalization of environmental impacts are all current issues in modern land consolidation. Methods for ecological balancing in land consolidation were developed in a research procedure at University of Technology, München-Weihenstephan, commissioned by the Bavarian Ministry of Agriculture[32],[33]. In addition to fundamental questions of resource evaluation, Geographic Information Systems for the data coupling were also applied. The GIS database is calculated from the inventory of the natural resources and the planned land use changes.

As well as the classic evaluation parameters such as ground water quality and quantity, surface water bodies, soil and soil erosion, local climate and effects on vegetation and fauna, integrated ecological parameters such as diversity, habitat networks and edge effects must also be considered. An analysis of changes to the quality of landscape elements over time is likewise essential. Fig. 3.1 (Maps 1 and 2) show the current status of the allotment division in the test area Oberhaselbach, and as an example, a planning variant of the planned spatial use after consolidation. Alone the changes from clearcutting, new tracks, slope direction, distance of small landscape structures etc. allow the storage and blending of the basis geometry, the setting-up of difference statistics, all related to areal size, clear-cutting length, edge effects (eg. neighbouring types) and structural losses.

Using a TIN cascading procedure the direction of surface water flow and the watersheds were calculated. By using the soil-loss equation the quality of soil losses within the watershed can be calculated for every alternative strategy of consolidation. Using GIS evaluation it is possible to compare very quickly the different variants for track and land consolidation planning. By examination of the habitat network, it is possible to quantify and

[32] Auweck, F., Bachhuber, R., Riedel, A., Theurer, R., Schaller, J., 1989: Handbuch zur Ökologischen Bilanzierung in der Flurbereingiung. Abschlußbericht. Lehrstuhl für Landschaftsökologie TU München-Wiehenstephan, unpublished.

[33] Bachhuber, R., Schaller, J., 1988: Methoden zur Umweltverträglichkeitsprüfung (UVP) agrarstruktureller Veränderungen. Schriftenreihe Bayer. Landesamt für Umweltschutz, München, H. 84, S. 65-81.

Fig. 2.2: Integration of the GIS Database for the Environmental Impact Assessment

Fig. 2.2

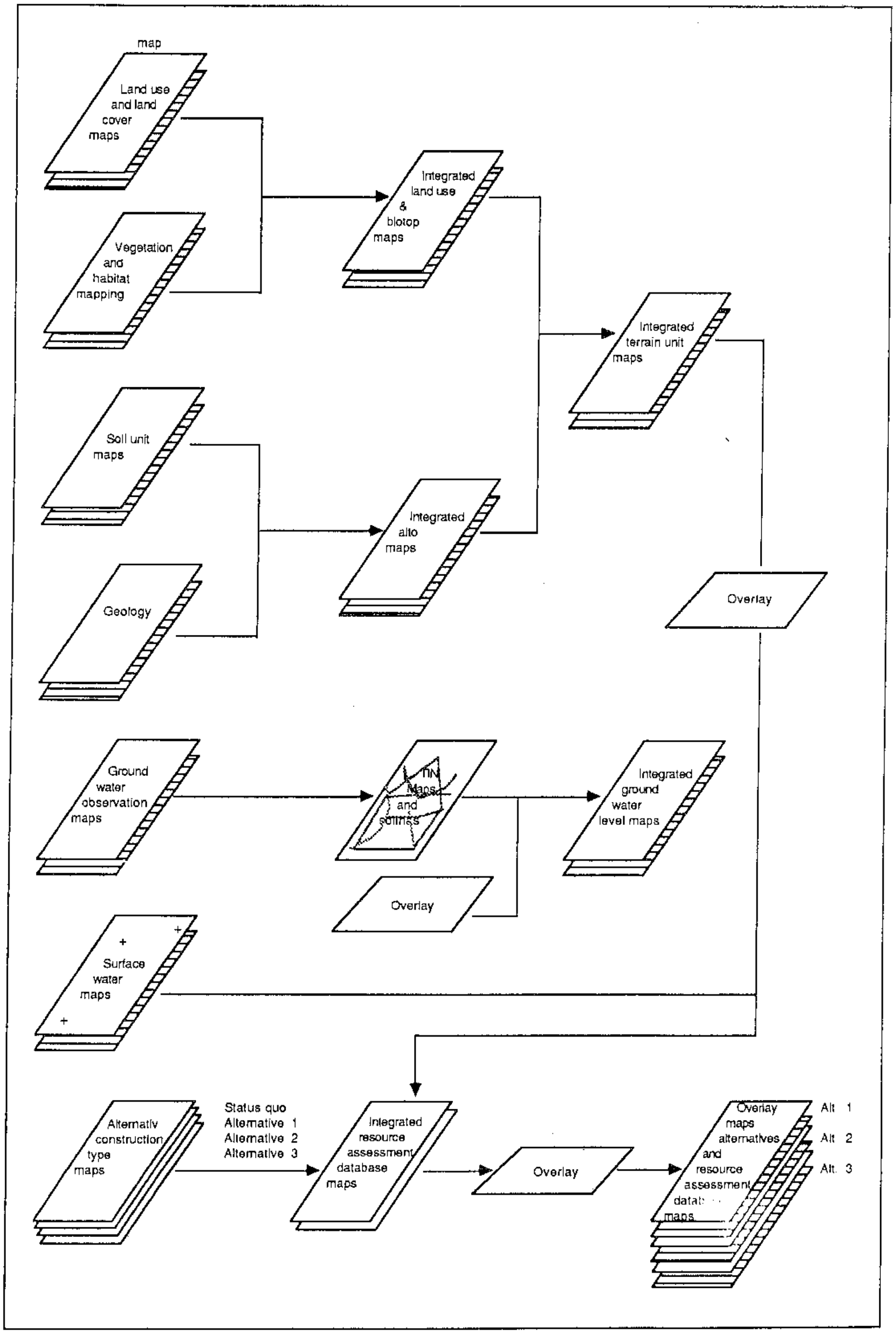
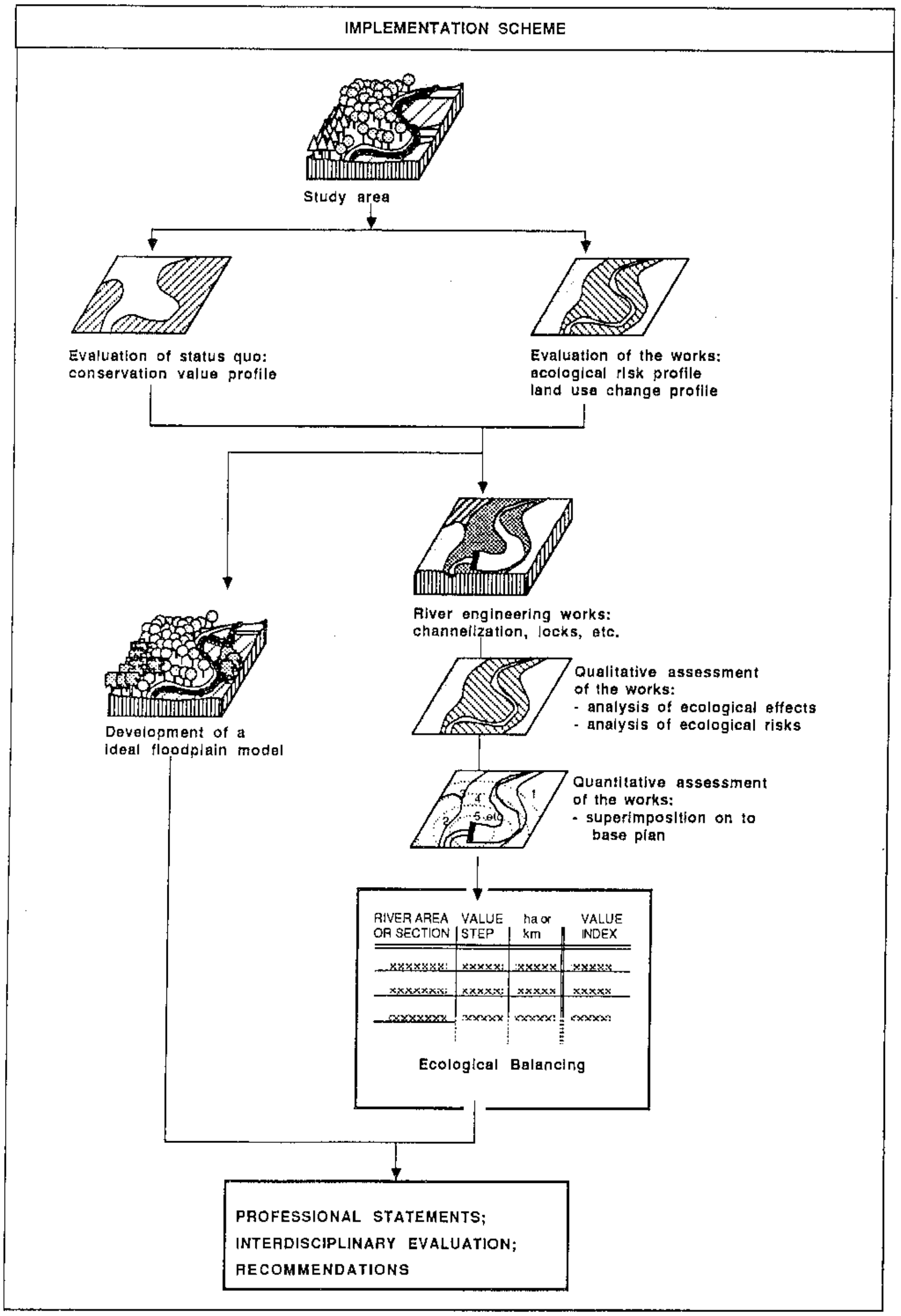


Fig. 2.3



Source: J.G. KÖPPEL, Planning Office Dr. Schaller illustrate the existing network and thinning out effects. The coupling of clear-cutting lengths, slope, soil types and use allow area-related calculations of erosion and deposition of pollutants in river bodies. With the aid of the technical evaluation basis and the possibility of GIS input, land consolidation planning has now completely new instruments at its disposal to support the necessary technical and planning decisions[34], [35].

Determination of Noise Pollution Effects on Residents near the new Airport Munich II
With the publication of the initial flightpath proposals for the new airport Munich II came sharp public protest and questions as to who could be affected in the vicinity. Geographic Information Systems have served, coupled with noise dispersion calculations, to determine the area-related effects on local communities, and to illustrate these statistically and cartographically. Through overlay of the calculated noise values on the ground (from standard aircraft noise calculation procedures) with the population size of the communities, it is possible to calculate quickly who will be affected by sporadic or continuous disturbance. This can be related to airport management models, aircraft types and chosen flightpaths. Fig. 4.1 shows, as an example, a three-dimensional representation of affected communities in the airport vicinity, whereby for a particular flightplan variant and airport management model, the population sizes are weighted against dBA noise level values and are illustrated as "annoyance mountains". Such GIS evaluations are very effective, and can be easily conducted and presented for lay people[36].

Environmental Impact Assessment for the Federal Motorway A94 between Ampfing and Forstinning (Southern Bavaria)
An Environmental Impact Assessment (EIA) Study has been carried out to compare two different routing alternatives with several planning variants of Autobahn construction between Munich and Passau in Southern Bavaria. The EIA was done for the Autobahn Construction Authority. GIS capabilities have been used for the assessment procedures and

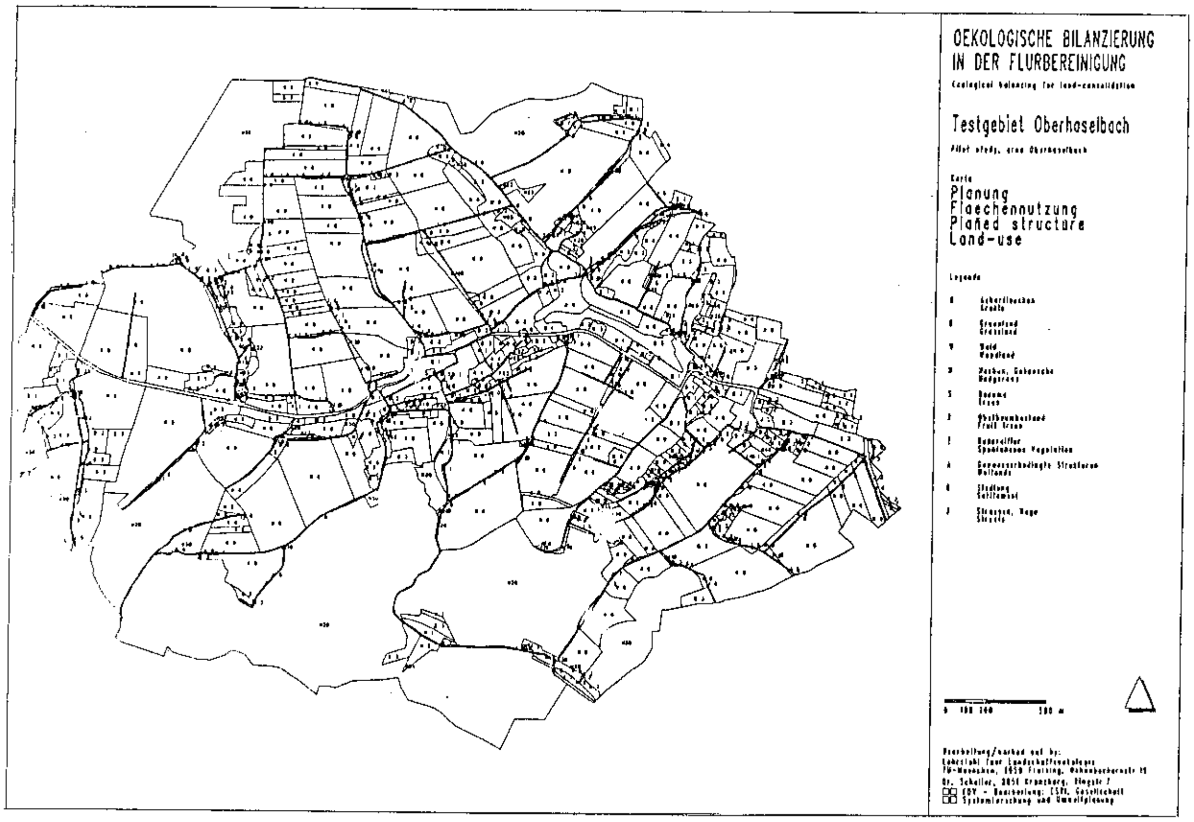
[34] Auweck, F. et al...., and Bachhuber, R., et al....

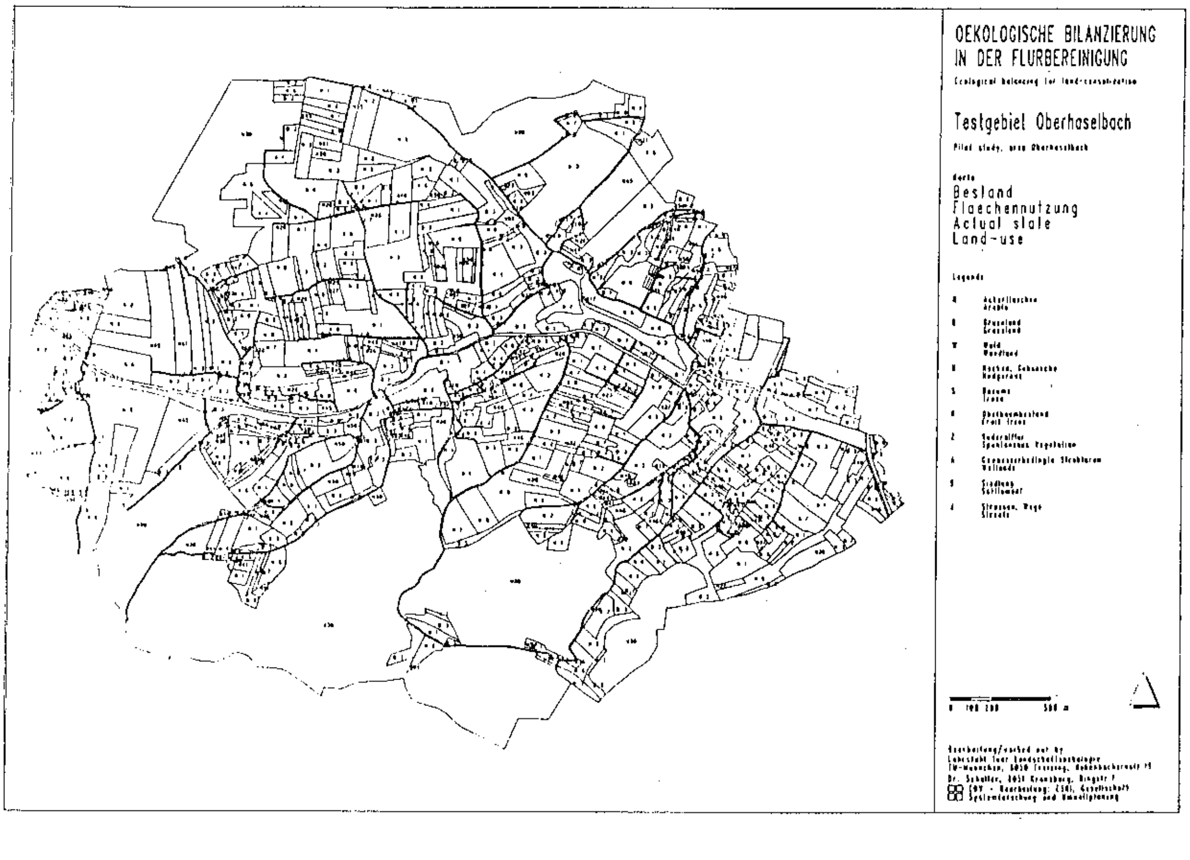
[35] Haber, W., Schaller, J., 1988: Connectivity in Landscape Ecology, Proceedings of the 2nd International Seminar of the "International Association for Landscape Ecology". Hrsg.: K.F. Schreiber, Münsterische Geographische Arbeiten Nr. 29, S. 181-190.

[36] ESRI Germany, 1988: Lärmgutachten zu den neuen Flugrouten Flughafen München II. Auszug: Lärmzonenberechnung nach AzB. Erstellung im Auftrag der Gemeinde Kranzberg, unpublished project report.

Fig. 3.1: Actual landuse and planned plots after consolidation

Fig. 3.1





to produce the results in form of statistical analysis and cartographic display. By using conventional methods in data analysis, advanced GIS tools of data processing such as overlay procedures, TIN and NETWORK applications led to sophisticated assessment methods for a large data base. Four types of geographic data have been evaluated:

- abiotic resource data
- biotic resource data
- land use and impact data
- planning data of the line variants.

A data bank of nine maps (scale 1:10.000) was developed and an integrated evaluation therein carried out. The assessment of impacts and eventual motorway operation were considered for three evaluation areas:

- landscape ecological terrain units
- vegetation valuation
- fauna valuation

The ecological valuations and their criteria are illustrated in Fig. 5.1

For the comparison of variants, the routes were digitized and blended with the basic data, with a 200 m buffer zone from each side of the central line, which has been differentiated by form of construction (levels, dammed, cut etc.). Fig. 5.2 depicts the map with the assessed ecological terrain units by five levels of sensitivity overlaid by the 400 m buffers of the construction variants. Through the comparative interpretation of the cartographically and statistically determined "affected aspects of the natural resources", it was possible todistinguish between optimal and most unfavourable variants. The planning corridors could thus be valued related to their ecological sensitivity [37].

---

[37] Schaller, J., 1987: Environmental Impact Assessment (EIA) of different routing alternatives of a planned autobahn between Munich and Passau (Southern Bavaria). In: Proceedings ARC/INFO User Conference 1987, ESRI Redlands, Cal.

Fig. 4.1

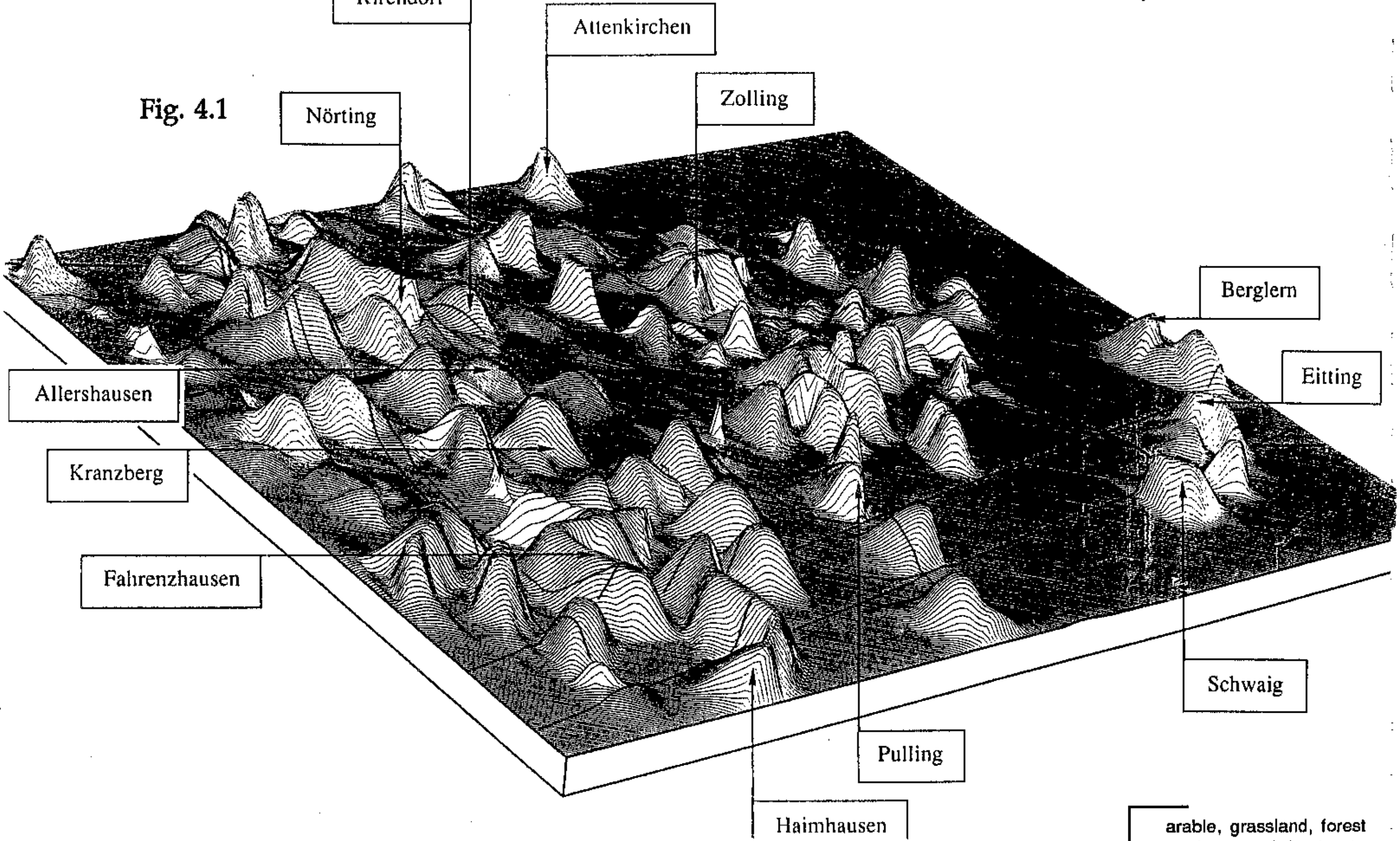
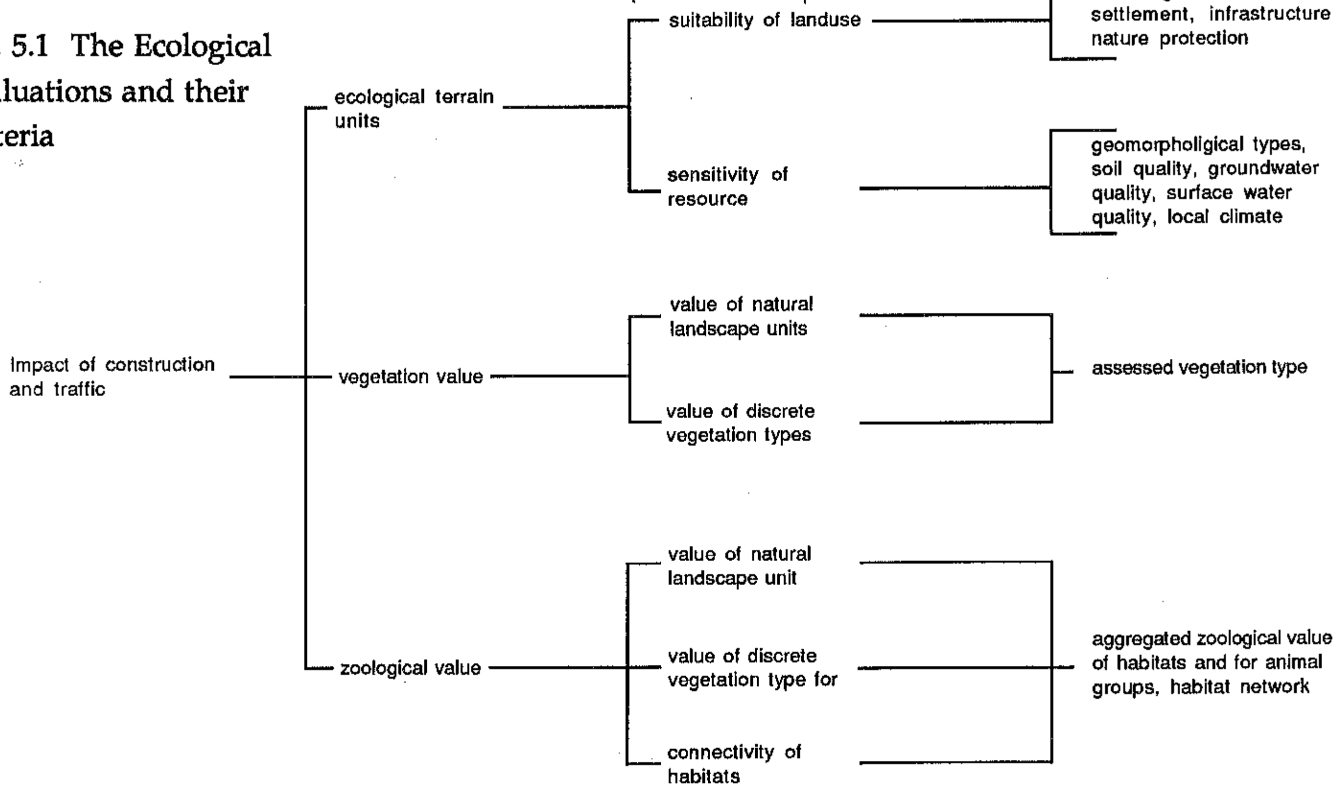
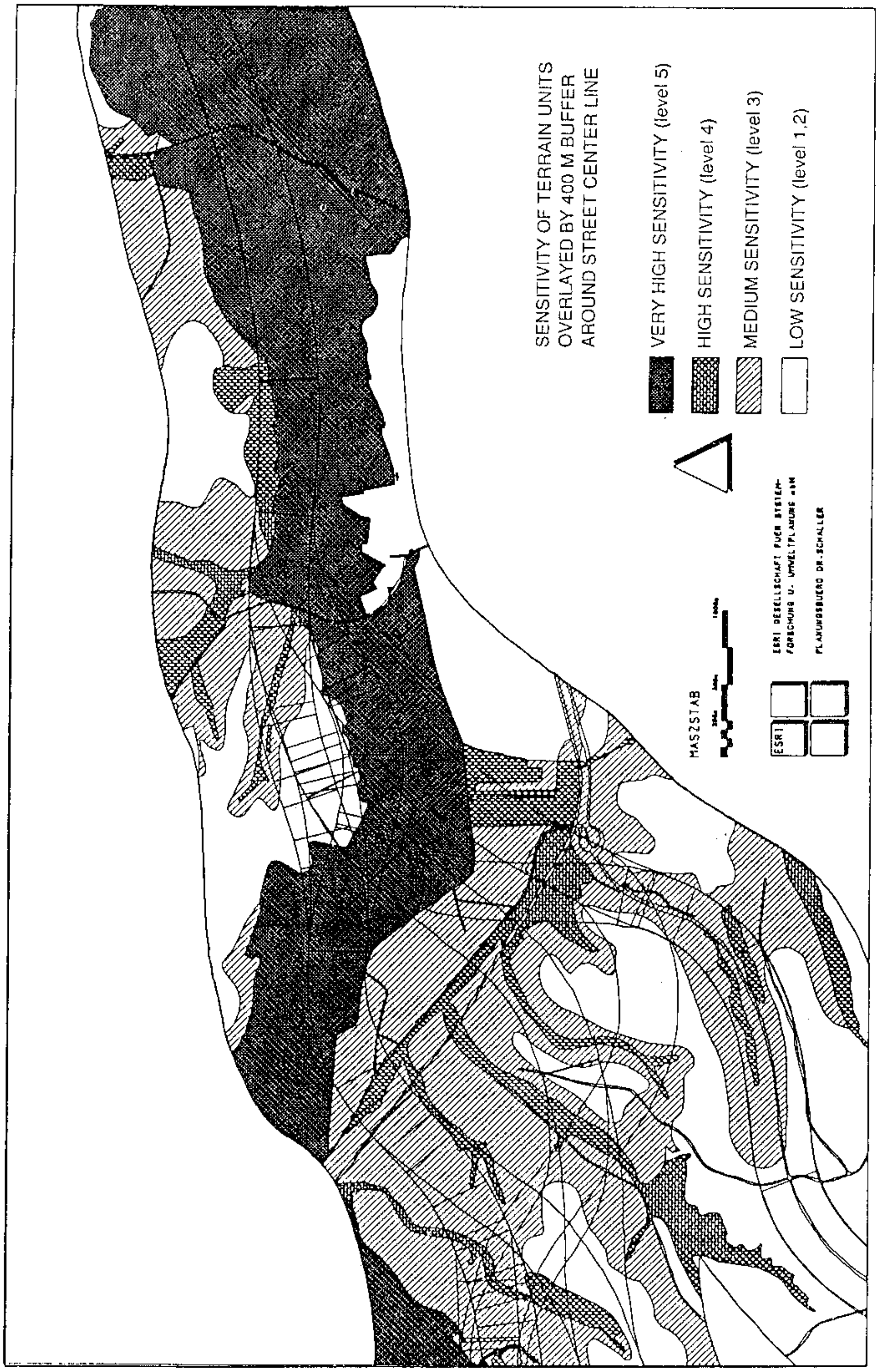


Fig. 5.1 The Ecological Evaluations and their Criteria



Ecological assessment of alternative routes of Federal motorway construction

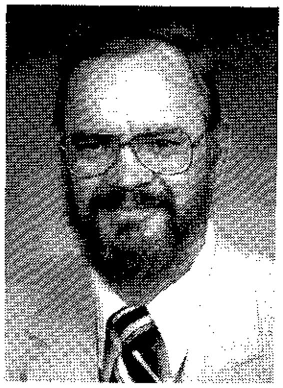
Fig. 5.2



CHAIRMAN ZILLMER: Thank you very much, Dr Schaller, for providing us with an overview of environmental planning in Germany. All countries are faced with many similar problems regarding the environment, and I think we can surely learn from each other how to apply GIS technology to most effectively resolve these problems. Also, with the unification of Germany, I am sure you will have many more challenges facing you in the 90s and we wish you all the best.

Our next speaker is Barry Wellar. Dr Wellar is Professor, Department of Geography, University of Ottawa, and Research Associate, Institute for Land Information Management, University of Toronto. He is a member of the Canadian Institute of Planners and is a past president of the Urban and Regional Information Systems Association (URISA). Dr Wellar comes with a wealth of knowledge and experience in GIS being one of the pioneers in this field. He has worked with many different groups over the years and is currently the Director, Land Information Technology Program, Commonwealth Association of Planners. Today he will speak on the use and transfer of land information technology for planning in the Commonwealth.

USE AND TRANSFER OF LAND INFORMATION TECHNOLOGY FOR PLANNING IN THE COMMONWEALTH



Dr BARRY WELLAR
Department of Geography
University of Ottawa, Ottawa

Introduction

The theme of this GIS Seminar, "The Coming of a New Decade - What Have We Learned from the 80s?" is provocative in that it provokes additional, related questions:

- What, in truth, do we know about GIS?
- On what basis/bases do we know what we claim to know about GIS?
- How do we distinguish between what was learned in the 80s about GIS from what we "learned" in the 70s or 60s?
- By what criteria can we claim that what we have learned about GIS was/is worth learning?
- What do we now do differently, what new things do we do, and what new or different purposes are served as a result of what we have learned regarding GIS?
- What new or different outcomes have been realized as a result of what we have learned about GIS?

No doubt those and other questions will be raised and addressed by most if not all the distinguished panelists selected to make presentations at the Seminar. It is my intention, therefore, to depart from the theme somewhat, as I have previously addressed the subject of GIS progress on several occasions (3, 4). In addition, I examine the matter again at some length in a paper prepared for the GIS/LIS '90 Conference and Proceedings (5).

It is my intention, instead, to begin by placing GIS activities -- past, present, future -- in the context of our failing global state of environmental health. Then I briefly report on an international education and training initiative that seeks to enhance the contribution of land information technology (LIT) to planning for sustainable development. As will be suggested, either of those "measuring sticks" is regarded as sufficient to make the case that our accomplishments to date are marginal relative to what remains to be done by or with GIS.

Geography of the Globe's Environmental Health

On a daily basis we are presented with media reports on things gone and going wrong with the globe's land, water, and air resources. And, in respect of a longstanding journalistic tradition, there is usually a *where* among the who, what, when aspects of the reports. The newspaper headlines which appear in Figure 1 are illustrative of such reportage.

The following comments, although limited in number, should be sufficient to establish why the findings and recommendations of the Bruntland Commission warrant consideration and action, why the Commonwealth Association of Planners launched its LIT/Sustainable Development Program, and why I observed above that "our accomplishments to date are marginal relative to what remains to be done by or with GIS".

First, a number of those and similar headlines (and associated stories) are by no means new; rather, they have been appearing for decades.

Second, thousands of such headlines appear, day in and day out, in newspapers around the globe. Few of us are in position, however, to become apprised of the "globality" of land, water, and air resource abuse, and to thereby realize just how much of the Earth's space has been or is being abused.

Third, the incidences of land, water, and air abuse which are reported by the media are by *no* means all that occur. Abuses may not have been discovered, abuses may not have been deemed newsworthy, or abuses may not have been perceived as such at the time or place of occurence. That they were not reported does not mean, obviously, that they did not occur.

And, fourth, the vast majority of such reports are locality-, event- or situation-specific, contain little or no reference to the why(s) and how(s) that underlie processes and relationships over time and space, ignore the chronic nature of the abuses, and overlook their additive, cumulative, negative consequences[38].

---

[38] An increasing number of newspapers are including environment- and science-oriented columns, and pages, on a weekly or more frequent basis. Relative to the magnitude and complexity of the information problem before us, however, that progress in reportage still falls

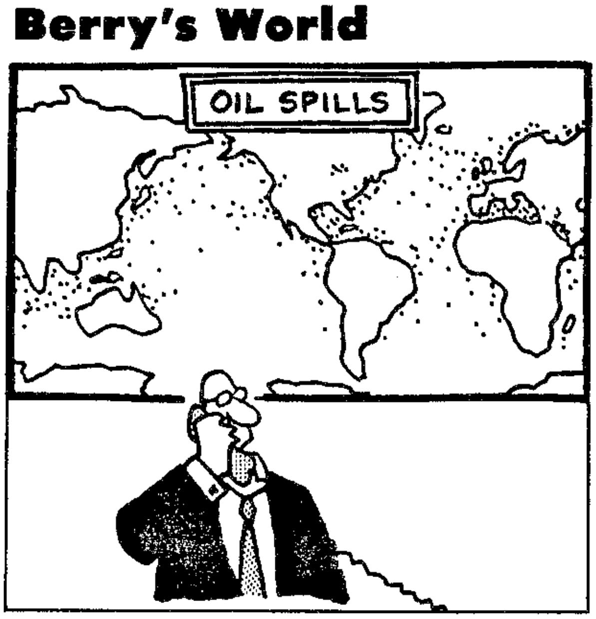
FIGURE 1. A Sample of Headlines on Land, Water, and Air Abuse:

Makings of "The Doomsday Map"?
Overexploitation risks survival of planet
Rain forests: Their destruction a worldwide problem
Third world becoming a toxic dumping ground
Garbage: Viable disposal plan an elusive goal for past 20 years
State looking for "candidates" to store toxics
The death of open spaces
Destroying a habitat: the threat to Hawaii
Sprawl could destroy way of life
Paving in the name of progress
Don't let cars choke our cities
New solutions needed to ease traffic jams
Population growth dooms environment
Oil's black death takes terrible toll
Coastal waters being used as toxic dump
100 000 eastern lakes hurt by acid rain
Cocktail of toxins threatens lake
More PCB-laced oil spills in river feared
Dirty air threatens one billion
Metro choking on auto fumes hearing warned
Mexico City pollution now "irreversible"
Air pollution killing Europeans, secret report says
Its not cool to kill the ozone
A warning on warming

In the GIS/LIS '90 paper, I make reference to "The Doomsday Map" as a companion to "The Doomsday Clock" (5). Figure 2 illustrates this point.

What kind of "Big Picture" would we have if we overlaid the "Oil Spills" map of Figure 2 with maps of all the other manifestations of land, water, and air abuse that are indicated by the headlines of Figure 1? While we may all agree that it would not be a pretty picture, that

far short of what is required to elaborate the information gap, much less begin to close it.



"This is an emergency! We're running out of map pins."

Fig. 2

alone is not sufficient if meetings such as this are to be more than academic exercises. Rather, what we must be prepared to do if the matters behind the media reports are compelling, is to use GIS lessons learned to help eliminate the problems behind the headlines. From the local to global scales. That exhortation takes my presentation to the work of the World Commission on Environment and Development.

Environment, Development and GIS/LIT

The widely-heralded document, *Our Common Future,* commonly referred to as the Bruntland Report, was released in 1987 (6). It was based upon a number of studies and reports that were produced during the 80s. Examination of the work of the World Commission on Environment and Development revealed a number of observations, findings and recommendations with GIS/LIT implications.

The following extracts illustrate the environment-development-GIS/LIT connection.

> "Opportunities for more sustainable forms of growth and development are also growing. New technologies and potentially unlimited access to information offer great promise." (6, p. 310)

"Although more is known about the state of the global environment now than a decade ago, there are still major gaps and a limited international capability for monitoring, collecting, and combining basic and comparable data needed for authoritative overviews of key environmental issues and trends. Without such, the information needed to help set priorities and develop effective policies will remain limited." (6, p. 321).

"Fortunately, the capacity to monitor and map Earth change and to assess risk is also growing rapidly. Data from remote sensing platforms in space can now be merged with data from conventional land-based sources. Augmented by digital communications and advanced information analysis, photos, mapping, and other techniques, these data can provide up-to-date information on a wide variety of resource, climatic, pollution, and other variables. High-speed data communications technologies, including the personal computer, enable this information to be shared by individuals as well as corporate and governmental users at costs that are steadily falling. Concerted efforts should be made to ensure that all nations gain access to them and the information they provide either directly or through the UNEP Earthwatch and other special programmes". (2, cited in 6, p. 322)

Appreciation of the environment-development-GIS/LIT connection is only one step, however, towards problem resolution. Much remains to be done before lessons learned and good intentions are translated into productive outcomes. In particular, the Bruntland Report recommendations need to be implemented if the potential contributions of GIS/LIT are to be realized.

Overview of the Cap Program on LIT and Sustainable Development

The LIT Program was approved in principle in November, 1989 by the Executive of the Commonwealth Association of Planners. Officials with primary responsibilities were named as follows:

William Robertson, Chairman of the Advisory Committee (Robertson is Surveyor General, Government of New Zealand, and President of CAP).

David Sherwood, Chief Executive Officer (Sherwood is Executive Secretary, Canadian Institute of Planners, and Secretary General of CAP).

Barry Wellar, Program Director (Wellar is Professor of Geography, University of Ottawa, Canada, and Member, Canadian Institute of Planners).

The following extracts from the *Prospectus* illustrate the purpose, orientation, and content of the program:

> "The Commonwealth Association of Planners (CAP) has identified land information technology (LIT) as an important factor in planning for the efficient management and sustainable development of a nation's resources, including its urban areas.
>
> The CAP has also concluded, however, that a directed, concerted program is required to ensure:
>
> 1) That the full potential of LIT for *planning* purposes is realized; and
>
> 2) That the transfer and use of LIT is *appropriate* to the needs, the ability to implement, and the ability to pay of local authorities, and especially of those in developing regions and countries". (1, p. 1-2)
>
> "On the basis of its international experience regarding the "over-selling" of LIT, it is the view of CAP that a fundamental change is required. That is, planners and others directly responsible for rural, urban and regional plans, and associated planning processes, must become *directly* involved in LIT initiatives. In particular, planners must be assisted and enabled to manage and direct the installation and expansion of land information technology in terms of their own special needs and their own political and administrative situations". (1, p. 2-3)
>
> "It is the view of CAP, therefore, that the power of the technology is such that *if* properly harnessed, LIT can significantly enhance the quality of data and information available for rural, urban and regional planning purposes. Further, since the quality of policy choices and policy decisions is a direct function of the quality of information available to policymakers, CAP believes that LIT is an important if not critical factor in shaping the planning contribution to the development policy process." (1, p. 3)

"Although there are many countries where information technology is accepted as essential infrastructure in governments at all levels, planners and the planning function receive only marginal consideration. That situation occurs, and will continue to occur, until practicing planners acquire the advice and expertise needed to:

1) Influence the *specifications* of LIT systems and services;

2) Take advantage of LIT systems and services to more effectively perform *existing* planning tasks;

3) Take advantage of the LIT systems and services to do *new things in new ways;*

4) *Make rational decisions* based on the experience of their professional colleagues *on the type of LIT system they may require,* and the implications of its implementation". (1, p. 4)

"A portfolio of workshops, short courses, advanced courses, training sessions and distance learning support is planned to demonstrate the many applications of land information systems in the working environment of the practicing planner or administrator. The topic is ideal for knowledge transfer through distance learning support. Regular communication and support through this technique would be crucial to the continued long-term success of the programme. Educational institutions could, we suggest, provide the focus in various countries for links through new forms of communication technology. A regional basis of cooperation in land information systems learning could be particularly effective". (1, 14-15)

"A series of workshops will give particular attention to those applications which are accessible to the users of desk-top "personal computers" (PCs) and "micro-computers". (1, p. 15)

As of this writing the status of the LIT Program is as follows:

1. The *Prospectus* has been distributed to the national planning bodies in the fifty (50) member countries of the Association. It is also being sent to government agencies, international and national organizations, and to the private sector for information purposes, and to solicit funds, speakers, materials, and Workshop demonstration equipment and software.

2. The first in an international series of Workshops has been scheduled. It will be held in Canada, February 19-21, 1991, at the Institute for Land Information Management (ILIM), University of Toronto. The Workshop brochure is in circulation, the format and content are finalized, and speakers and an on-site demonstration are being arranged.

3. The second Workshop has tentatively been set for June, 1991 in the Caribbean. Preliminary discussions have been held regarding the timing and location of subsequent Workshops in East and West Africa, the United Kingdom, S.E. and S.W. Asia, and New Zealand-Australia-Pacific Islands.

Let me close this section with several remarks which serve to establish that the LIT Program is one which especially lends itself to involvement of and leadership by the Canadian GIS, environment, and development communities.

First, a number of the headlines in Figure 1 are of Canadian origin, and similar ones either are or may soon become applicable to Canada's resource systems, economic systems, or human settlement systems. Even in Canada, then -- Is anyone surprised? -- there is evidence of much of what was found to be of concern to the World Commission on Environment and Development.

The LIT Program, involving fifty or more countries, therefore offers Canadian planners, politicians, citizens and the GIS field an opportunity to learn from others how to more beneficially link environment and development through GIS. In view of the troubled health of our land, water, and air resources, it is an offer that we should accept.

Second, on the matter of leadership, it is meetings like this which remind us how long and how well Canada has performed as pioneer and implementor of information systems and services, geographic and otherwise. When this Seminar's offerings are combined with references to EMR/CISM conferences on GIS, LRIS efforts in the Maritimes and Alberta, SaskGIS, the Canadian GIS industry, and such organizations as CISM, CIP, CAG, CCA, CIPS, GIAC, etc. it is readily seen that we have *many* sources of lessons learned on the environment-development-GIS connection.

In respect of Canada's earned reputation for international service, therefore, and our own self-interest in cleaning up "The Doomsday Map", it is appropriate that Canada's GIS community take on a leadership role in directing and promoting the LIT Program, both abroad and at home[39].

And, third, and very importantly, it warrants emphasizing that the LIT Program is a "natural vehicle" for Canada and the GIS community. The Program builds an existing technological and applications strengths. The timing is right in terms of broad and enthusiastic acceptance of the need to achieve a mutually beneficial link between environment and development. And, there is a demonstrated need to incorporate a GIS capability into decision systems affecting the disposition of land, water, and air resources.

Conclusion

This paper introduces and briefly overviews an international education and training initiative. The purpose of the LIT/Sustainable Development Program is to strengthen the contribution which land information technology makes to planning, and to achieving the efficient management and sustainable development of resource systems, economic systems, and human settlement systems.

The presentation also represents an invitation, however, to Seminar attendees and *Proceedings* readers. They are invited to examine and monitor the LIT Program, to propose suggestions for improvement, to offer assistance, and to help ensure that "the Canadian content" of the Program fairly reflects what Canada has to offer as we head into the 90s and then the next century.

---

[39] On the matter of self-interest, and witness the pollutants (land, water, air) found in the Arctic, Antarctic and other "remote" regions, any "escape" by a clean Canada from a dirty rest-of-the-world would be relatively ephemeral. That is, since water and air systems are indifferent to political or other administrative boundaries, in the long term Canada goes as the world goes, environmentally speaking.

References

1. Commonwealth Association of Planners, 1990. Prospectus, Land Information Technology (LIT): A Key Ingredient for Sustainable Development. Ottawa, Canada: CAP Secretariat, c/o Canadian Institute of Planners.
2. A. Khosla, 1986. "Decision Support Systems for Sustainable Development". Background Paper. New York, New York: World Commission on Environment and Development, United Nations.
3. B. Wellar, 1989. "Emerging Trends in Structuring and Directing GIS Research", in GIS: Challenge for the 1990s. Ottawa, Ontario: Energy, Mines and Resources/Canadian Institute of Surveying and Mapping, pp. 601-606.
4. B. Wellar, 1989. "In Truth, What Do We Know About GIS?", in 1989 URISA Proceedings, Vol. II, pp. 1-6.
5. B. Wellar, 1990. "Science, Applications, Coherence and GIS: Seizing the Moment", forthcoming in the GIS/LIS '90 Proceedings.
6. World Commission on Environment and Development, 1987. Our Common Future. New York, New York: General Assembly of the United Nations.

CHAIRMAN ZILLMER: Thank you, Barry. I would also like to thank the technician behind the screen for an excellent job in handling such a complex arrangment of overheads that accompanied Dr Wellar's presentation.

Our next speaker is George Takach a Toronto based lawyer with the firm of McCarthy Tetrault. He is going to be talking about what I think is going to be one of the key issues of the 1990s which we will have to address. Mr Takach practices computer/commercial law with an emphasis on technology, computers and related matters. He regularly assists purchasers of computer systems and related services with the negotiation and drafting of various computer contracts. He also represents software developers and hardware vendors, assisting them with licensing, distribution and related intellectual property issues, as well as with general corporate matters such as equity and bank financings. His book entitled "Contracting for Computers" was published in 1989 by McGraw-Hill.

He is a special lecturer in Computer Law at the Faculty of Law, University of Toronto and Osgoode Hall Law School, York University. Ladies and gentlemen please welcome Mr. George Takach.

DATA DISSEMINATION - WHO IS LIABLE?

GEORGE S. TAKACH
Lawyer, Author
McCarthy Tétrault

This paper gives a very general overview of some of the legal issues relevant to the topic "Data Dissemination - Who Is Liable?". This question is relevant to the suppliers and users of GIS and related systems because geographical and other data is invariably produced by such systems, and such data often is exploited commercially or otherwise made available to customers who come to have great reliance on it.

The short answer to the question posed above is that several different persons and entities may be liable for problems arising out of the use of data produced by GIS systems. An obvious candidate for liability is the developer or supplier of the relevant system, but other participants in the GIS community may be exposed to liability as well. For example, depending on the particular circumstances, a user of GIS data that collects such data from several sources and then reformats it for further commercial sale or some other form of exploitation or distribution may also be responsible for errors in the final form of the data. In short, everyone who is involved in the creation and distribution of GIS data, directly or indirectly, should consider the issues described in this brief paper.

A question related to that posed by the title of this paper might be "Data Disseminators - Liable To Whom?". The answer to this question again will always be very fact specific, such that the possible parties who may be able to bring claims in any given situation may vary from case to case. Nonetheless, there is a strong likelihood that customers will be in a position to press claims, particularly if they have a contract with the supplier of the GIS system or data.

Persons and entities other than customers may also have a claim, based simply on their reliance on erroneous data that causes them some damage. In this regard, however, it is worth noting that the law is more likely to compensate, through a finding of negligence, a person who suffers some personal injury or property damage due to GIS data or systems than someone who suffers only financial loss. Nonetheless, courts have awarded compensation in situations where only economic losses had occurred, and therefore it is prudent for suppliers and users of GIS data and systems to conduct themselves, and to consider the issues discussed below, as if a larger rather than smaller number of potential claimants exists.

Yet another question related to that posed by the title of this paper might be "Data Disseminators - Liable For What?". The short answer to this question is "errors", which in turn encompasses a broad spectrum of possible errors involving the collection of GIS data, as well as its processing (or manipulation), its conversion from one format to another, its distribution and even its representation. In this regard it is worth describing two relatively recent lawsuits involving data dissemination that illustrate two of the many kinds of errors that may give rise to liability.

In the first case, which comes from the United States, an insurance company sued the publisher of a instrument approach chart seeking indemnity for money paid in a settlement of wrongful death actions filed by representatives of passengers killed in the crash of an airplane. The chart at issue was used by pilots in making instrument approaches to airports. The claim was that the chart was defective, and that this defect caused the crash. The court upheld this claim, though it should be noted that the pilot and the airline were also found partly responsible.

What makes this case very interesting is that the data on the chart was accurate, and that the defect was found to lie in the misleading graphic representation of the information. The chart included all matters relevant to the instrument approach, including directional heading, distances, minimum altitude, turns, etc. The chart portrayed two views of the proper approach. A "top", or plan, view presented the course and course changes, while a "side" view, or profile, showed altitude and altitude changes. The defect that was found by the court was that the scale used by the two views was different, and thus the chart was found to be unreasonably dangerous.

The second case involved the corporate name search data base of the federal Department of Consumer and Corporate Affairs. In order to incorporate a company, a search is made by the Department's database to ensure that the proposed name does not conflict with existing names. In this case, the Department's computerized name search system initially showed a certain name to be available, and as a result a company was incorporated under this particular name. Several months later the Department implemented a more powerful computer system which discovered that the recently registered name in fact did conflict with a previously registered one. Accordingly, the name of the new corporation had to be changed, and this entity brought a claim against the Department to recover the extra costs of printing new advertising material, etc.

The trial judge in this case held the Department liable for negligence. In coming to this conclusion the judge found that the earlier computer system that did not disclose the conflicting name was less reliable than the previous manual system that it automated, and that it was not a defence that such computer system was as efficient as it could be having regard to the state of the art at the time. Indeed, the judge concluded that the Department should have verified manually the computer search results. This trial decision was overturned on appeal, but not primarily on the basis of the trial judge's finding of negligence. Rather, the appeal judge held that a statement in the form letter sent to all users of the name search service released the Department from all liability resulting from the existence of a conflicting name. These two cases hold several lessons for suppliers and users of GIS and related systems who wish to minimize their liability for data dissemination.

First, all reasonable measures should be taken to decrease the likelihood of errors. For example, in a situation involving a newly installed GIS system, it may be sensible to verify the relevant output data manually rather than to rely solely on the computer. It may also be appropriate that periodic accuracy and other quality control checks be carried out even on systems that have been used for some time. In essence, suppliers of GIS systems and data should endeavour to exercise a reasonable standard of care in the development and delivery of their products and services. In this regard it should be noted that simply complying with the "industry standard" may not be sufficient; it is always open for a court to decide that the industry standard itself is not reasonable.

The second measure would be to shift, by means of a written contract, a certain amount of the risk associated with the GIS or other system, or the GIS data, to the user of it and/or for the supplier to disclaim or at least limit liability contractually. Accordingly, persons and entities dealing in GIS systems and data should consider having their customers sign agreements which contain, in favour of the supplier, warranty disclaimers, limitation of liability provisions and other clauses with similar objectives.

A third item to be considered is insurance. It may be possible to obtain product liability, errors and omissions, or some other form of insurance to cover the risks associated by the particular GIS system or data product. Such insurance may be expensive, but rather than the high cost of insurance leading to a decision not to take out insurance, perhaps it should lead to a higher pricing structure for the products or services in order to pay for the carrying of insurance.

While all suppliers of GIS systems and data should consider taking these measures, those suppliers who provide products and services to customers in the United States, or who provide products and services that, if defective, could result in personal injury and/or property damage, should be particularly vigilant in attempting to reduce exposure to liability in the ways mentioned above.

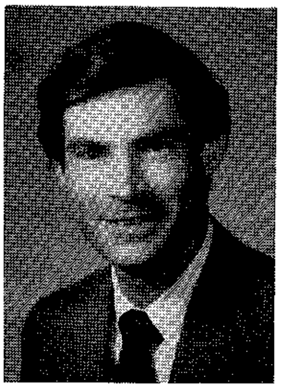
In conclusion, suppliers of GIS systems and data can be liable to a wide variety of users of these GIS products and services. Accordingly, suppliers of GIS systems and data should regularly review their operations with counsel to determine what steps, including those noted above, the supplier should be taking to minimize liability.

CHAIRMAN ZILLMER: Thank you very much, George, for a sobering look at some of the issues of liability we may be faced with in the coming years. I think perhaps we can appreciate why the conservative approach makes sense in terms of looking at the data we are developing and the systems we are using. We should look closely at, not only the disemmination, but the manipulation and the analysis issues as well.

Our last speaker of the morning is also visiting us from abroad. We welcome Mr John Griffin who is Vice President for Business and Technology Integration at Batelle, an 8000 employee contract research company located in Columbus, Ohio, USA. Mr Griffin has a masters degree in economic geography from the Ohio State University. He has been an active user of GIS systems for the purpose of selecting sites for radio-active waste disposal facilities. He has also prepared a detailed cost benefit analysis and program evaluation of a GIS system implemented by the United States Bureau of Indian Affairs. His talk today will focus on the method and findings of that cost benefit analysis.

Ladies and gentlemen, please welcome John Griffin.

COST AND BENEFIT ANALYSIS OF GEOGRAPHIC INFORMATION SYSTEM IMPLEMENTATION



JOHN M. GRIFFIN
Vice President, Business & Technology Integration
Battelle

I'd like to try to make a transition from the previous speaker to what I'm going to talk about. There's only one way I can do that, and that's by reading a quote out of the report that I'm going to be drawing this information from.

> *This report was a work prepared for the United States by Batelle. In no event shall the United States or Batelle have any responsibility or liability for any consequence of any use, misuse, inability to use or reliance upon the information contained herein, nor does either warrant or otherwise represent in any way the accuracy, adequacy, efficacy and applicability for the contents.*

Does that just about cover it? [LAUGHTER]

The Office of Trust and Economic Development of the Bureau of Indian Affairs (BIA) has among its responsibilities the management of land and natural resources for the benefit of Indian Tribes. The BIA involves itself with planning and management of water and land resources, real estate, forestry, energy and minerals, and transportation. Significantly, all of these areas of emphasis have a definite geographic focus. Supporting this management function is the Geographic Information Systems and Remote Sensing Office located in Lakewood, Colorado.

The planning and management functions require that data and analyses be performed for a variety of different geographic areas. Obviously, the reservations are key geographic units. However the management functions also require that subparts of reservations, selected because of special characteristics, be analyzed. Furthermore, the reservations must be examined with respect to the surrounding areas thus mandating the availability of non-reservation information as well. With the millions of acres of land and massive amounts of information available to describe the land and its attributes, a formalized approach for managing geographic information is needed.

In the early 1980s the BIA began to consider the use of a Geographic Information System (GIS). In 1985 and 1986, the BIA installed seven Data General computer systems and the MOSS software to provide GIS capabilities. The seven systems were installed at the Central Office in Lakewood; at the Albuquerque, Portland, and Billings Area Offices; and at the Fort Apache, San Carlos, and Mescalero Agency Offices.

The Central Office provides overall GIS support to all area offices, manages the digitization of data, maintains and consults on software issues, and performs administrative functions necessary for the continuation and furtherance of the GIS and Remote Sensing capabilities. The area offices provide services and applications assistance to agencies that do not have GIS systems. Finally, the agencies that have GIS systems use them directly in support of the management functions of the BIA on the reservation.

The purpose of this analysis was to evaluate the 1986 decision to implement the GIS system. A complete comparative cost evaluation and a benefit/cost analysis is presented. Actual costs and benefits were measured for the first 2.5 years and extrapolations made for the remaining years. As will become evident, this is a rigorous evaluation that considered initial capital investments, training, operations and digitization of data.

The analytic framework used for this evaluation is that described in the document entitled *Economic Analysis Procedures for ADP*, Publication 15, Naval Data Automation Command, Washington D.C., December 1980. The approach, methods, and analytic techniques are those recommended for use in that document. The data for the analysis came from records of costs obtained from the Lakewood Office and from interviews with the area and agency office GIS coordinators. Additionally, independent verification of certain costs associated with manual production of products was made by Battelle cost estimators. Finally, a literature search was performed to obtain insights and information from other groups that had implemented GIS systems.

Theoretical Investment Expectation

The decision to implement a new technology such as the GIS system has a predictable investment pattern. During the early years of the investment cycle, heavy costs are incurred as capital equipment is obtained, training is performed, and data compatible with the system software are obtained. Once over the heavy investment period the operating costs of the system become the dominant cost elements and are usually substantially less than the costs incurred during first few years and less than the alternative ways of performing the same tasks. Benefits are the inverse of costs. In the early years, the benefits are minimal because usage levels are typically low and operators are not yet as efficient as they can be. As more experience is gained with the system and the capability is better understood by potential users, the use levels go up and the efficiency of usage increases. At some point the level of usage must plateau at the capacity of the new system. Eventually, the hardware and software reach the end of their useful life and a new investment cycle starts.

The uncertainties associated with the GIS investment decision are whether the cost savings and benefit stream will exceed the investment; whether the benefits will exceed the system investment before the system reaches the end of its useful life; and whether the discounted present value of the positive savings exceeds the discounted present value of the investment.

Even if the monetary cost savings do not exceed the investment, there may be reasons to proceed with the investment. Often a new technology provides benefits that are qualitative or that are difficult to quantify. Other times, the investment may be associated with potential benefits that have a probability of occurring but are not yet realized. For the GIS investment the following types of benefits are relevant:

- Reduction in operating costs due to efficiency and productivity increases.
- Increased capacity of existing personnel to perform routine and special analyses.
- Enhanced ability to prepare analyses and materials that are reproducible, objective and fully documented.
- Increased analytical capabilities associated with faster and more efficient data manipulation abilities.
- Enhanced responsiveness through increases in the speed of analyses calculations, data retrieval and preparation of mapped data products.
- Increased flexibility in being able to use data sets for multiple purposes thereby increasing the effectiveness of data collection activities.
- Enhanced quality through reduction in errors and improved accuracy of graphical materials, tables, and analyses.
- Improved and enhanced credibility of analyses and reports due to the quality of the final

products and the presentation formats.

- Expanded ability to bring high quality geographic information to more functional areas within the BIA.
- Enhanced ability to communicate complex resource issues that would be impossible to describe without GIS maps and analysis.
- Increased assurance that the most current data will be used by all participating users.

The investment pattern and potential benefits outlined above form the hypothesis to be tested during this evaluation. The main issue is not so much whether these benefits hold true for the BIA-GIS implementation--because they undoubtedly have--but rather has the magnitude of these benefits resulted in an overall system that is cost effective.

Description of Fixed Costs

The fixed capital costs for the GIS are defined as the expenditures for purchase of computer hardware, support hardware, system hardware maintenance, facilities modifications, and expendable materials. The Albuquerque, Billings, Fort Apache, and the Central offices had identical Data General 20 computer hardware configurations. All offices received their computer system in early 1986. Support hardware are the terminals, digitizers, and plotters required to operate the GIS capability. The GIS support hardware was purchased in 1986 to coincide with the computer purchase; however, the Fort Apache agency added two terminals in 1987. System support is defined as the contracted services of a computer professional to install, debug, or modify the DG-20 computer operating system. GIS software support is not considered a part of this category since the GIS software is not part of the computer operating system and support of the GIS software is the responsibility of the Central Office staff.

Hardware maintenance is the responsibility of the local offices and is divided into two cost categories; Computer (CPU) hardware and GIS hardware (terminals, printers, and plotters). Maintenance of the hardware components is accomplished by one of two approaches. The first approach is contract maintenance (i.e. a service agreement with a fixed annual fee) and the second is emergency maintenance (i.e. purchase time and materials for repairs only as needed).

Materials are the supplies required to maintain the system and prepare report and map products. These materials include such items as magnetic tapes for system backup and data storage, and paper and pen supplies for printers and plotters. Because these materials are generally purchased in small quantities and on a need basis, complete and separate records have not been maintained. For the purpose of this study an estimate of the total supplies purchased to date was determined during the field interview. This estimate was then averaged for the two and one-half years that the system has been operational.

Albuquerque, Billings,and the Central office GIS facilities are located in modern multi-story facilities and have not required any modification to the facilities. The Fort Apache facilities, are in a single story barracks style building. Due to the type of facilities the Fort Apache Agency has encountered overheating problems with their computer system. In 1987 an air-conditioning system was installed to eliminate this problem. The addition of an air-conditioning system has appeared to lower the humidity in the GIS working area to a level where static-electricity had become a problem. To eliminate this new problem anti-static pads were purchased in 1988.

Salvage is defined as a return on the initial hardware investment through sale or transfer of equipment to another component or organization. Salvage value is assumed to be minimal and would not to occur until 1990. Discussions with the various offices indicate that the Fire Control Group has a need for the equipment. Thus a fifth year (1990) salvage value of 10 percent was used to show a return on the BIA investment. The only exception to the 10 percent salvage value assumption is the Data General MV2000 computer transferred to the BIA Branch of Forestry in 1986. Because this equipment was transferred during the same year it was purchased, the salvage value was assumed to be the same as was the purchase price.

Description of Variable Costs

The variable costs involved with the GIS system are defined to be the cost of digitizing data, labour costs at the field installation, training costs, central office support, and support contractor labour. These variable and operating costs are directly related to the number of people employed at each installation and to the level of system use.

Each month the Area Offices and Agencies submit reports that describe the GIS activities for that month. The monthly reports prepared since the start of 1986 were collected for the

Albuquerque, Billings and Fort Apache offices. Based on information contained in these reports a list was prepared of individual projects for which the GIS had been used. For each project the following information was obtained:

- A measure of the amount of time (computer or labour) required to accomplish the project using the GIS system.
- Identification of the grade of person performing the work.
- The type of functional area supported by the project.
- An estimate of the manual time that would have been required to produce the same product.
- Identification of the grade of person who would have been required to perform the manual work.

The raw information was obtained from the monthly reports, summarized, and taken to interviews with the GIS coordinators at each of the three field offices. Based on interviews the raw information was refined and revised to identify the data themes used for each project and to obtain better insights into the way in which the field coordinators had estimated the costs of performing the same work on a manual basis. The costs of performing each of the projects was then calculated for both the GIS and manual methods.

In addition to the labour directly associated with the individual projects, each of the field offices had labour charges that are related to the GIS but that cannot be ascribed to any one project. As part of the field interviews we asked each GIS coordinator to indicate the allocation of his time to various functions--non-GIS related activities, general planning, data capture, and GIS system management and maintenance. The responses to this are shown on page 190.

The GIS technology requires that users and potential users be trained on the hardware and software. The training within BIA occurs in two ways. First, the Central Office provides training and materials to be used for training sessions. Second, the Area Offices and Agency Offices will actually perform some of the training functions, particularly for agency personnel. The number of days of training ascribed to each of the field installations is shown below.

Days of Training Time

Office	1986	1987	1988
Albuquerque	0	120	41.5
Billings	21	36	20
Fort Apache	0	8	0
Central Office	0	16	8

The actual costs of training were calculated by multiplying the time involved times the average rate of a GS9.

The Central Office in Lakewood provides support to all the field installations using the GIS system. The labour and travel budgets of the Central Office were obtained and allocated to the field offices with MOSS GIS systems. Ten percent of the Central Office costs were allocated to each field office based on the assumption that one-half of the Central Office time is spent directly helping the field offices and that six field offices have the DG/MOSS system. It was assumed that each field office received the same level of assistance. The GIS program received special support services from a contractor in 1986 and 1987. The costs amounted to $26,634 in 1986 and $10 000 in 1987. Ten percent of these support contractor costs were allocated to each of the field offices.

One of the most expensive aspects of the GIS system is the preparation of data for use in the system. Most of the actual data digitization for the GIS field installations occurs through the Central Office and its data input subcontractors. The cost of each data theme that was digitized through the central office has been recorded by theme type and reservation. By searching these records it was possible to obtain an accurate estimate of the cost of digitizing the data used for projects at each of the three field installations.

Manual Costs

The estimated costs of performing the same work manually as was done with the GIS system were derived from several different sources. First, each of the GIS coordinators estimated the amount of time it would have required had the project been done manually. These estimates had been recorded monthly so the estimates were made at the time the work was actually being done. The GIS coordinators took into consideration the complexity of the work, the status of the original data sources, and the difficulty of any analytic work that was done. Secondly, two of the field offices, Billings and Albuquerque, did not include

Time Allocation of GIS Field Staff

	Albuquerque	Billings		Fort Apache	
Job Function	**Co-ord.**	**Co-ord.**	**Asst.**	**Co-ord.**	**Asst.**
Non-GIS					
1986	25%	20%	50%	0%	n/a
1987	30	20	50	0	0
1988	25	20	50	0	0
Planning					
1986	20	30	0	50	n/a
1987	15	30	0	50	0
1988	15	30	0	50	0
Data Capture					
1986	25	10	50	10	n/a
1987	30	10	50	10	10
1988	20	10	50	10	10
System Management					
1986	25	15	0	20	n/a
1987	20	15	0	20	0
1988	20	15	0	20	0
Projects					
1986	5	25	0	20	n/a
1987	5	25	0	20	90
1988	20	25	0	20	90

the costs of drafting final products in their cost estimates. Battelle independently estimated the cost associated with producing maps of the same quality as the GIS system. Third, where there were projects for which no manual estimate of effort had been made, Battelle estimated the costs based on similar projects carried out in that field office. The actual costs were calculated as the number of hours times the hourly rate of a GS9. For Albuquerque and Billings, the estimated number of maps produced was multiplied by $229 and added to the labour costs.

Forecasts and Comparisons of Total Costs

Previous sections described the fixed, capital costs and variable costs at the three field offices from the start of the GIS investment in 1986 through the first half of 1988. To perform the appropriate cost and economic analyses, the costs must be forecasted through the end of the useful life of the hardware and software. The useful life is five years thus forecasts were made for the second half of 1988, 1989, and 1990.

The forecasts required that certain assumptions be made concerning the cost items. The important assumptions are listed below.

- The most important assumption in the forecast was the ratio of manual effort to GIS effort. To forecast this ratio the average ratio of manual to GIS costs for the actual time period was used as a starting point. This value was 10 to 1. However this ratio does not include the costs of producing mapped products of equal quality. The independent cost estimates for manual map production involved seven hours of draftsmen time for each map. It was further assumed that a map would be produced each hour of GIS usage (a very low estimate since maps can be prepared within minutes). Therefore, the maximum ratio of manual time to GIS time is the 10 to 1 ratio for set-up, calculation, and analysis plus a 7 to 1 ratio for actual map production. This yields a total ratio of 17 to 1.

- Most of the data digitization costs for the three field offices were complete. For the purpose of forecasting, however, it was assumed that each year there would be a maintenance level of digitizing as new themes are added and existing themes are updated. Because the useful life of many data themes are ten years, the assumption was made that each year ten percent of the original digitization investment would be incurred. For some of the themes such as the public land survey, soils, etc, the ten year life is too short, however in general this cycle should keep the data base current.

- For the forecast period it was assumed that no new capital equipment would be required for the GIS systems.
- The capital equipment needs of the manual system included purchase of a second drafting work station when the level of use doubled. For all three sites this meant that an $800 work station was added in 1989.
- Maintenance costs, expendables, area office costs (excluding training), and central office costs were assumed to grow at the rate of inflation (3.5 percent).
- No further training costs were incurred in the forecast period.
- In 1990 it was assumed that the computers, monitors, and printers could be salvaged or transferred to other government operations. A salvage value of ten percent of the original purchase price is taken as a credit.

Using the methodology described above, forecasts of the total GIS and manual system costs were prepared through 1990. The forecasts include all capital and operating costs and thus represent the overall costs associated with the 1986 decision to implement the GIS. Table 1 shows the Total Costs Forecasts for the combination of all three installations.

Comparison of GIS and Manual Costs

One of the most direct and easiest to understand comparisons between two alternative systems is the ratio of discounted costs. For the three field offices combined, the ratio of total manual costs to GIS cost is 1.68. This ratio indicates that the GIS system was less costly than the manual system assuming the same level of output. The Albuquerque discounted cost ratio is 1.08 meaning that the GIS costs were slightly less than the manual costs. Billings' ratio was 1.00 which indicates that over the course of the five years, the GIS costs were essentially equal to what the manual costs would have been. Fort Apache has the highest ratio at 3.09. The very positive cost results at Fort Apache result from relatively low costs for acquiring data and very high usage levels because of the ability to support timber sales.

The significance of the cost ratios is that even without considering any type of qualitative benefits related to performing a task in a better manner, the GIS system has been shown to be cost effective. It should be pointed out that even though Billings did not have an overall positive cost ratio, in the last two years of the analysis when digitizing costs were not as high as they had been, the yearly cost ratios were very positive. Billings typify the

Table 1 - Total System Costs Forecast

Cost Category	1986	1987	1988-1st	1988-2nd	1989	1990	TOTAL
	Total System Costs						
Facility Costs	$0	$5 000	$525	$0	$0	$0	$5 525
Equipment	127 404	2 290	0	0	0	0	129 694
Maintenance	17 992	9 182	3 971	3 971	8 727	9 032	52 875
Expendables	2 411	1 585	1 030	1 030	2 101	2 175	10 332
Salvage Value	0	0	0	0	0	(9 489)	(9 489)
Digitizing Costs	285 598	128 411	50 104	50 104	51 421	53 213	618 850
Project Costs	4 886	34 151	17 741	19 665	40 707	42 131	159 281
Area Office Costs	53 005	83 313	38 557	32 468	66 369	68 691	342 403
Central Office Costs	9 282	17 967	6 561	6 561	13 581	14 057	68 009
Support Contractor Costs	7 989	1 500	0	0	0	0	9 489
Total Costs	508 567	283 399	118 489	113 798	182 905	179 810	1 386 968
Discount Ratio	0.954	0.867	0.788	0.788	0.717	0.652	
Total Discounted Costs	**485 173**	**245 707**	**93 369**	**89 673**	**131 143**	**117 236**	**1 162 301**
	Total System Manual Costs						
Facility Costs	0	0	0	0	0	0	0
Equipment	2 400	0	0	0	2 400	0	4 800
Maintenance	0	0	0	0	0	0	0
Expendables	2 060	2 096	1 697	418	1 833	1 897	10 002
Salvage Value	0	0	0	0	0	0	0
Digitizing Costs	0	0	0	0	0	0	0
Project Costs	271 724	296 349	213 079	227 846	571 866	719 398	2 300 262
Area Office Costs	38 628	49 916	24 609	28 789	56 286	58 256	256 483
Central Office Costs	0	0	0	0	0	0	0
Support Contractor Costs	0	0	0	0	0	0	0
Total Costs	314 812	348 361	239 385	257 053	632 386	779 551	2 571 547
Discount ratio	0.954	0.867	0.788	0.788	0.717	0.652	
Total Discounted Costs	300 331	302 029	188 635	202 558	453 420	508 267	1 955 240
Ratio of Manual/GIS Costs	0.62	1.23	2.02	2.26	3.46	4.34	1.68

problem with GIS systems. The cost of acquiring the initial digitized data is very high. The Billings Area Office has jurisdiction over 6.5 million acres of land which is almost twice as much as either of the other two offices. Even with this large land area and the resultant high cost of obtaining digitized data, the costs of the GIS and the manual system were equal to each other. Furthermore, most of the data themes that have been digitized will last for at least another five years thus meaning that Billings would demonstrate a positive cost ratio in upcoming years even if new hardware was acquired.

Several economic analysis methods were used to compare the GIS system and the manual system. The techniques selected for use are the Present Value Analysis, Savings and Investment Ratio Analysis, the Discounted Payback Analysis, and Breakeven Analysis.

Present Value Analysis

Present Value Analysis is a technique that places the costs for alternatives on an equal basis and expresses those costs in terms of their worth on the date of the investment decision. The alternative with the lowest present value cost is considered to be the least costly alternative and is recommended for selection by the decision maker. Present Value Analyses work well for alternatives that produce the same types of benefits and where the useful lives of the technology are equal.

In comparing the GIS and manual systems, the benefits of both systems are satisfactory completion of the specific projects conducted at the field offices. The useful lives of the systems are essentially the same and have been defined as five years based on the typical replacement cycle of hardware. Figure 1 shows the results of the present value analysis. The differences between the manual costs and GIS costs are discounted and reported as either "cost" or as "savings". The Total System has a present value net savings of almost $800 000 over the five year period.

Savings and Investment Ratio Analysis

The decision to implement a GIS system is characterized as a situation where the requirement is already being met but a less costly alternative is perceived. The Savings and Investment Ratio (SIR) is a technique used to measure the degree of financial benefit attained from the alternative investment. The SIR is defined as the relationship between the future cost savings or avoidance of costs and the investment cost necessary to realize those savings. A SIR of 1.0 indicates that the savings and investment are equal. Any value greater than

Table 2. Savings and Investment Ratio Analysis

	1986	1987	1988-1st	1988-2nd	1989	1990	Total
Capital Investment							
Facility Costs	$0	$5 000	$525	$0	$0	$0	$5 525
Equipment Costs	127 404	2 290	0	0	0	0	129 694
Maintenance	17 992	9 182	3 971	3 971	8 727	9 032	52 875
Expendables	2 411	1 585	1 030	1 030	2 101	2 175	10 332
Digitizing Costs	285 598	128 411	50 104	50 104	51 421	53 213	618 850
Total Discounted Capital Costs	413 468	126 988	43 836	43 422	44 632	42 002	714 349
Salvage	0	0	0	0	0	(9 489)	(9 489)
Operating Costs GIS							
Project	4 886	34 151	17 741	19 665	40 707	42 131	159 281
Area Office	53 005	83 303	38 567	32 468	66 369	68 691	342 403
Central Office	9 282	17 967	6 561	6 561	13 581	14 058	68 010
Support Contractor	7 989	1 500	0	0	0	0	8 489
Total Discounted GIS Operating	71 705	118 719	49 533	46 251	86 510	81 422	454 140
Operating Costs Manual							
Project	271 724	296 349	213 079	227 846	571 866	718 398	2 300 262
Area Office	38 628	49 916	24 609	28 789	56 286	58 256	256 483
Central Office	0	0	0	0	0	0	0
Support Contractor	0	0	0	0	0	0	0
Total Discounted Manual Operating	296 076	300 211	187 298	202 228	450 385	507 030	1 943 229
Savings to Investment Ratio		2.06					

1.0 means the savings outweigh the investment and the investment should be recommended. Because the analysis utilizes present value dollars, the opportunity costs for the investment dollars are directly considered.

The SIR is calculated as the present value of savings divided by the present value of the investment less the present value of any terminal value of the investment (salvage). Table 2 displays the information used for the Savings and Investment Ratio Analysis. The savings are computed as the difference between the total discounted manual operating costs ($1 943 229) and the GIS total discounted operating costs ($454 140). The total discounted investment cost is $714 349 which includes both the capital and digitized data. The data were included in the investment because the manual system would not have required these costs. A terminal value of the investment was taken as $9489 and considered only the value of computers, monitors, and printers. No salvage or terminal value was taken for other equipment or for the database.

A strong case could be made that the database has substantial value, but for the sake of a cautious and conservative analysis no credit was taken.

The SIR for the GIS investment decision was computed to be 2.06 meaning that the investment in a GIS should be recommended.

Discounted Payback Analysis

The discounted payback analysis is a technique to identify when the discounted savings of an investment will payback the investment required to implement that investment. The analysis gives an indication of how quickly net benefits, as measured by cost savings, will recoup the initial investment.

The payback analysis requires calculation of the cumulative net savings of the alternative and the initial investment. The point at which the discounted cumulative savings equals the investment is the payback point. For the GIS system, the payback calculations result in a payback of 3.03 years as is shown in Table 3 and Figure 2.

Paybacks of three years or less are generally regarded as fast. Therefore the payback of the GIS system is only slightly longer than optimal. Most decision makers would decide to invest in a technology with a 3.03 year payback.

Breakeven Analysis
Breakeven analysis is a measure of when a decision maker is indifferent between two alternatives. That is, under what conditions are the two alternatives identical in terms of costs.

To calculate the breakeven point, it is necessary to compute the simple cost equations that are shown below for each alternative:

	TC(GIS)	= $714,349 + $108.4(L)
	TC(manual)	= $14,802 + $1564.8(L)
where:		
	TC	= Total Costs
	L	= Labour Cost per Hour
and:		
	$714 349.0	= capital investment for the GIS system
	$14 802.0	= capital investment for the manual system
	$108.4	= average GIS operating cost per hour
	$1 546.8	= average manual operating cost per hour

Solving these two equations for the value of "L" gives the breakeven point in the level of usage. For this GIS system the breakeven point is a total of 480 hours of use. This means that the decision maker should have no preference between the systems if the use level is 480 hours. If more hours are anticipated, then the GIS system is preferred and if less hours of usage is expected, then the manual system is preferred. During the first 2.5 years of actual use, the GIS systems at the three installations were used a total of 1470 hours which is well above the breakeven point. Given these criteria, the decision maker would select the GIS system.

Summary of Comparisons
The GIS system is the preferred system based on the Present Value Analysis, Savings and Investment Ratio, and Breakeven Analysis. The Payback Analysis indicated that the GIS investment would be paid-off within 3.03 years. Thus with respect to all three comparative assessments and considering the speed with which the investment would be returned, the GIS would be selected by a decision maker.

Table 3 - Discounted Payback Analysis
TOTAL SYSTEM COSTS

Cost Category	1986	1987	1988-1st	1988-2nd	1989	1990	Total
Facility Costs	$0	$5 000	$525	$0	$0	$0	$5 525
Equipment Costs	127 404	2 290	0	0	0	0	129 694
Maintenance	17 992	9 182	3 971	3 971	8 727	9 032	52 875
Expendables	2 411	1 585	1 030	1 030	2 101	2 175	10 332
Salvage Value	0	0	0	0	0	(9 489)	(9 489)
Digitizing costs	285 598	128 411	50 104	50 104	51 421	53 213	618 850
Project Costs	4 886	34 151	17 741	19 665	40 707	42 131	159 281
Area Office Costs	53 005	83 313	38 557	32 468	66 369	68 691	342 403
Central Office Costs	9 282	17 967	6 561	6 561	13 581	14 058	68 010
Supports Contractor Costs	7 989	1 500	0	0	0	0	9 489
Total Costs	508 567	283 399	118 489	113 798	182 905	179 811	1 386 969
Discount Ratio	0.954	0.867	0.788	0.788	0.717	0.652	
Total Discounted Costs	485 173	245 707	93 369	89 673	131 143	117 237	1 162 301
Total Operating Costs	17 705	118 719	49 533	46 250	86 510	75 235	447 953
Total Capital Costs	413 468	126 988	43 836	43 422	44 632	42 002	714 349

TOTAL SYSTEM MANUAL COSTS

Cost Category	1986	1987	1988-1st	1988-2nd	1989	1990	Total
Facility Costs	$0	$0	$0	$0	$0	$0	$0
Equipment Costs	2 400	0	0	0	2 400	0	4 800
Maintenance	0	0	0	0	0	0	0
Expendables	2 060	2 096	1 697	418	1 833	1 897	10 002
Salvage Value	0	0	0	0	0	0	0
Digitizing Costs	0	0	0	0	0	0	0
Project Costs	271 724	296 349	213 079	227 847	571 866	719 398	2 300 262
Area Office Costs	38 628	49 916	24 609	28 789	56 286	58 256	256 483
Central Office Costs	0	0	0	0	0	0	0
Support Contractor Costs	0	0	0	0	0	0	0
Total Costs	314 812	348 361	239 385	257 053	632 386	779 551	2 571 547
Discount Ratio	0.954	0.867	0.788	0.788	0.717	0.652	
Total Discounted Costs	300 331	302 029	188 635	202 558	453 420	508 267	1 955 240
Ratio of Manual/GIS Costs	0.62	1.23	2.02	2.26	3.46	4.34	1.68
Total Operation Costs	298 041	302 029	188 635	202 558	451 700	508 267	1 951 230
Savings	226 337	183 309	139 103	156 307	365 189	433 032	1 503 277
Cumulative Savings	226 337	409 646	548 749	705 056	1 070 245	1 503 278	

Discounted Capital Costs = $714 349

Discounted Payback = 3.03 years

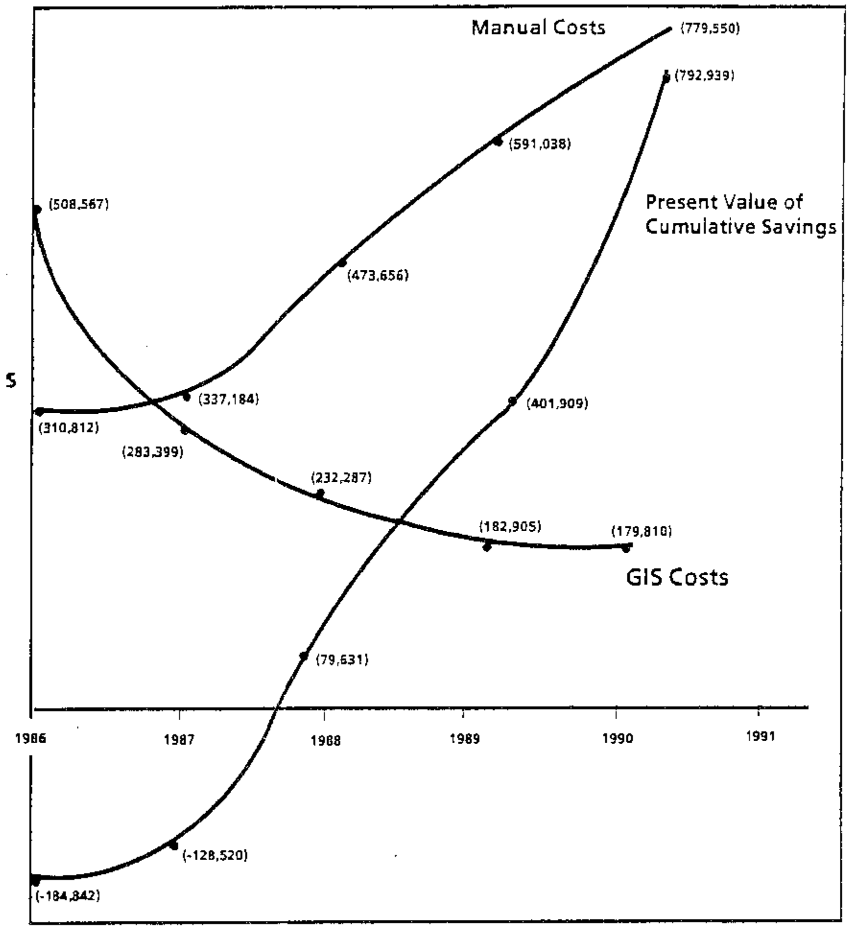
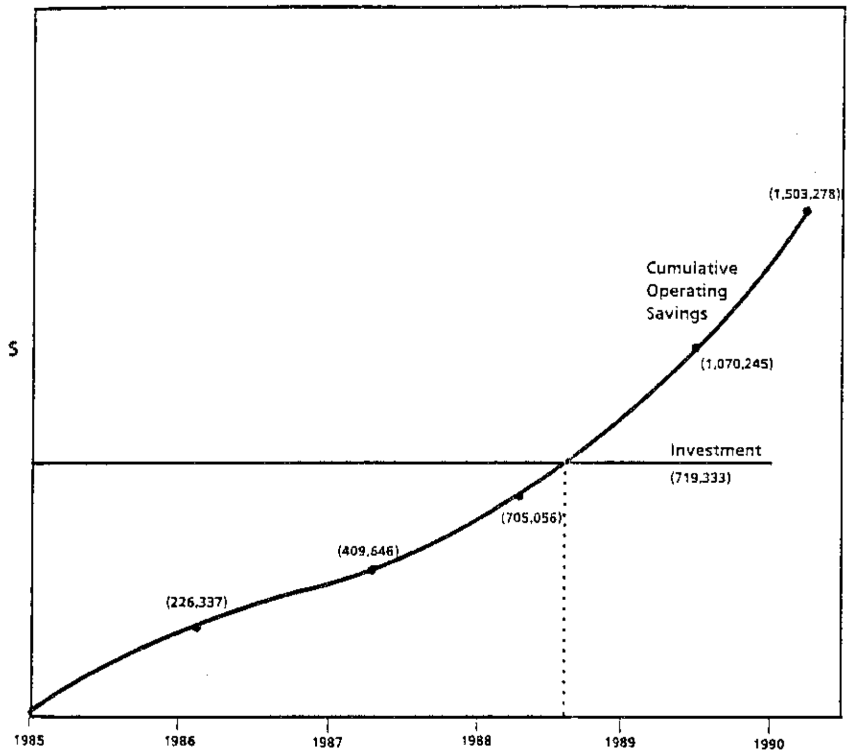


Fig. 1
Manual and GIS
Present Value
Analysis

Figure 1. Manual and GIS Present Value Analysis

Fig. 2

Discounted
Pay Back
Analysis



Conclusions

The purpose of this report was to evaluate the decision to implement the Geographic Information System technology within the Bureau of Indian Affairs. A comprehensive economic analysis and benefit cost analysis were performed of the 1986 decision to implement the GIS. The major conclusions from these analyses are presented below.

1. The GIS system implemented by the BIA in 1986 has been shown to be more cost effective than a manual system for performing the same level of work. The ratio of total discounted costs for utilizing the manual system rather than the GIS indicates that the manual system is 68 percent more costly.

2. Based on the present value of the two cost streams, the discounted savings from utilizing the GIS will be more than $792 939 by the end of the hardware's useful life, 1990.

3. The GIS system is associated with a Savings to Investment ratio of 2.06 for the useful life of the system. This ratio can be interpreted to mean that the GIS investment will be returned in savings by more than double the initial investment. To be conservative in the analysis, the costs of digitizing data were included as part of the investment costs.

4. The initial investment including data digitization costs will be paid back in 3.03 years of operation.

5. Based on the average operating costs, the breakeven analysis showed that the GIS was the more cost effective choice if the use of the system would amount to more than 480 hours over the useful life of the hardware.

6. The GIS was less expensive than the manual system for each of the three offices. In Billings, the GIS had costs approximately equal to the manual system. The higher costs at Billings is attributable to the fact that the Billings Area Office was responsible for digitizing data for 6.5 million acres of reservation lands, more than the other two field installations combined. These data have a useful life that is much longer than five years. Thus if the GIS continues, Billings can anticipate larger than average yearly cost savings.

7. The highest use of the system occurred at the Fort Apache Agency Office. The GIS was used to directly support the 10 to 12 timber sales that take place each year. It would appear that installations that have a high level of repetitive work will yield higher cost savings than installations that have specialized applications.

8. The GIS system was found to have other non-quantitative benefits that add to the attractiveness of the cost savings. Faster production times, higher levels of reproducibility and documentation of work, expanded land management abilities, more efficient use and sharing of data, increasing quality, and enhanced credibility are the intangible benefits deemed relevant to consider in the decision to implement the GIS.

In summary, the economic analyses clearly indicate that the GIS is a more cost effective and beneficial technology for producing the geographic information and analyses required by the BIA. Any decision maker faced with a choice between implementing the GIS or a manual system would select the GIS system if the decision was based on pure economic criteria.

-- APPLAUSE

CHAIRMAN ZILLMER: Thank you, very much, John. That was a very interesting and timely presentation.

Ladies and Gentlemen, that concludes the formal part of the program. We shall now move down the hall to room 107 where we will be having lunch and subsequently welcome our guest speaker, Stephen Lewis.

DR ZARZYCKI: Ladies and Gentlemen: may I have your attention, please. We come now to the high point of our seminar: the address by Mr Stephen Lewis, whom I think everybody knows. At least, everybody who is from Ontario and Canada. As you know, Mr Lewis is in charge of the transition team to install the New Democratic Party government in Ontario. Mr Lewis really does not require an introduction, but I have some remarks here about him.

During the conference, I was asked by many participants whether the timing of the seminar and the selection of Mr Lewis as a guest speaker was just luck or the result of some kind of divine intervention. Now, I leave it up to you to decide what it was!

However, we are extremely happy to have Mr Lewis here with us. Mr Lewis was first elected to the Ontario legislature in 1963 at the age of 25, and in 1970 became provincial leader of the New Democratic Party. With Mr Lewis as leader, the NDP became the official opposition in 1975. Three years later he resigned his seat. Since 1979, he received a dozen honorary degrees from Canadian universities. In 1982 he won the Gordon Sinclair ACTRA award for outspoken opinion and integrity in broadcasting, so you can prepare yourselves for a very, very interesting talk.

Before his appointment as Ambassador for Canada at the United Nations, in 1984, he was a noted radio and television commentator on issues of public concern, and he became a prominent arbitrator in the labour relations field. In 1986, Mr Lewis chaired the committee which drafted the Five-Year program on African economic recovery. Later that year, the Secretary General of the United Nations appointed Mr Lewis as his special advisor on Africa to aid in the mobilization of the international community. Although he resigned from his appointment to the United Nations in 1988, he was asked to serve in his personal capacity as a special advisor on Africa to the end of 1990.

Ladies and Gentlemen: please welcome Mr Lewis.

[APPLAUSE]

GUEST SPEAKER

STEPHEN LEWIS

Thank you immensely for so amiable an introduction. I am utterly delighted to be here. I see that the metamorphosis of power has already influenced the way in which I am treated. To have described *this* as the high point of the seminar, when I am usually referred to in vastly more disparaging and pejorative terms, is for me almost more than my frail psyche can endure. And I may say that it was neither luck nor divine intervention which brings me here at this propitious moment.

My patterns of speaking were tracked by the GIS, and it become obvious that this was an auspicious conjunction of events. I am enormously delighted to be here, and especially delighted to be here to share this luncheon with colleagues from Zimbabwe, a country for which I have an enormous personal affection. I am, as became clear to them over the course of lunch, utterly transported with joy: still levitating from the events of September 6, and very pleased to welcome all of you to the promised land.
It's extraordinary to have one's political juices churned again. I was under the impression that that might never happen as an encore in my dissolute political life. As a matter of fact I thought that never again would I be subject to the maniacal spasms of *The Left*. When you're a democratic socialist who has worked for four years for the Tories, you're not only cleansed, you're positively neutered.

So it is a joy to know that one's passions can be aroused again. And I must say that the process of transition is really utterly fascinating, as some of you may have heard me say a week or two ago. I have learned more in the last little while than I ever imagined possible. I recall that on the Friday after the election at the request of Bob Rae, I met with Peter Barnes, the secretary to the cabinet, and it was one of those convulsive moments of life I will never forget. And it was overwhelming because of the simplest of factors. I asked a number of questions and I actually got answers! I spent over 15 years in the Ontario Legislature attempting to assault the impenetrable cerebrums of conservatives, and never got a reply to any request of any kind. Suddenly to find out the way in which government works internally and to learn some of the fascinating aspects was for me an exhilarating process.

I feel like many New Democrats, a little daunted by what lies ahead, although I am viewing it from a distance. My role ends on October 1st when the cabinet is sworn in. But I am, like many of you, immensely hopeful about what the future will hold. I think it will be an enormously exciting for the Ministries of Ontario. I think the evidence of a palpable and real agenda will animate the work of the ministries in a way that will be enormously gratifying to those in the public sector and in the Ontario public service. I think that the openness and candour and accessability and imagination which I sense Bob Rae and his colleagues are determined to bring to the process, will be a fascinating dimension of the next four years, as a new political culture emerges in the Province. And I hope for all of you that it will be one of those experiences of a life time. I should not put it as though it will end in four years, because of course, you know as I do, that we are now on an eternal process of government.

And I thought to myself, impishly, what the pleasure it is for the Ministry of Natural Resources that Bob Rae is the Premier and not I. I remember back in 1977 I fought a campaign almost the entire basis of which was directed at the alleged depredations of the Ministry of Natural Resources and, except for a few closet subversives in the Ministry, most of the leadership felt I was nuts. And to be fair so did a large number of voters in the Province of Ontario. But here you have a government's view which is balanced, moderate and sensible and therefore easy to embrace.

And the centrality of the Ministry, the centrality as I am learning, of the GIS, (and the way in which it is used so extensively in so many applications around the province), each and every application strikes terror in my heart. Because technology has always reduced me to Luddite status. But it is still an area which will allow most of the people in this room, certainly any who are attached directly or indirectly to the Ministry of Natural Resources, to feel a sense of primacy in the debate over the next number of years. Particularly as it impinges on the environmental factors in a way which will be enormously gratifying to all of you. You will be inevitably at the nerve centre of public policy.

I want to begin the more formal observations I have, with a disclaimer. I don't pretend to a moment's expertise on the subject matter. There was a time when I addressed an analogous group and I read carefully and I understood not at all. Which is alas, something that has been true of my public life. But I am appeased in my anxieties to know that there are all kinds of people in this room who can speak knowledgeably and with authority about the subject matter. And despite my lack of expertise, I shall not resist saying what I want to say. I learned a very, very long time ago not to allow an absence of knowledge to impede opinion.

And since that's a view I certainly share with the political leadership of Canada, I'm not going to feel self-conscious about the views I want to disgorge, although I am a trifle intimidated by following in the footsteps of David Suzuki whom you had at last year's luncheon. He made, as I read it this morning, a quite remarkable address, knitting together an encyclopedic range of matters dealing with the nature of the international environment and the integration of the worlds species and elements. There is not much left for me to adorn for those of you who were here last year. And I thought to myself, therefore, if you will indulge me, and there's not much you could do about it anyway, that I want to come at some of the broad matters, somewhat differently, in a fashion which may at the outset be seen as unorthodox. I want to draw on the elements of the brief international experience I've had, to attempt to illumine some of the debate which will be raging through the decade of the 1999s around subject matters which concern everyone in this room. And let me begin, if I may, in a fashion unexpected, but whose relevance I hope will become obvious.

There will be, I think, two epochal events in the 1990s for the world generally. One will undoubtedly be the international conference on development and environment, to be held in Brazil in 1992, about which we will all hear an increasing amount as the conference comes closer. And the reverberations from which will set major environmental and resource policy for this world for the rest of the decade. The second event which can be described as epic making, will occur not this weekend, but next. It will occur on September 29 and 30 in New York when there is the largest ever gathering of world leaders in history at what is called the *Summit for Children*. There has never been such a gathering. There will be at least eighty heads of government and heads of state assembled; north, south, east, west. We've had east-west summits, we've had north-south summits, we've never had them all together in one place at one time. And there is between these two events, a conjunction of circumstance which is worth addressing. Incidentally, one interesting coincidence about the two events is that they will both be chaired by Canadians. The Brazil Conference on development and environment will be chaired by Morris Strong, who will be known by many of you. And the Summit on children will be chaired in part by the Prime Minister of Canada, co-chairing it with the President of Mali.

And I wanted to dwell initially on the Summit on Children in a way which I hope has evident application. All of these leaders are getting together at the end of the month in New York to attempt to establish a series of goals and targets for the children of the world by the year 2000, largely and primarily the children of the developing world. And they are brought together at this moment in time because of the indescribably tragic, grotesque and indefensible conditions under which children of the developing world live their lives.

Seven thousand children under the age of five die every day from preventable diseases: measles, diphtheria, tetanus, whooping cough, simply for the lack of a course of vaccines which would cost $1. One dollar for the life of a child. Almost 8000 children a day in the developing world under the age of five, die of dehydration induced by diarrhoea for the absence of something which is called "Aural Rehydration Therapy." A little package of salt and sugar which, when mixed with water and ingested orally, can stop the dehydration, induce rehydration and with a little supplemental feeding, save the child's life, all for the expenditure of seven cents. Seven thousand children in the developing world under the age of five die every day from acute respiratory infections mostly pneumonia, because of the absence of antibiotics, valued at one dollar. Again a dollar to save the life of a child. And a thousand children under the age of five in the developing world go blind everyday for the want of a vitamin A supplement that would cost ten cents.

Now, if you will excuse the digression for a moment, in my own aggravation about it, you have to ask yourself the nature of international values, the nature of this fascinating international morality that we've constructed. That we lose the lives of tens of thousands of children a day for the sake of pennies. It takes nothing to mobilize two billion dollars a month to underwrite an armada in the Gulf. But to provide the amounts of money in order to sustain the life of children in the developing world, that somehow has alluded the sophisticated capacities of industrial societies. The Gulf stuff we call the *noisy emergencies*, the death of the children we call the *silent emergencies*. What the executive director of UNICEF has called *the obscene daily harvest of children*. Why do I raise it? Because the relationship to the subject matter is both poignant and fascinating.

One of the things that will be endeavoured at the Summit is the mobilization of the resources and the capacities of the world to intervene in a way which will save millions of children's lives in the decade of the 1990s. And in an ironic, but wholly fascinating way, it speaks to the question of population. And it is felt by large numbers of people as is everywhere evident, that population and its pressure on resources is one of the great environmental problems of this age. Then let it be noted, that if you want to bring birth rates down, you must first bring death rates down. That if you want to bring fertility rates down, you must first bring infant mortality rates down. The equation is not immediately evident until you think of the words of someone like Julius Neyere, the former President of Tanzania, who made the observation that the single strongest contraceptive there is, is the confidence on the part of parents that their children will live. And everywhere in the post-war period, where we have been able to see a reduction in the population rates, that reduction has been preceded by a decline in the infant mortality rates as families feel they don't have to have so many children in order for some of them to survive.

And if in the process of bringing the infant mortality rates down, one can in an equivalent way provide literacy and infant and maternal support for the mothers in particular, then you are launched on a road to relieving the pressure on resources in a fashion which makes the links evident. And one of the most pronounced aspects of this extraordinary Summit on Children is precisely to achieve that end. And it raises, if I may, in a nutshell, one of the great issues of the 1990s. There is an assumption that all of the big issues will deal with the political convulsions, will deal with what is happening in the Gulf, will deal with the liberation of Eastern Europe, will deal with the marginal application of pluralism in the Soviet Union, will deal with the new rapprochement between east and west, will deal with the apparent reduction in the arms race. That's not the central issue of the 1990s for this world.

I remember listening to a remarkable speech by Sonny Ramphal, the Secretary General of the Commonwealth, before he resigned in Washington last October. Sonny is one of the most wondrous speakers in the English language; he set out a litany of all the things that were wrong with the world in a sort of State of the World address. He said if you think those things in which we are all now engaged will be on the agenda for the 90s you're crazy. There is only one agenda for the 1990s, and that is the need to overcome the north-south divide. The need to overcome this unbridgeable barrier that we have erected between the developed and the developing world. The need to overcome the reality of three to four billion people living lives of incomparable impoverishment, while as David Suzuki said so eloquently last year, the western world indulges itself to the point of relative obscenity.

When one talks about saving the lives of children, let me put it in terms of sub-Saharan

Africa, in a way that I think will bring it vividly to you. There are 45 countries in sub-Saharan Africa, and if all the goals for children were achieved, if all the targets were achieved, in health, in education, in nutrition, in clean water, in sanitation, it would cost, from external resources, every year of the next decade, $6.8 billion That is to say all of the goals that the world would wish to embrace for sub-Saharan Africa could be achieved by $6.8 billion a year provided from external resources. The saving in lives: 18 million children's lives.

Now let me give you a juxtaposition. For every year of the 1990s, those same 45 sub-Saharan African countries will be spending $9.7 billion on servicing their debts. In other words, the poorest countries on the face of the earth will be paying $9.7 billion a year to the wealthiest countries on the face of the earth. These are not commercial debts in large measure. These are not commercial banks to whom they owe the money in large measure. These are debts which are overwhelmingly owed to governments. By extracting the money from those impoverished economies we are at the same time destroying the lives of the children. And there is a certain madness in that. And that's why the nature of the international debate in the next decade, and the way in which it impinges on our kind of society is absolutely integral to any appreciation of the social and historical forces at work.

You can't imagine what the 1980s felt like in the developing world. Everybody calls it the lost decade. Every single economic index by which the strength of a society was measured was down overall. In sub-Saharan Africa, in Latin America, in the poor countries of Asia like Bangladesh, and much of the Caribbean trade was down, investment was down, foreign aid was down. The prices we paid for their commodities were down, and the debt and debt servicing increased exponentially. As a matter of fact there are two figures which say it all. I'll share them with you, I need not then further embroider. In 1980, the developed world transferred net to the developing world some $50 billion annually, over and above everything they paid us, by way of interest on their debts, and capital repayments. We transferred to them, by way of loans, grants, trade and investment $50 billion more.

In 1990 the developing world pays to the developed world net $40 billion annually. A shift of $90 billion in one decade. That is to say over and above everything that we convey to them by way of aid, and trade, and investment, they pay to us by way of interest on their debts and capital repayment, $40 billion more. And as I am standing here you cannot get through the decade of the 1990s without an international, economic collision so long as that disparity continues.

We are creating a fourth world of permanent impoverishment. And it is the kind of indefensible and unconscionable act in human relationships which speaks urgently to the nature of the international environment and the kind of society that we would wish to create. I remember, in Suzuki's speech last year, that he told you about Brazil and about the rain forest. And he pointed out that in the last several years Brazil has paid $50 billion dollars in interest payments on its debts while ravaging the rain forests in the process. And in the same period of time, the debt itself has increased dramatically, because there never seems a way of paying it off. And what is so crazy about this phenomenon is that we need the developing world in a way we have never needed the developing world before. And it's not a matter of gratuitous self worth that we can visit our generosity at times of famine, like Ethiopia. And it's not a matter of simply setting up trade markets for the future. It's a matter, if I may use the phrase, quite simply, of saving this planet. It's a matter of dealing with the environmental crisis in a way which somehow salvages the earth for the 21 century.

I think it's fair to say that my most memorable day in the general assembly of the United Nations was a day early in October 1987, when Madame Gro Harlem Brundtland took the podium of the general assembly, and tabled her world commission report on environment and development. And it was a galvanic moment. You could feel the excitement coursing through the general assembly. And let me tell you, the general assembly was a place where people were, if not comatose, very close to it a great deal of the time. But when Madame Brundtland spoke there was a life and a feeling that was quite overwhelming. And she of course introduced into our vocabulary the now conventional phrase, *sustainable development*.

It's rather interesting, by the by, what has happened to the phrase. There are increasing numbers of environmental groups around the world who are sorry for the phrase, sustainable development. They feel that merely to put the two words together means that you emphasize the development and the sustainability counts for very little. But certainly the anxiety and priority around the environment emerged as never before when Madame Brundtland's report on development in the environment was issued. There followed her to the platform of the general assembly, one after another, heads of government and heads of state in the world and environment ministers expressing an almost religious fidelity for the recommendations of the report. But there were two interventions that were particularly fascinating.

The first was, if memory serves me, from the foreign minister of Argentina, speaking on behalf of the Latin American and Caribbean group. Now that's the way international forums function: if there are 159 countries, which means effectively there are 159 political parties, you can't all speak to every issue. So frequently representatives of a group's view are chosen. And in this case it was the foreign minister of Argentina and he made a quite fascinating intervention, the substance of which was, "We will participate with you in saving the environment, if it doesn't mean an erosion of our constitutional integrity." It's rather interesting that in Latin America the sense of jurisprudence, the sense of the legal construct, the sense of the integrity of the nation's state, is perhaps more powerful than anywhere else in the world. And it makes you understand why Brazil reacted so strongly to what they felt what was the gratuitous intrusion of the world about their rain forest. Not so much as they regarded us as wilful predators ourselves, although they did, but mostly because they thought that it violated their sense of sovereignty. And sovereignty is nowhere more powerfully felt than in Latin America.

So that speech indicated what was going to happen down the road, although very few people paid attention to it in that context. But the most memorable speech, and this is a nice piece of timing, came from the then Prime Minister, the now President of Zimbabwe, Robert Mugabe, who was speaking on behalf of the entire developing world on that occasion, the non-aligned nations, as they call them. Zimbabwe was president of the non-aligned. And I remember Mugabe's speech very well. I like Mugabe; he's a very straight forward and direct fellow. There's not a lot of adornment in his words. He looked out at the general assembly (I am now quoting with a great deal of licence but you will get the sense), and he said in effect, Look if this world commission report on environment and development means that those of you in the western world want to deal with acid rain, and polluted rivers, and waste disposal, and exploring the disposal of radioactive nuclear waste, and recycling, and all the other things with which you are collectively occupied, that's fine. Go to it. But don't expect us to be involved. Because for those of us in the developing world, the environment means one thing and one thing only. It means poverty. And if you're not prepared to deal with poverty, then you cannot count on us for international collaboration on saving the environment. And he spoke it without malice, and without provocation, and without an inflammatory spasm, he just spoke it.

For the developing world, and you can see it when you read Brundtland and the chapter on poverty, poverty is everything. You can't do anything until you overcome the

And I must say that, although from time to time, some of these issues seem a little beyond one, you can't live life any more, watching this horrendous despoliation of the environment, largely forced by the disparities in the world, without recognizing that there comes a moment in time, when you pay a price which is ultimately fatal. And whether it's Suzuki or the World Watch Institute or Madame Brundtland or anyone else who says the decade of the 1990s is the turning point, I firmly believe from everything I've read and learned, that we won't get past the year 2100 unless the 1990s precipitate the change. And in a very real sense, you're involved collectively in technology, which will allow public policy to be more sensitive, and more creative, and more adaptive in all the areas of environmental concern. That's a bloody exciting thing. And the next several years will find you at the centrepiece of public debate. So I salute you for that. And I'm sorry to have provided the occasional dour look at the world, generally, but I am more and more seized with the sense of urgency that we're losing lives and we're losing the planet, and public policy is playing at the margins.

Thank you for having me.

[APPLAUSE]

[GABRIELLA ZILLMER]

I have the pleasure to take this opportunity to thank you, Mr Lewis, for your insightful comments and to say that you have touched on issues which everyone in this room is dedicated to addressing in some way. In our way, we've chosen to use the GIS technology to address this. The theme of this seminar was "The Coming of a New Decade - What have we learned from the '80s?" Up until today we have been looking at that in terms of the GIS technologies we use. Mr Lewis has provided us today very eloquently with some of the other things we have learned from the '80s which we *have* to address in the '90s. On behalf of the people in attendance here, I thank you for your comments and I wish you well in the upcoming months. You'll be a busy man, I hope you come back to visit with us again. Thank you.

[APPLAUSE]

Intentionally
Blank
Page

5118-3
(1 k P.R., 90 11 02)
ISBN 0-7729-7826-3