# Report on the Application of Computer Technologies to Community-Based Environmental Impact Assessment in the Inuvialuit Settlement

**Price Waterhouse**

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# A REPORT ON THE APPLICATION OF COMPUTER TECHNOLOGIES TO COMMUNITY-BASED ENVIRONMENTAL IMPACT ASSESSMENT IN THE INUVIALUIT SETTLEMENT

## TABLE OF CONTENTS

## 1.0 EXECUTIVE SUMMARY

This document summarizes the results of a meeting held in Inuvik on February 27 - 28, 1990 to discuss the application of computer technologies to community-based environmental impact assessment (EIA) in the Inuvialuit Settlement Region (ISR). The meeting was sponsored by the Canadian Environmental Assessment Research Council and was facilitated by Price Waterhouse and Resource Futures International.

The meeting was attended by representatives of the various agencies and communities involved in the EIA process.

The meeting clearly confirmed that, in the face of increasing development activity, timely access to a broad spectrum of information is critical. Progress in computerization by many of the local agencies was described and the lack of similar resources within the communities was evident. A strong desire to take advantage of computer technology was expressed by the community representatives, but the need for extensive training and a multi-year commitment to such a program was emphasized. The need to coordinate overall computer activity in the region and to share data and information was a recurring observation.

The increased importance of traditional knowledge was evident and the need to capture, preserve and pass on this knowledge was stressed.

There was consensus that a program to apply technology to community-based EIA in the ISR should be initiated and that this program should not only pursue the specification and implementation of computer-based support within the Hunters and Trappers Committees, but also look at the central coordination of information management within the region.

It was also suggested that further research into the possible use of computer technologies, such as expert systems, to capture and make accessible traditional knowledge is an important consideration.

## 2.0 INTRODUCTION

The history of the twentieth century is dominated by massive industrial, technological and population growth with little respect for its impact on our environment.

It is only recently that citizens and their governments have considered the extent and often irreversible impact of this growth and they are now elevating environmental protection to the front of citizen concern and political agendas.

Of ever-increasing prominence is the concept of sustainable development. “Our Common Future”, the Brundtland Report, has as its central thesis that in order for development to be sustainable, it must ensure “that it meets the needs of the present without compromising the ability of future generations to meet their own needs”. A major implication of sustainable development is the need to marry wise resource use and management of the environment with development objectives.

Environmental Impact Assessment (EIA) has been adopted as an effective planning tool to help decision-makers deal with the environmental consequences of their decisions and to help embrace the goal of sustainable development. Indeed, the concept of sustainable development is rooted in the traditional cultural and harvest attitudes of the North, where sustainable use of resources and wildlife are fundamental to survival.

In Canada, EIA was formalized in the early 1970’s with a cabinet decision to establish the Environmental Assessment and Review Process (EARP). Guidelines were established by Order-in-Council in 1984 and the Federal Government in its October, 1989 Throne Speech made a commitment to introduce legislation to strengthen the federal EARP.

In the Inuvialuit Settlement Region (ISR), a process of assessing environmental impact has been established as a result of the Final Agreement, with an active Screening Committee and Review Board to assess development initiatives. The Final Agreement has provided the 2,500 Inuvialuit of the Western Arctic with rights of land ownership and management over 91,000 square kilometres of land.

Effective EIA is dependent upon the availability and review of a vast amount of information and the application of a broad range of specialized expertise. Information can include land and sea characteristics,

land use data, harvest patterns, wildlife data, geological formation, meteorological data, and so on. Required expertise can range from engineers to accountants, from biologists to geologists to meteorologists to government officials. This is often overwhelming in the face of imposed timeframes and potential impacts of development decisions.

In the ISR, the process depends on grass-roots input from the local communities and, to an increasing degree, the Hunters and Trappers Committees (HTCs) are being asked to provide knowledge, information, opinions and advice on the potential effects of development projects.

In parallel to the evolution of EIA, computer technology has advanced dramatically in the last decade. Computer-based information management now pervades all of our activities and is no longer constrained to the data processing of financial transactions. We do our banking with computers, buy airplane tickets through computers and generate our maps and reports with computers. The advancement of microcomputer technology allows powerful computer systems to be available economically on the desk top or in the rural community. Communications technology now allows local computers to access data and expertise which was unavailable in a local setting. Computer technology is beginning to play a critical role in EIA - data bases, geographic information systems (GIS), simulation models and expert systems are all technologies that are now being applied or being developed for application to EIA. In fact, comprehensive EIA will not be possible without the power of the computer.

Within the ISR, computing is playing a growing role. GIS systems are being implemented, harvest information is being stored on computers, traditional knowledge is being captured, satellite data is being analyzed and communication links are being established to large computers in other parts of the country. And the young people attending schools and colleges are learning more and more about computers.

However, computing in the ISR is still limited to the offices in the towns, but as the role of computing increases within the context of EIA, it is appropriate to look at the utility and degree to which these and other computer systems might be used to assist communities in the contribution of their knowledge and information to the EIA process and to permit better access to information held by others.

## 3.0 ENVIRONMENTAL IMPACT ASSESSMENT IN THE INUVIALUIT SETTLEMENT REGION

### 3.1 The Process

The Inuvialuit Final Agreement sets out a two-stage process called the Environmental Impact Screening and Review Process for assessing the environmental implications of all development projects or projects of consequence to, the Inuvialuit Settlement Region. The process applies to all levels of projects, whether they be national, regional, or local in scope. The process must be applied before any permits or licenses may be granted by government.

The term "development" has wide meaning and includes any commercial or industrial undertaking or venture, including support and transportation facilities relating to the extraction of non-renewable resources from the Beaufort Sea. As well, it includes any government project (Federal, Territorial, provincial, municipal, or Crown agency) except those within the limits of communities that have no effect on wildlife resources outside of those communities.

Figure 1 shows the pathways followed by a proposed development. An Environment Impact Screening Committee assesses whether a proposed development requires detailed environmental impact assessment. An Environmental Impact Review Board carries out any formal assessments deemed necessary by the Screening Committee. Both the Screening Committee and the Review Board have equal representation from Inuvialuit and Government organizations.

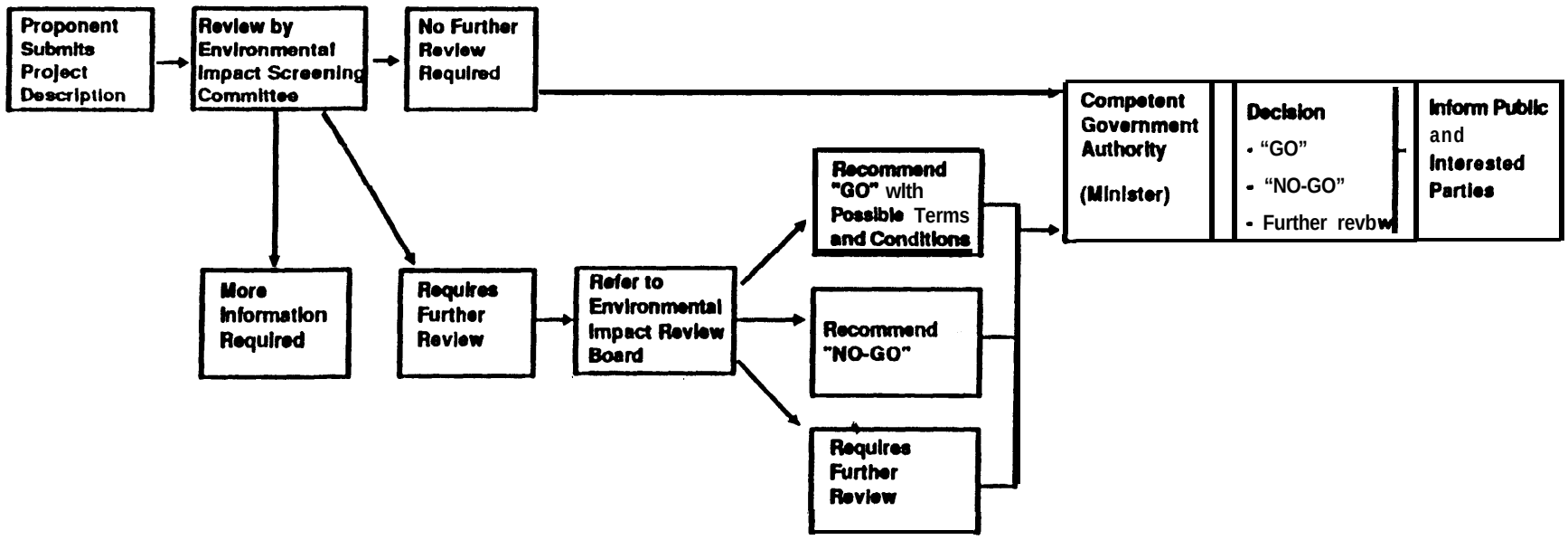
Proponents of development proposals must submit a project description to the Screening Committee during the preliminary planning stage. This description must explain the purpose of the project, the nature and the extent of the proposal, the rationale for the site selection, and other information and technical data which will permit an adequate assessment of the effects of the project on the environment.

The Screening Committee then determines if the development could have a significant environmental impact. The process allows for examination of both environmental and related social effects of developments. The Screening Committee may decide that:

- the proposal would have no significant impact and therefore may proceed without further assessment;

# ENVIRONMENTAL IMPACT

## SCREENING AND REVIEW PROCESS




- Baseline Monitoring
- Predicting Impacts
- Assessing Impact Significance
- Evaluating Proposal
- Evaluating Proposal
- Public Consultation
- Monitoring Compliance and Mitigation

- that the proposal could have significant impact and requires further assessment and review; or
- that the proposal is deficient and that submission of another project description is necessary.

Proposals requiring further assessment and review are referred to the Environmental Impact Review Board. The Review Board evaluates the information it receives and recommends to the government body having the power to authorize the proposal, whether or not the development should proceed. The Review Board may also recommend terms and conditions of approval, including mitigative and remedial measures, or further assessment of the proposal.

The responsible government authority then determines whether the development may proceed, whether it requires further impact assessment and review, and whether it accepts or wishes to modify the recommendations of the Review Board. The final decision of the government authority must be transmitted to interested parties and be made public.

## 3.2 **Information Requirements**

The validity and effectiveness of any environmental assessment depend greatly on the quality and availability of information about the environment within which the project will be carried out. Accurate and pertinent information and knowledge is essential for predicting the likely effects of a proposal on the environment; for assessing the significance of these effects; and for monitoring actual effects during construction and operation, and following completion. Information is usually required in a wide variety of subject areas such as on wildlife, fisheries, vegetation, water resources, socio-economic factors and cultural values/traditions, to name just a few.

Equally important is the need to make this information available to those who wish or need to participate in the assessment process. For any given project, the necessary information may reside with many different sources including studies specifically undertaken for that project, government data bases, and the personal knowledge and experiences of people living within the area. In the ISR, one of the important holders of information are Hunters and Trappers Committees.

Other holders of information include:

- committees;
- individuals;
- departments of the Terriiorial Governments;
- federal government departments; and
- industry

Making the appropriate information available to those who need it, when they need it, and in the required format, is a substantial challenge.

# 4.0 COMPUTER TECHNOLOGIES IN THE ISR

## 4.1 Current Uses of Computer Technology

The use of computer systems is rapidly growing within the ISR. Computer technology is largely microcomputer (PC) based and is focused on data base management systems (DBMS) and geographic information systems (GIS) applications. Most uses of computer systems are for specific purposes and projects and, reflecting normal early stage computing, there is limited coordination and no integration of systems.

Community level computing is limited to the Community Corporations who are using PCs for office administration purposes.

Representative computer projects include:

The Regional Land Use Planning Division of the Department of Renewable Resources of the GNWT uses the SPANS GIS and provides administrative and technical support out of Yellowknife to the three Regional Land Use Planning Commissions.

The Mackenzie Delta/Beaufort Sea Regional Land Use Planning Commission has recently completed its land use Plan Options Study, in part using the Yellowknife GIS above.

The Joint Secretariat in Inuvik is using a PC-based data base management system to manage the results of its on-going harvest study.

The Joint Secretariat has installed the SPANS GIS although it is not operational. It is planned to use the system in conjunction with the harvest information.

The Inuvialuit Land Administration office in Tuktoyaktuk is using the PAMAP GIS system to digitize baseline maps and capture non-federal land use data. There have been difficulties in compatibility between new releases of the software.

Under a Technology Enhancement Program agreement, EMR's Canada Centre for Remote Sensing and the GNWT Department of Renewable Resources are jointly operating a remote sensing technology centre in Yellowknife. Nine demonstration projects are active. A major part of the program deals with GIS.

A project of potential interest is underway in the North Slope Borough in Alaska. GIS technology has been installed and a range of information (land use, traditional knowledge, 16 classes of wildlife) has been captured through community involvement.

Arctic College is establishing a GIS curriculum.

The Dene Cultural Institute is embarking on a project to collect traditional environmental knowledge and investigate ways of using expert systems to capture and apply the knowledge.

There is a wealth of data (wildlife, fisheries, land use, traditional ecological knowledge, etc.) contained in various studies and research reports whose value is lost without proper cataloguing and integration of data.

In most cases, there is, or has been, strong community involvement in the gathering of data. However, the output of these systems is not as widely shared.

## 4.2 Potential Use of Computer Technology in the ISR

Within the ISR and community-based EIA, the opportunities to apply computer technology are compelling. A sample of technologies which are now stable and can operate on microcomputers includes:

### Geographic Information Systems (GIS)

GISs permit the storage, management and manipulation of geographic data such as is found on maps and charts. A GIS facilitates the input, storage, modification, display, analysis and merging of this data.

A GIS can be used to capture, manage, analyze and display land use information, wildlife patterns, harvest information and proponents' project plans. In the community, a GIS could store local land use data, trap

lines, migration patterns, archaeological sites, harvesting locations and could analyze the impacts of development projects.

**Data Base Management Systems (DBMS)**

DBMSs allow the input, storage and retrieval of large amounts of similar data such as harvest data, permits, names and addresses, descriptions of reports and studies, etc. Once data has been loaded into a DBMS, it is not difficult to generate reports of the data and to perform analysis. Most common DBMSs can pass data to a GIS for display.

A DBMS could be used to store and report harvest data as is being done by the Joint Secretariat. It could be used to set up a reference directory of studies which have been performed in the region or a directory of names and addresses of experts who may be contacted for assistance. A DBMS could be used to log project data for future reference and it could be used to store proponent commitments to permit conformance tracking. In this manner, previously difficult to access information stored in reports becomes much more accessible.

**Decision Support Systems (DSS)**

DSSs are systems which permit the analysis of information and data to assist in the making of decisions. They generally allow the changing of the data to see what the effect of the changes would be on the overall problem. A DSS could be a spreadsheet program, allowing what-if questions, or a complex computer model which might simulate the effects of an oil spill.

DSSs could assist the community in analyzing the potential impacts of a proponent's development plan and allow for the modification of aspects of the plan to see what the effects of alternatives might be. Through the use of the computer, it is easier to produce and retain documentation of the analysis which was performed.

**Models and Simulation**

Models and simulation allow a computer to be programmed to behave the way a specified machine, plant or element of the environment might act. This allows the computer to show what might happen if

something was done to the item that has been modelled. For example, if the computer was programmed to know of the tides, currents and land formations of a stretch of river and it was programmed to understand how oil behaved in water, the computer could show what might happen if an oil spill occurred.

A model could be programmed to show an area of land in the region, as well as our best understanding, for example, of caribou responses to certain types of developments. Details of a proponent's project could then be input and the system could predict what the effects might be on caribou migration patterns or foraging activity.

**Expert Systems**

Expert systems, or knowledge-based systems (KBS), is new technology which allows the computer to be programmed to give advice the way a human expert would. KBSs can capture the rules and experience that an expert would apply in analyzing a situation. A KBS has a further characteristic of being able to explain or show the reasoning which was applied to the problem and therefore has significant training value.

Within the community, expert systems could be used to capture the knowledge of the elders and allow it to be applied to the analysis of development proposals. The ability of expert systems to explain the applied reasoning could assist in the communication of community knowledge to the young people.

Expert systems can also be used to provide access to specific knowledge not available in the community, but required for the assessment of proposals.

**Public Access Databases**

To a greater and greater degree, information and data are being stored on computer systems. Holders of this information are also increasingly making this information available to interested parties. Advancing technology is making the access to this data a simpler task through easy to use query languages, better communication technology and greater processing power in the microcomputer. There are a growing number of data bases containing information relevant to EIA and several of the active computer projects in the ISR will likely permit third party access.

Computerized access to data bases will provide the community with more information to apply to assessments. It will also provide an easier method of accessing and referencing the information than current paper-based methods.

# 5.0 MEETING TO DISCUSS THE APPLICATION OF COMPUTER TECHNOLOGIES TO COMMUNITY-BASED EIA IN THE ISR

## 5.1 Introduction

The meeting, sponsored by the Canadian Environmental Assessment Research Council, was held on February 27 - 28, 1990 in Inuvik to discuss the utility of computer technology to community-based environmental impact assessment (EIA) in the Inuvialuit Settlement Region.

Participation included representatives of the various bodies involved in the EIA process, representatives of the Hunters and Trappers Committees, FEARO, CEARC and consultants from Price Waterhouse and Resource Futures International who facilitated the sessions. Attendance was comprehensive although difficult flying conditions forced some invitees to miss the first day. Appendix 1 contains the list of attendees.

The meeting was convened in response to the growing pressures from development in the region and the concern that, while the communities are being called on to play a greater role in the EIA process, they have few resources with which to manage their participation. Wiih the growing role of computers in the region, the introduction of computers within the community would facilitate greater balance in the participation of all parties in the process.

In advance of the meeting a discussion paper was circulated which contained a series of questions to stimulate discussion. This paper, the agenda and the list of invitees are included as Appendix 2.

During **Day 1,** the EIA process in the ISR was discussed and the major computer-based initiatives which were active in the region were summarized. The broad information requirements (project information, land use, harvest patterns, community data, cultural information, economic factors, vegetation, wildlife, fisheries, water, geological, meteorological, sea) of the process and the participants were discussed and an effort was made to identify the sources and holders of information relevant to the process (individuals, HTC's, advisory committees, territorial and federal governments, industry).

Descriptions and demonstrations were provided of representative computer technologies which could assist community-based EIA. These included database management systems, geographic information systems,

decision support systems, simulation models, expert systems and artificial intelligence, public databases and word processing and desktop publishing.

**Day** 2 concentrated on discussing potential applications of computer technology and considerable time was spent on the issues related to the introduction of computers in the communities.

## 5.2 Presentations

Doug Wright led a discussion of the EIA process in the ISR. The overheads used are included as Appendix 3 and the points which arose included:

The process operates against very tight time schedules as described in the agreement and as required to meet weather restrictions for drilling, seismic, etc. This puts extreme pressure on the part-time staff in the community and often conflicts with hunting and trapping patterns.

The process is only effective if proper monitoring and enforcement procedures are in place.

There are limits on the amount of information available for the assessment of proposals and on the amount of money available to support the process.

Projects are difficult to understand and may involve concepts which are outside the knowledge, experience and credulousness of the elders (the ice island concept).

Traditional knowledge from within the community is only beginning to be applied and respected. However it is being eroded as the elders grow older.

Industry has significantly more resources than the community and therefore is perceived to exert more control.

Reports often do not get circulated and there was concern over control of versions of reports.

There was agreement that better application of process checklists, availability of mapping data and recording of decisions to support follow-up would be beneficial.

There was agreement that industry held considerable information which would be useful to the region and the communities.

There was strong concern that the issue of cumulative effects was not being properly addressed and that it required regional attention.

The Land Use Planning effort was described by Billy Day. The project has used the SPANS geographic information system in Yellowknife with terminal access in Inuvik. The working groups which were established, and paid, in each community were extremely effective and have valuable experience. In addition to land use data, there has also been an effort to capture traditional knowledge, traditional names and local lore.

Jane Bicknell described the Inuvialuit Land Administration computerization efforts. Most of the area has now been digitized and loaded on the PAMAP system, although not much analysis has been done. Again community participation was involved and working groups were dovetailed with the Land Use Planning teams. Efforts are now focused on generating databases of private land holdings, past and current rights, historic land use and traditional names.

Mike Fabijan, of the Joint Secretariat, described the Harvest Study which is resident on a Paradox database and will be integrated with the SPANS geographic information system in the next phase. The Harvest Study has depended upon the input from the hunters and trappers and innovative calendars and family involvement has been introduced to facilitate data capture. The information gathering process is now routine within the communities.

Bill Stinson, Arctic College, indicated that it was equipped to provide computer training and had computing facilities based on IBM compatible personal computers.

Martha Johnson, of the Dene Cultural Institute, described an active project in Fort Good Hope to begin a process of capturing and cataloguing traditional ecological knowledge. She indicated that community people have been trained to administer questionnaires and interviews. She stressed the need to address the issue of translation between northern languages and english or french, particularly within the context of understanding the knowledge of the elders.

Grant Thomas and Todd Heather demonstrated a variety of representative personal computer-based systems. The overheads used are included as Appendix 4. The technologies discussed included database management systems, geographic information systems, decision support systems, simulation models, expert systems and publicly accessible databases. The software which was demonstrated included:

| | |
|---|---|
| **RAISON** | a system for graphically modelling environmental systems; |
| **QUIKMap** | draws maps and allows complex plotting of geographic information; |
| **SPANS** | a geographic information system for modelling and analysis; |
| **Fulltext** | provides easy access to large documents; |
| **Simcity** | simulates urban planning and development; |
| **Idea Generator** | a problem solving tool to guide in logical thinking; |
| **Financial Models** | Lotus 123 spreadsheets to show investment analysis; |
| **Hyperpad** | easy and flexible access to information through the use of hypertext techniques; |
| **PD Framework** | a database management and reporting system; |
| **VPExpert** | an expert system development tool. |

Brian Smiley of the Data Assessment Division of DFO's Institute of Ocean Sciences demonstrated his workstation based oceanographic database and mapping systems. This demonstration provided the clearest example of the power of basic computing and the utility of readily accessible data. Brian

emphasized that the data which had been aggregated had taken considerable effort to assemble and to prove its accuracy and he stressed that data can be very dangerous if it is not known to be accurate and kept up to date. There was uniform agreement that information of this nature and in this form would be of great use within the community. A description of the Data Assessment Division's programs is included as Appendix 5.

## 5.3 **Results of Discussions**

During the discussion of applications and issues the following points arose:

There was agreement that the use of the computer would assist the communities. Applications which were mentioned included word processing, display of maps and land use/wildlife/harvest/vegetation/project data, checklists for the screening process and completeness of project descriptions, continued capture of traditional knowledge, directories of studies and experts, capturing information for monitoring and compliance.

There was an identified need to capture information to provide a trail of the review process and its results and recommendations. Also to track previous projects for accuracy of compliance.

There was agreement that traditional knowledge must somehow be captured, protected and more broadly applied.

There is a lot of information available, or in the process of being captured. This includes local, government and industry-based information. Broader coordination and access to this information was encouraged. The need to share and avoid duplication was agreed.

Faster access to information will definitely speed the EIA process.

It was stressed that any plans to introduce computers must recognize the instability of electrical supply and telephone communications.

There was a common concern over the accuracy of information and the effort which would be required to keep the data current.

There was extreme sensitivity over information security and the need to ensure that access to data was properly controlled and policed. The meeting was told of situations in which traditional burial ground information had fallen into the hands of tourists and sites had been trespassed.

There was recognition that computer technology within an HTC will strengthen its posture in its relationship with proponents.

It was agreed that initial systems could operate in english only.

There was discussion over how technology should implemented, whether all locations should start or whether a program should be phased.

The group stressed that training had to be a key element of any effort to computerize. Training funds may be available through the IRC (Section 16) and Canada Manpower. Arctic College would provide curriculum and facilities.

It was suggested that a central support capability should be seriously considered to coordinate training, software, data, system maintenance and support, etc. The initiative might be sponsored by the Game Council and administered by the Joint Secretariat.

It was emphasized that no computerization initiative should be entertained unless it had the necessary political will and long term (multi-year) commitment. There have been too many examples of projects being started without longer term funding causing either unemployment or the loss of trained people to jobs elsewhere. There was a suggestion that there may be a role for industry.

Despite the issues and challenges there was complete agreement that the use of computers was a necessity in the face of the increased developmental pressure. Examples of this increase are an anticipated two fold increase in project activity and a twenty fold increase in traffic on the Dempster Highway.

# 6.0 CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Conclusions

The development activity being experienced within the ISR is placing enormous pressure on the need to access comprehensive information under tight time limitations. Computerization will be the most effective means of addressing this need. The progress towards implementing computer systems on the part of the various agencies and industrial proponents involved in EIA is placing those organizations who do not have similar resources and facilities at a distinct disadvantage.

The introduction of computer systems within the HTCs will improve their ability to play a more balanced and timely role in the EIA process. The HTCs have expressed a strong interest in improving their computer literacy and technology base. Achieving a practical and effective computing infrastructure within the HTCs will require a sensible phasing of implementation, coupled to a comprehensive training program and a multi-year funding commitment.

The movement towards computerization in the north will benefit from greater coordination, the sharing of experience and the establishment of standards, or protocols, to permit and encourage the sharing of data and information. This should also extend to industrial participants.

The increased appreciation and respect for the value of traditional ecological knowledge is creating a challenge to find ways of capturing and preserving this knowledge in the face of an aging population of elders and the adoption of new lifestyles on the part of the youth.

## 6.2 Recommendations

**Establishment of a computer technology program**

1. A project should be commissioned to document the following:
   an inventory of the information holdings in the region;

   the information requirements of the community;

and the information holdings outside the region but of relevance to the community.

The project should also describe the data administration policies and procedures which will be required and should recommend the roles, responsibilities and location of the necessary functions.

2. A feasibility study should be performed to establish a program to apply computer technology to community-based EIA in the ISR. The study should establish

- Nature and scope of the program;
- Funding requirements and sources;
- A workplan outlining resource estimates and scheduling recommendations;
- Potential participants and program partners.

3. An initial workshop should be organized to specify, design and mock-up a community-based EIA workstation (personal computer) which would be used by the HTCs. The workshop should consist of a limited number of representatives who can speak for the requirements of the community and should have a strong computer technician who can program the computer and who is also an authority on the software and hardware available in the marketplace. The workshop would require a minimum of 5 days and would have as its deliverables:

- A specification of the software and hardware required for a first version of a community-based computer system;
- Identification of interfaces to other systems and the data exchange/communications requirements;
- A working prototype of a workstation which will serve as a "touch and feel" example of the concept and provide for full understanding and agreement with the design;
- Recommendations as to how the technology should be supported and how it is best to be implemented.

**Recommended research**

A research effort should be initiated to investigate ways of gathering, classifying, inventorying, maintaining and accessing traditional knowledge. There is increasing evidence that knowledge-based (expert) systems technology will be the technological vehicle to achieve this. Nations such as India and China, who face similar erosions of knowledge associated with cultural and scientific heritage, are using expert systems to capture herbal remedies, traditional dance and other aspects of traditional cultural knowledge.

Appendix 6 outlines a proposed research project to investigate the application of artificial intelligence to traditional ecological knowledge.

# APPENDIX 1

# ATTENDEES

# ATTENDEES


Ann Kasook
Inuvik HTC
Box 1365
Inuvik, XOE OTO
Tel. 403-979-2603
Fax 403-979-2610

Frank Elanik
WMAC
Box 123
Aklavik, XOE 1 CO
Tel. 403-978-2723
Fax 403-978-2842

Fred Wolki
Tuktoyaktuk HTC
Box 286
Tuktoyaktuk, XOE 1C0
Tel. 403-977-2457
Fax 403-977-2467

Eleanor Young
Regional Land Use Planning
Box 2123
Inuvik, AOE OTO
Tel. 403-979-3986
Fax 403-979-3791

Jane Bicknell
Inuvialuit Land Administration
Box 290
Tuktoyaktuk, XOE 1C0
Tel. 403-977-2202
Fax 403-977-2467

Mike Fabijan
Joint Secretariat
Box 2120
Inuvik, XOE OTO
Tel. 403-979-2828
Fax 403-979-2610

Manf red Hoefs
Yukon Terr. Government
10 Burns Rd.
Whitehorse, Yl A 2C6
Tel. 403-667-5715
Fax 403-667-3641

Peter Green
Paulatuk HTC
Paulatuk, XOE OBO
Tel. 403-580-3004
Fax 403-580-3015

Martha Johnson
Dene Cultural Institute
Box 207
Yellowknife, Xl A 2N2
Tel. 403-873-6617
Fax 403-873-3867

Gary Wagner
Joint Secretariat
Box 2120
Inuvik, XOE OTO
Tel. 403-979-2828
Fax 403-979-2610

Roger Binne
Renewable Resources, GNWT
Bag Service 1
Inuvik, XOE OTO
Tel. 403-979-2938
Fax. 403-979-2604

Bill Stinson
Arctic College
Inuvik
Tel. 403-979-2556
Fax 403-979-2850

Laurie Henderson
WMAC
Box 5928
Whitehorse, Y1A 5L6
Tel. 403-668-6407
Fax 403-668-3164

Billy Day
Regional Land Use Planning
Box 2123
Inuvik, AOE OTO
Tel. 403-979-3986
Fax 403-979-3791

# ATTENDEES


Brian Smiley
Data Assessment Division
Institute of Ocean Sciences
DFO
Box 6000
Sydney, BC, V8L 4B2
Tel. 604-356-6551

Patrice LeBlanc
CEARC
Executive Secretary
13th Floor, Fontaine Bldg.
Hull, K1A OH3
Tel. 819-997-l 000
Fax 819-994-l 469

Mary Ann Spicer
FEAR0
13th Floor, Fontaine Bldg.
Hull, K1 A OH3
Tel. 819-997-2223
Fax 819-997-l 469

Doug Wright
Resource Futures International
Suite 406
1 Nicholas St
Ottawa, K1N 7B7
Tel. 613-563-2636
Fax 613-563-4758

Dave Brown
Memex
81 Metcalfe St., 3rd Floor
Ottawa, K1P 6K7
Tel. 613-233-9144
Fax. 613-232-2235

Todd Heather
Price Waterhouse
1 First Canadian Place, Suite 3300
Toronto, M5X 1H7
Tel. 416-863-l 133
Fax 416-365-8215

Grant Thomas
Price Waterhouse
180 Elgin St, Suite 1100
Ottawa, K2P 2K3
Tel. 613-238-8200
Fax. 613-238-4798

# APPENDIX 2

# DISCUSSION PAPER

**Distribution List**

Sadie Whitbread
Aklavik HTC

Ann Kasook
Inuvik HTC

Fred Wolki
Tuktoyaktuk HTC

Gibson Kudlak
Hoiman HTC

Peter Green
Paulatuk HTC

Sachs Harbour HTC

Frank Elanik
WMAC

Laurie Henderson
WMAC Secretariat

Jane Bickneli
Inuvialuit Land Administration

Alex Aviugana
Regional Land Use Planning Commission

Gary Wagner, Mike Fabijan
Joint Secretariat

Martha Johnson
Dene Cultural Institute

Manfred Hoefs
Yukon Territorial Government

Gary White
Science institute of Northwest Territories

Angus Robertson
Renewable Resources and Environment
Department of Indian and Northern Affairs

Bruce Rigby
Arctic College

Roger Binne
Department of Renew&e Resources, GNWT

Brian Smiley
Institute of Ocean Sciences
Department of Fisheries and Oceans

Helmut Epp
Canada/NWT Centre for Remote Sensing

Bob Bell
CEARC

**APPLICATION OF COMPUTER TECHNOLOGIES TO COMMUNITY-BASED EIA IN THE ISR**

**AGENDA**

**February 27,** 1990

| | |
|---|---|
| 9:00 | Introduction |
| | Objectives of the meeting |
| 9:30 | EIA in the ISR<br>a discussion of the process and information requirements |
| 10:00<br>10:15 | Coffee |
| 10:15 | EIA in the ISR, cont'd |
| 11:00 | Computer technology and strategies in the ISR |
| 12:00 -<br>1:15 | Lunch |
| 1:15 | Overview and discussion of computer technologies<br>database management systems, GIS, decision support, simulation, expert systems, etc.<br><br>with demonstrations |
| 3:15 -<br>3:30 | Coffee |
| 3:30 -<br>4:30 | Discussion of potential computer applications in EIA |
| 4:30 - | Hands-on access to demonstration software |

**APPLICATION OF COMPUTER TECHNOLOGIES TO COMMUNITY-BASED EIA IN THE ISR**

**AGENDA**

**February 28, 1990**

| | |
|---|---|
| **9:00** | Discussion of computer applications in EIA cont'd |
| **10:00 - 10:15** | Coffee |
| **10:15** | Discussion of issues related to computer technology in the community |
| **12:00 1:15** | Lunch |
| **1:15** | Summary and conclusions |
| | **A** feasible research agenda? |
| 2:oo - **4:30** | Review session with HTC representatives |

# A MEETING TO DISCUSS
# THE APPLICATION OF COMPUTER TECHNOLOGIES TO
# COMMUNITY-BASED EIA
# IN THE ISR

## Discussion Paper

## February 27 - 28, 1990, Inuvik

CEARC

February 13, 1990

## 1. Background

The history of the twentieth century is dominated by massive industrial, technological and population growth with little respect for its impact on our environment.

It is only recently that citizens and their governments have considered the extent and often irreversible impact of this growth and they are now elevating environmental protection to the front of citizen concern and political agendas.

Environmental Impact Assessment (EIA) has been adopted as an effective planning tool to help decision-makers deal with the environmental consequences of their decisions and to help embrace the goal of sustainable development. Indeed, the concept of sustainable development is rooted in the traditional cultural and harvest attitudes of the North, where sustainable use of resources and wildlife are fundamental to survival.

In Canada, EIA was formalized in the early 1970's with a cabinet decision to establish the Environmental Assessment Review Process (EARP). Guidelines were established by Order-in-Council in 1984 and the Federal Government continues to reiterate its intention to introduce legislation to strengthen federal EARP.

In the Inuvialuit Settlement Region (ISR), the process of assessing environmental impact has been formalized as a result of the Final Agreement, with an active Screening Committee and Review Board to assess development initiatives.

Effective EIA is dependent upon the availability and review of a vast amount of information and the application of a broad range of specialized expertise. Information can include land and sea characteristics, land use data, harvest patterns, wildlife data, geological formation, meteorological data, and so on. Required expertise can range from engineers to accountants, from biobgists to geologists to meteorologists to government bureaucrats. This is often overwhelming in the face of imposed timeframes and potential impacts of devebpment decisions. In the ISR, the processes depend on grass-roots input from the local communities and, to an increasing degree, the Hunters and Trappers Committees (HTCs) are being asked to provide knowledge, opinions and advice on the potential effects of development projects.

In parallel to the evolution of EIA, computer technology has advanced dramatically in the last decade. Computer-based information management now pervades all of our activities and is no longer constrained to the data processing of financial transactions. We do our banking with computers, buy airplane tickets through computers and generate our maps and reports with computers. The advancement of microcomputer technology allows powerful computer systems to be available economically on the desk top or in the rural community. Communications technology now allows local computers to access data and expertise which was unavailable in a local setting. Computer technology is beginning to play a critical role in EIA - data bases, geographic information systems (GIS), simulation models and expert systems. In fact, comprehensive EIA would not be possible without the power of the computer.

Within the ISR, computing is playing a growing role. GIS systems are being implemented, harvest information is being stored on computers, traditional knowledge is being captured, satellite data is being analyzed and communication links are being established to large computers in other parts of the country. And the young people attending schools and colleges are learning more and more about computers.

However, computing in the ISR is still limited to the offices in the towns, but as the role of computing increases within the context of EIA, it is appropriate to look at the utility and degree to which these and other computer systems might be used to assist communities in the contribution of their knowledge to the EIA process and to permit better access to information held by others.

## 2. Environmental Impact Assessment In the Inuvialuit Settlement Region

### The Process

The Inuvialuit Final Agreement sets out a two-stage process called the Environmental Impact Screening and Review Process for assessing the environmental implications of all development projects or projects of consequence to, the Inuvialuit Settlement Region. The process applies to all levels of projects, whether they be national, regional, or local in scope. The process must be applied before any permits or licenses may be granted by government.

The term 'development" has wide meaning and includes any commercial or industrial undertaking or venture, including support and transportation facilities relating to the extraction of non-renewable resources from the Beaufort Sea. As well, it includes any government project (Federal, Territorial, provincial,

municipal, or Crown agency) except those within the limits of communities that have no effect on wildlife resources outside of those communities.

The figure provided on the following page shows the pathways followed by a proposed development. An Environment Impact Screening Committee assesses whether a proposed development requires detailed environmental impact assessment. An Environmental Impact Review Board carries out any format assessments deemed necessary by the Screening Committee. Both the Screening Committee and the Review Board have equal representation from Inuvialuit and Government organizations.

Proponents of development proposals must submit a project description to the Screening Committee during the preliminary planning stage. This description must explain the purpose of the project, the nature and the extent of the proposal, the rationale for the site selection, and other information and technical data which will permit an adequate assessment of the effects of the project on the environment.

The Screening Committee then determines if the development could have a significant environmental impact. The process allows for examination of both environmental and related social effects of developments. The Screening Committee may decide that:

- the proposal would have no significant impact and therefore may proceed without further assessment;
- that the proposal could have significant impact and requires further assessment and review; or
- that the proposal is deficient and that submission of another project description is necessary.

Proposals requiring further assessment and review are referred to the Environmental Impact Review Board. The Review Board evaluates the information it receives and recommends to the government body having the power to authorize the proposal, whether or not the development should proceed. The Review Board may also recommend terms and conditions of approval, including mitigative and remedial measures, or further assessment of the proposal.

The responsible government authority then determines whether the development may proceed, whether it requires further impact assessment and review, and whether it accepts or wishes to modify the recommendations of the Review Board. The final decision of the government authority must be transmitted to interested parties and be made public.

**Environmental Information Requirements**

The validity and effectiveness of any environmental assessment depend greatly on the quality and availability of information about the environment within which the project will be carried out Accurate and pertinent information is essential for predicting the likely effects of a proposal on the environment; for assessing the significance of these effects: and for monitoring actual effects during construction and operation, and following completion. Information is usually required in a wide variety of subject areas such as on wildlife, fisheries, vegetation, water resources, socio-economic factors and cultural values/traditions, to name just a few.

Equally important is the need to make this information available to those who wish or need to participate in the assessment process. For any given project, the necessary information may reside with many different sources including studies specifically undertaken for that project, government data bases, and the personal knowledge and experiences of people living within the area. In the ISR, one of the important holders of information are Hunters and Trappers Committees.

Other holders of information include:

- committees:
- individuals;
- departments of the Territorial Governments;
- federal government departments: and
- industry

**Making** the appropriate information available to those who need it, when they need it, and in the required format, is a substantial challenge.

## 3. Computer Technologies In the ISR

**The use** of computer systems is rapidly growing within the ISR. Computer technology is largely microcomputer (PC) based and is focused on data base management systems (DBMS) and geographic information systems (GIS) applications. Most uses of computer systems are for specific purposes and

projects and, reflecting normal early stage computing, there is limited coordination and no integration of systems.

Community level computing is limited to several Community Corporations who are using PCs for office administration purposes.

Representative computer projects include:

The Regional Land Use Planning Division of the Department of Renewable Resources of the GNWT uses the SPANS GIS and provides administrative and technical support out of Yellowknife to the three Regional Land Use Planning Commissions.

The Mackenzie Delta/Beaufort Sea Regional Land Use Planning Commission has recently completed its land use Plan Options Study, in part using the Yellowknife GIS above.

The Joint Secretariat in Inuvik is using a PC-based data base management system to manage the results of its on-going harvest study.

The Joint Secretariat has installed the SPANS GIS although it is not operational. It is planned to use the system in conjunction with the harvest information.

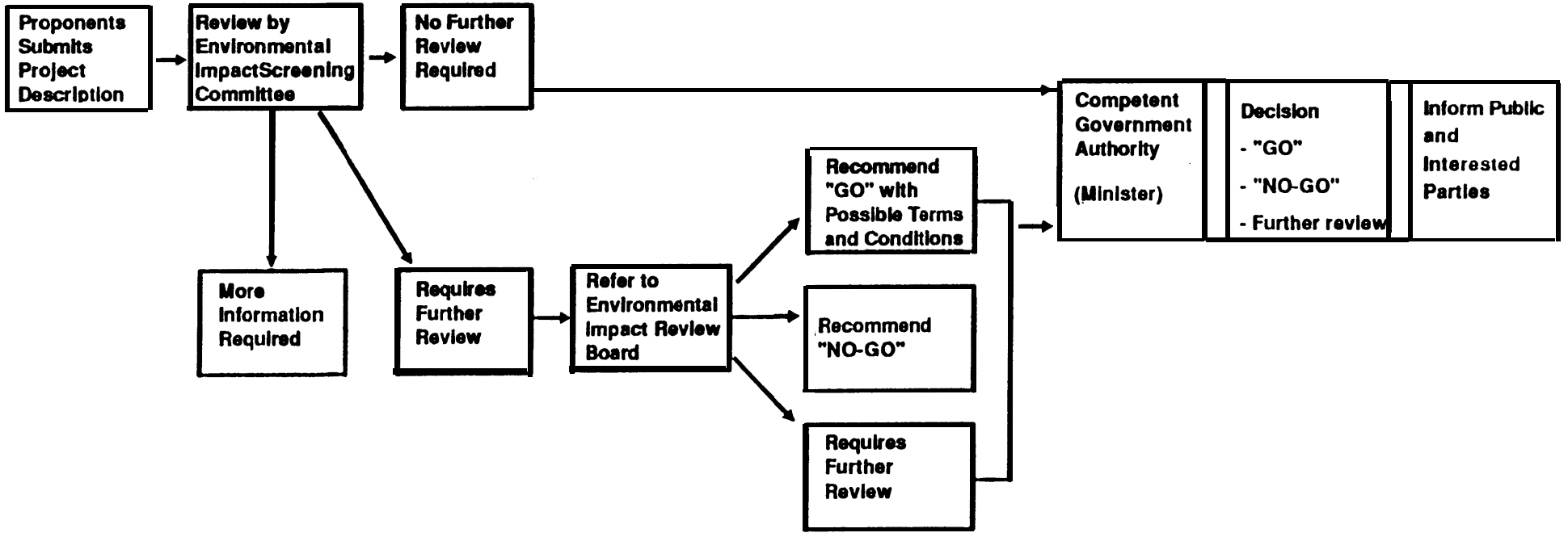
The Inuvialuit Land Administration office in Tuktoyaktuk is using the PAMAP GIS system to digitize baseline maps and capture non-federal land use data There have been difficulties in compatibility between new releases of the software.

Under a Technology Enhancement Program agreement, EMR's Canada Centre for Remote Sensing and the GNWT Department of Renewable Resources are jointly operating a remote sensing technology centre in Yellowknife. Nine demonstration projects are active. A major part of the program deals with GIS.

A project of potential interest is underway in the North Slope Borough in Alaska. GIS technology has been installed and a range of information (land use, traditional knowledge, 16 classes of wildlife) has been captured through community involvement.

## ENVIRONMENTAL IMPACT

## SCREEN AND REVIEW PROCESS




- Baseline Monitoring
- Predicting Impacts
- Assessing Impact Significance
- Evaluating Proposal
- Evaluating Proposal
- Public Consultation
- Monitoring Compliance Mitigation

Ardic College is establishing a GIS curriculum.

The Dene Cultural Institute is embarking on a project to collect traditional environmental knowledge and investigate ways of using expert systems to capture and apply the knowledge.

There is a wealth of data (wildlife, fisheries, land use, traditional ecological knowledge, etc.) contained in various studies and research reports whose value is lost without proper cataloguing and integration of data

In most cases, there is, or has been, strong community involvement in the gathering of data. Is there value in accessing these systems for community based EIA?.

4. Patentlal Use of Technology

Within the ISR and community-based EIA, the opportunities to apply computer technology are compelling. A sample of technologies which are now stable and can operate on microcomputers includes:

## Geographic Information Systems (GIS)

GISs permit the storage, management and manipulation of geographic data such as is found on maps and charts. A GIS facilitates the input, storage, modification, display, analysis and merging of this data.

A GIS can be used to capture traditional environmental knowledge, to display land use, wiidlife patterns, harvest information and devebpment project plans.

## Data Base Management Systems (DBMS)

DBMSs allow the input, storage and retrieval of large amounts of similar data such as harvest data, permits, names and addresses, descriptions of reports and studies, etc. Once data has been loaded Into a DBMS, it is not difficult to generate reports of the data and to perform analysis. Most common DBMSs can pass data to a GIS for display.

A DBMS could be used to store and report harvest data as is being done by the Joint Secretariat. It could be used to set up a reference directory of studies which have been performed in the region or of names and addresses of experts who may be contacted for assistance.

### Decision Support Systems (DSS)

DSSs are systems which permit the analysis of information and data to assist in the making of decisions. They generally allow the changing of the data to see what the effect of the changes would be on the overall problem. A DSS could be a spreadsheet program, allowing what-if questions, or a complex computer model which might simulate the effects of an oil spill.

DSSs could assist the community in analyzing the potential impacts of a proponent's development plan and allow for the modification of aspects of the plan to see what the new effects of alternatives might be. Because a computer is used, it is easier to produce and retain documentation of the analysis which was performed.

### Models and Simulation

Models and simulation allow a computer to be programmed to behave the way a specified machine, plant or element of the environment might act. This allows the computer to show what might happen if something was done to the item that has been modelled. For example, if the computer was programmed to know of the ties, currents and land formations of a stretch of river and it was programmed to understand how oil behaved in water, the computer could show what might happen if an oil spill occurred.

A model could be programmed to show an area of land in the region, as well as our best understanding, for example, of caribou responses to certain types of developments. Details of a proponent's project could then be input and the system could predict what the effects might be on caribou migration patterns or foraging activity.

### Expert Systems

Expert systems, or knowledge-based systems (KBS), is new technology which allows the computer to be programmed to give advice the way a human expert in a specific area would. KBSs can capture the rules

and experience that an expert would appiy in analyzing a situation. A KBS has a further characteristic of being able to explain or show the reasoning which was applied to the problem and therefore has significant training value.

Within the community, expert systems could be used to capture the knowledge of the eiders and allow it to be applied to the analysis of development proposals. The ability of expert systems to explain the applied reasoning could assist in the communication of community knowledge to the young people.

Expert systems might also be used to access specific knowledge not available in the community, but required for the assessment of proposals.

**Public Access Databases**

To a greater and greater degree, information and data are being stored on computer systems. Holders of this information are also increasingly making this information available to interested parties. Advancing technology is making the access to this data a simpler task through easy to use query languages, better communication technology and greater processing power in the microcomputer. There are a growing number of data bases containing information relevant to EIA and several of the active computer projects in the ISR will likely permit third party access.

Computerized access to data bases will provide the community with more information to appiy to assessments. It will also provide an easier method of using the information than current paper-based methods.

Will the application of these and/or other computer technologies be of utility in the community?

**5. Questions**

The following questions should be considered at the meeting:

EIA Process and Information Needs

1. Is the EIA process well understood?

2. Who are the major participants and holders of information in the EIA process?

3. What is the nature of the information and in what form is it available?

4. What are the information needs of the community? Is the information available?

5. At what points in the EIA process is the information required?

6. How does the community currently access information, are there constraints? Is there a need to link communities to share information?

7. Are there barriers to the sharing of information?

Use of Computers

8. Are reports the best way of making information available? Can computers help in presenting information in easier to understand, graphical forms?

9. How is traditional community-based environmental knowledge referenced and accessed? Is it being lost? Could expert systems be used to preserve this knowledge?

10. What is the level of knowledge of computers in the community? Is any computing done?

11. What are the training needs? Are there special approaches? What are the young people learning in school? Can the local schools and colleges provide the training?

12. What are the physical issues related to computers in the community, electrical power, telephone lines?

13 How would computers and software be maintained?

14. What are the issues and difficulties in keeping data up to date and making sure it is accurate (data management)?

15. Can or should the current computer projects be integrated or coordinated?

16. Is there need for a central computer technology processing facility?

17. Can useful pilot or demonstration projects be identified which would be of value to the community and the HTC's?

# APPENDIX 3

# PRESENTATION MATERIALS - EIA

# MEETING TO DISCUSS THE APPLICATION OF COMPUTER TECHNOLOGY TO EIA IN THE ISR

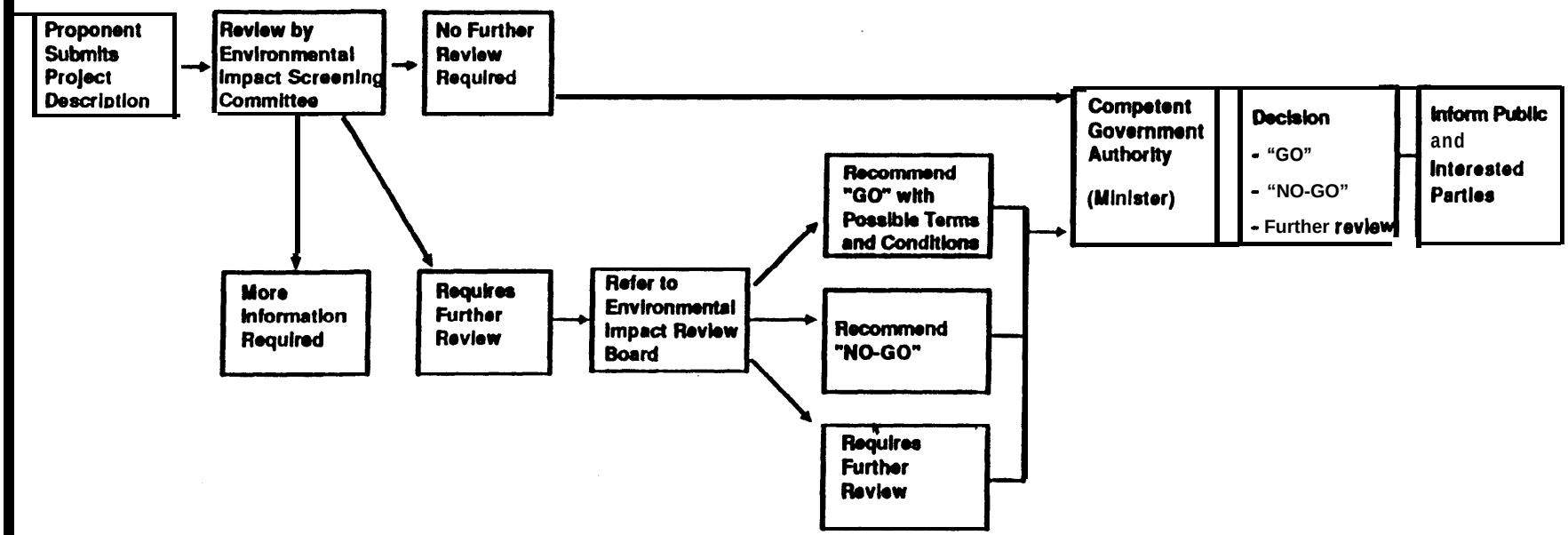
INUVIK, FEBRUARY 27-28, 1990

## A FEASIBLE RESEARCH AGENDA?

CANADIAN ENVIRONMENTAL ASSESSMENT RESEARCH COUNCIL

## ENVIRONMENTAL IMPACT

## SCREENING AND REVIEW PROCESS




- Baseline Monitoring
- Predicting Impacts
- Assessing Impact Significance
- Evaluating Proposal
- Evaluating Proposal
- Public Consultation
- Monitoring Compliance and Mitigation

# TYPES OF PROJECTS

- OCEAN DUMPING
- ROADS
- SEISMIC SURVEYS
- DREDGING
- TRANSMISSION LINES/CORRIDORS
- QUARRYING
- SEWAGE TREATMENT
- OIL AND GAS EXPLORATION AND DRILLING

# INFORMATION REQUIREMENTS

- PROJECT INFORMATION
- LAND USE
- HARVEST PATTERNS
- COMMUNITY INFORMATION
- CULTURAL VALUES
- ECONOMIC FACTORS
- NATURAL ENVIRONMENT

# NATURAL ENVIRONMENT

- VEGETATION
- WILDLIFE
- FISHERIES
- WATER RESOURCES
- GEOLOGICAL INFORMATION
- METEOROLOGICAL DATA .
- SEA CHARACTERISTICS

# HOLDERS AND USERS OF INFORMATION

- INDIVIDUALS
- HUNTERS AND TRAPPERS COMMITTEES
- WILDLIFE MANAGEMENT ADVISORY COMMITTEES
- TERRITORIAL GOVERNMENT DEPARTMENTS
- FEDERAL GOVERNMENT DEPARTMENTS
- INDUSTRY
- OTHERS

# QUESTIONS

- WHO ARE THE PARTICIPANTS AND HOLDERS OF INFORMATION IN THE EIA PROCESS?
- WHAT IS THE NATURE OF THE INFORMATION
- WHAT FORM IS IT IN?
- WHAT ARE THE INFORMATION NEEDS OF THE COMMUNITY?
- ARE THERE BARRIERS TO SHARING INFORMATION?
- WHAT IS THE BEST WAY OF MAKING INFORMATION AVAILABLE?
- CAN COMPUTERS HELP?

# APPENDIX 4

# PRESENTATION MATERIALS - COMPUTER TECHNOLOGIES

# REPRESENTATIVE TECHNOLOGY PROJECTS

- REGIONAL LAND USE PLANNING
  - GIS

- LAND ADMINISTRATION
  - GIS

- HARVEST STUDY
  - DBMS, GIS

- REMOTE SENSING - TECHNOLOGY ENHANCEMENT PROGRAM
  - GIS

- ALASKA
  - GIS

- ARCTIC COLLEGE
  - GIS CURRICULUM

- DENE CULTURAL INSTITUTE
  - TRADITIONAL ENVIRONMENTAL KNOWLEDGE

SCIENCE INSTITUTE
- RESEARCH CAPABILITY

# DATABASE MANAGEMENT SYSTEMS (DBMS)

- INPUT
- STORE
- UPDATE
- RETRIEVE AND REPORT
- TEXT AND NUMERIC
- DBASE, CLIPPER

# GEOGRAPHIC INFORMATION SYSTEMS (GIS)

- INPUT
- STORE
- UPDATE
- DISPLAY, GRAPHICS
- GEO-REFERENCED DATA
- CAN LINK TO A DBMS
- SPANS, QUICKMAP, PAMAP

# DECISION SUPPORT SYSTEMS (DSS)

- ANALYZES INFORMATION
- CHANGE CONDITIONS TO SEE EFFECT - "WHAT IF"
- DIFFERENT ANALYTIC METHODS
- ACT ON DATA IN A DBMS
- LOTUS I-2-3, STATISTICAL PACKAGES

# SIMULATION MODELS

- **MODELS OF A LIMITED DOMAIN**
- **CHANGE CONDITIONS TO** SEE EFFECT
- **OPTIMIZE**
- **CUSTOM DEVELOPMENT**

# EXPERT SYSTEMS (ES)

- DUPLICATE HUMAN REASONING IN A LIMITED DOMAIN
- CAPTURE KNOWLEDGE, EXPERIENCE, RULES OF THUMB
- PROVIDE EXPERT ADVICE
- COMBINE DIFFERENT SOURCES OF EXPERTISE
- MULTIPLIES THE ACCESS TO EXPERTS

# PUBLIC ACCESS DATA BASES

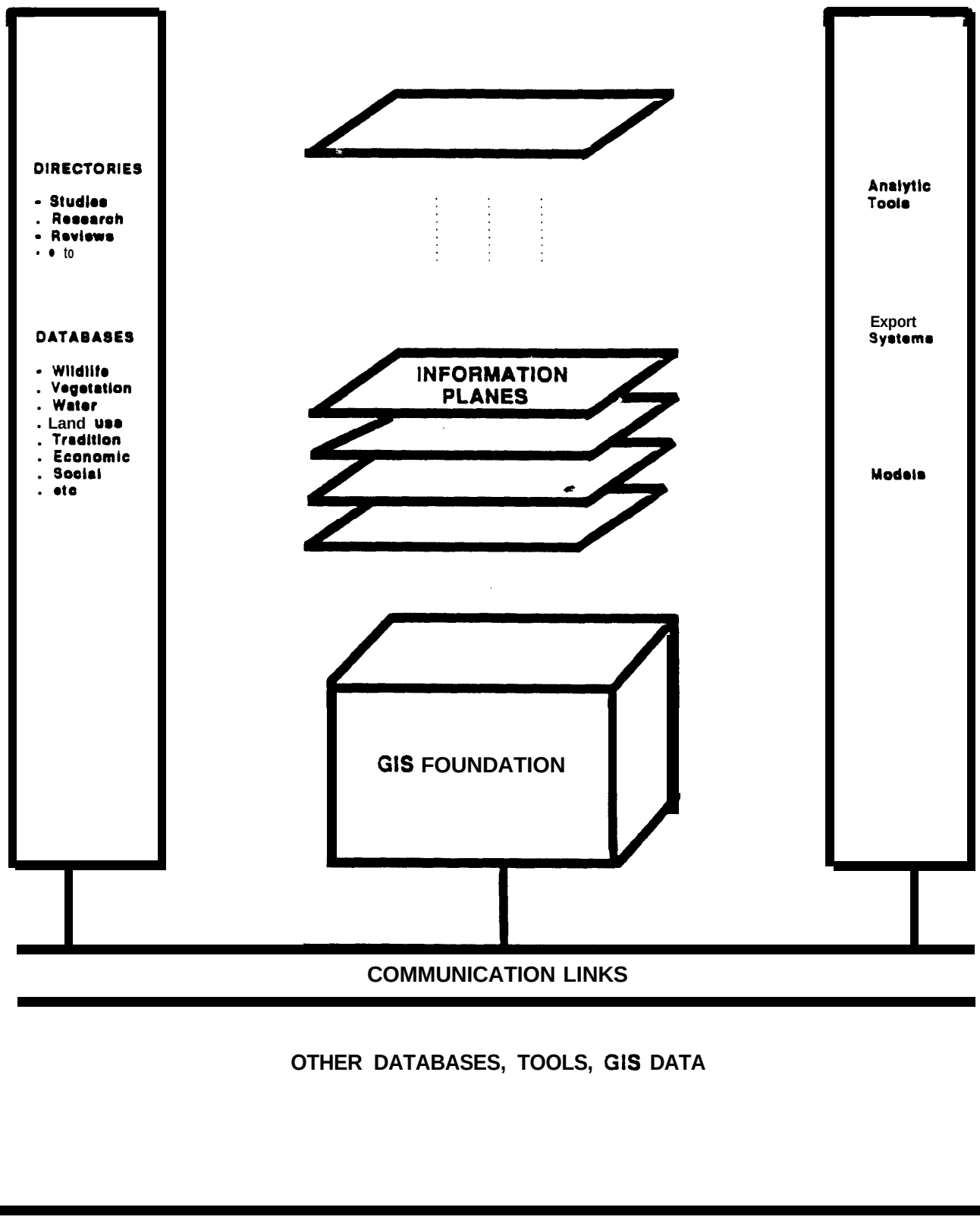
- GROWING AVAILABILITY OF INFORMATION RESIDENT ON COMPUTERS
- REQUIRE A COMPUTER TO ACCESS
- REQUIRES COMMUNICATION FACILITIES

# OTHER TECHNOLOGIES

- WORD PROCESSING
- DESK TOP PUBLISHING
- STATISTICAL ANALYSIS

PRESENTATION GRAPHICS

# AN EIS TECHNOLOGY MODEL



# ISSUES

- COMPUTER AWARENESS
- TRAINING
- MAINTENANCE AND SUPPORT
- POWER
- COMMUNICATIONS
- DATA MANAGEMENT
- COORDINATION
- USER INTERFACES, PRESENTATION METHODS
- FUNDING

# APPENDIX 5

# DATA ASSESSMENT DIVISION PROGRAMS

# DATA ASSESSMENT DIVISION PROGRAMS: BACKGROUND AND STATUS

1. Arctic Data Cataloguing and Appraisal (ADCAP)
   West Coast Data Cataloguing and Appraisal (WESCAP)

2. Arctic Industrial Activities Compilation (AIAC)

3. Oceanographic Data Information System (ODIS)

Prepared by

Brian D. Smiley
Institute of Ocean Sciences
Fisheries and Oceans Canada
P.O. Box 6000
Sidney, British Columbia V8L 4B2

(telephone: 604-356-6551)

## A. ARCTIC DATA CATALOGUING AND APPRAISAL PROGRAM (ADCAP)

* growing demand for "one stop" directories to existing oceanographic information.

* scientists, engineers, assessors, regulators and others ask --

"What data have been collected by whom, when and where??"
"How reliable are these data??"
"In what form and where can these data now be found??"

* initiated in 1979 by the Institute of Ocean Sciences

* cooperative work
with the Freshwater Institute (DFO), since 1983.

* OBJECTIVES:

- To compile and examine the available documentation of all historical oceanographic studies (data sets), mainly in Canada's Arctic waters.

- To appraise the reliability of the measurements, based on objective scrutiny of documentation -- (evaluate the reported methods and materials employed in collection, storage and analysis)

- To summarize pertinent details of each data set: in published catalogues -- (overviews, tables, maps, indexes, references)

- To archive in an interactive, geo-referenced computer database (ODIS) with maps, station/data set reports

* inventoried all existing data:

- published and unpublished
- raw or analyzed
- public and proprietary
- governments, industry and universities

* commenced with physical oceanographic data:

- water temperature
- salinity
- ocean currents speed and direction
- water levels
- wave heights and directions

* proceeded to chemical oceanographic data:

- nutrients
- dissolved oxygen and pH
- heavy metals
- oil-related hydrocarbons
- organochlorines
- synthetic organics
- particle or grain size
- pigments and so on

* finally tackled biological oceanographic data:

- bacteria, ice algae and plankton
- zoobenthos
- marine and anadromous fishes
- seals and other pinnipeds
- toothed and baleen whales

* priority given to Beaufort Sea and Northwest Passage areas

* an example list of catalogued/appraised measurements is as follows: taken from Beaufort Fish catalogue -- Ratinsky et al. 1988)

Number
no. in gillnet
no. in seine
no. in trawl/trawl
no. in bottom grab
no. in plankton net
no. in commercial fishery
no. killed by poison
no. killed by explosives
no. caught on longline
no. counted from sonar scans

Morphometrics
length -total
length -standard
length -fork
weight
meristics eg. no. of caecae/gill rakers

Age
no. of annuli, scale
no. of annuli otolith
no. of annuli: fin ray
no. of annuli, operculum

Reproduction
testes, p/a
testes, rel.developm.stage
testes, length or girth

testes, volume
no. of eggs
egg diameter

Food
gut contents, % full
gut contents, weight
gut contents, volume
gut contents, no. of food items

* devised a data rating system.

* based on judged sufficiency of available documentation concerning methods and materials.

* picked fundamental criteria which are common to most applications.

* applied to each type of measurement or observation in every data set.

* assigned ratings to assist the user in making own judgment about the usefulness of existing data.

* applied same five rating categories to all disciplines

| RATING | DEFINITION |
|---|---|
| 0 | Data are found or judged to be wrong |
| 1 | Data are suspect & probably not internally consistent; trends within the data set are probably not real. |
| 2 | Data were not or could not be investigated; insufficient documentation is available for appraisal. |
| 3 | Data are internally consistent; trends within the data set are probably real; comparison with other data may be difficult or impossible. |
| 4 | Data are internally consistent; they are sufficiently standardized or tied to a reference; comparison with other "4" rated data should be possible. |

* carried out under contract to experienced and reputable companies/individuals.

* relies on expertise and guidance of DFO research scientists, especially for data rating criteria and quality control.

* expected inventory of 95% or better of all data sets. (about 700 data sets with 600 different measurement types)

* total cost about one million dollars ($150,000 per year). (or about $50,000 per published catalogue)

* funding sources from DFO, PERD, NOGAP, FJMC and DOME

* directories published as volume series in Can. Data Report of Hydrography and Ocean Sciences No. 5.

* hard copies of many data sets archived in Technical Records at Institute of Ocean Sciences.

* same approach in progress to catalogue and appraise existing oceanographic data of British Columbia's Pacific waters (program called WESCAP).

* status of ADCAP/WESCAP catalogues

3

| Region / Discipline / Volume (period) | Status (Jan. 1990) Compile | Appraise | Publish |
|---|---|---|---|
| **BEAUFORT SEA** | | | |
| Physics | | | |
| Vol. 1 (1935-1981) | complete | complete | 1982 |
| Vol. 12 (1935-1986) | complete | complete | 1987 |
| Chemistry | | | |
| Vol. 2 ( ) | complete | complete | 1982 |
| Vol. 20 (1950-1988) | draft | draft | 1990 |
| Plankton | | | |
| Vol. 9 (1913-1986) | complete | complete | 1987 |
| Zoobenthos | | | |
| Vol. 11 (1914-1986) | complete | complete | 1987 |
| Marine fishes | | | |
| Vol. 15 (1896-1985) | complete | complete | 1987 |
| Seals | | | |
| Vol. 8 (1823-1985) | complete | complete | 1986 |

| | | | |
|---|---|---|---|
| Whales | | | |
| Vol. 10 (1848-1983) | complete | complete | 1986 |
| Vol. 24 (1848-1989) | -- | -- | 1990 |
| QUEEN ELIZABETH ISLANDS | | | |
| Physics | | | |
| Vol. 6 (1948-1980) | complete | complete | 1983 |
| Vol. 21 (1948-1989) | draft | draft | 1990 |
| Chemistry | | | |
| Vol. 16 (1952-1985) | complete | complete | 1986 |
| Marine Fishes | | | |
| Vol. 17 (1819-1985) | complete | complete | 1988 |
| NORTHWEST PASSAGE | | | |
| Physics | | | |
| Vol. 3 (1908-1982) | complete | complete | 1983 |
| Vol. 14 (1908-1986) | complete | complete | 1987 |
| Chemistry | | | |
| Vol. 4 (1928-1981) | complete | complete | 1983 |
| Vol. 22 (1928-1988) | draft | draft | 1989 |
| Zoobenthos | | 4 | |
| Vol. 23 (1936-1982) | draft | -- | 1991 |
| Marine fishes | | | |
| Vol. 17 (1819-1985) | complete | complete | 1988 |
| Seals | | | |
| Vol. 19 (1835-1985) | complete | complete | 1989 |
| NORTHWEST PASSAGE | | | |
| Whales | | | |
| Vol. 13 (1820-1984) | complete | complete | 1987 |
| CANADA BASIN AND ARCTIC OCEAN | | | |
| Physics | | | |
| Vol. 7 (1883-1983) | complete | complete | 1984 |
| Chemistry | | | |
| Vol. 18 (1926-1983) | complete | complete | 1986 |
| BAFFIN BAY | | | |
| Physics | | | |
| Vol. 5 (1900-1981) | complete | complete | 1983 |

QUEEN CHARLOTTE SOUND/HECATE STRAIT/DIXON ENTRANCE

| | | | | |
|---|---|---|---|---|
| Physics | | | | |
| Vol. 1 | (1903-1984) | complete | complete | 1985 |
| Vol. 3 | 1937-1984) | complete | complete | 1986 |

WATERS WEST OF VANCOUVER ISLAND AND QUEEN CHARLOTTE ISLAND OUT TO 200 MILE FISHERY LIMIT

| | | | | |
|---|---|---|---|---|
| Physics | | | | |
| Vol. 2 | (1905-1984) | complete | complete | 1986 |

STRAIT OF GEORGIA AND ADJOINING WATERSQ

| | | | | |
|---|---|---|---|---|
| Chemistry | | | | |
| Vol. 4 | (1926-1983) | draft | -- | 1991 |

* plan to revise and update catalogues every five years or so.

* Catalogue references in the ADCAP series

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Published (as of February 1990):

Volume 1.
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## B. ARCTIC INDUSTRIAL ACTIVITIES COMPILATION PROGRAM

* imperative to have complete, reliable log of major activities of offshore oil and gas development.

* such information is:

  of varying completeness,
  in different formats and detail, and
  scattered amongst several agencies and companies.

* inventory initiated by Institute of Ocean Sciences, in 1982.

* carried out in cooperation with federal regulatory agencies such as:
  DIAND (Dept. Indian Affairs & Northern Development)
  COGLA (Canada Oil and Gas Lands Administration)
  EPS (Environmental Protection Service)

* conducted by university students and research contractors.

* published as catalogues (overviews, tables, maps, listings) in

  Can. Data Report of Hydrography and Ocean Sciences No. 32.

* for some activities, microcomputer versions also available as menu-driven, geographical databases.

* compilations completed/in preparation:

Marine dredging in Canadian Beaufort Sea (1959-83)
Seismic/drilling activities in Canadian High Arctic (1974-84)
Drill waste discharges in Canadian Arctic (1973-85)
Vessel/aircraft traffic in Canadian Beaufort Sea (1980-86)

1. Marine Dredging in Canadian Beaufort Sea

   - over 100 operations authorized from 1959 to 1983.
   - almost 50 million cubic meters of clay, sand & gravel.
   - construction of harbours and piers, navigation channels, artificial islands, glory holes, hamlet landfill, etc.
   - mainly using suction hopper dredges in August-September.

- details about:

  company
  dredge name and type
  year, start and stop date(s)
  purpose
  load area name
  latitude(s) and longitude(s)
  water depth(s)
  dump method
  sediment type
  load and dump volumes

2. Seismic Surveys and Well Drilling in the Sverdrup Basin

- over 45 seismic surveys logged nearly 25,000 km (75% from offshore sea ice) from 1974 to 1984.

- 80 wells (31% spudded offshore) for exploration and delineation, majority commissioned by Panarctic Oil

- details include:

  proponent
  well name & number
  survey period
  spud & release date
  latitude(s) and longitude(s)
  camp and sump information
  access road & airstrip requirements
  vehicles and major equipment
  well depth/survey distance
  drill mud components

3. Chemical Drill Waste Discharges in Offshore Canadian Arctic

- compiled well histories and drillwaste discharges for 151 drilling sessions at 109 wells from 1973-1985, in Can. Beaufort Sea, Sverdrup Basin and Davis Strait.

- transcribed/standardized drill fluid nomenclature, units and quantities from 7,000 records.

- IBM/PC computer database (8 megabytes).

- allows interactive searches and plotting by:

  region
  well name and identification
  well status (dry, abandoned, suspended, etc)
  contractor and operator

drill mud type and fluid additives
discharges within prescribed distance
water depth
month and year
drill rig type

- enables simple statistical analyses,
but limited by data's poor quality and incompleteness.

4. Vessel/Aircraft Traffic and Seismic Surveys in the Canadian Beaufort Sea

- compiled operational details concerning:

vessel movements
(supply boats, dredges, icebreakers, tugs, barges, and drillships),

helicopter/fixed wing traffic
(scheduled or charter, onshore/offshore and offshore/offshore, ice reconnaissance),

associated with:

dredging
exploratory drilling
seismic and sounding surveys
island/camp maintenance and resupply
contingencies and emergencies

- relies on 10 day activity summaries from 1980-86,
sponsored by U.S. Mineral Management Surveys and
Can. Dept. of Indian and Northern Affairs,
part of the effects studies of marine industry on bowheads.

- analyzed tabulated, graphed and plotted all activities
and published as one catalogue in 1989.

## C. OCEANOGRAPHIC DATA INVENTORY SYSTEM (ODIS)

* geo-referenced computer directory.

* menu-driven, no special computer skills needed.

* pertains to all known historical oceanographic data
in selected Canadian Arctic and British Columbia marine waters.

* divulges a subset of the ADCAP and WESCAP catalogue information.

* permits rapid searches about:

"who collected/observed what, where, when and how"
(or how complete and reliable are existing data)

* also provides status and availability of the data.

* began in 1981 at Institute of Ocean Science.

* evolved from computer-drawn maps for catalogues.

* realized awkwardness of many bulky, sing1 e-discipline catalogues.

* recongized advantages in computer revision and updating.

* developed under contract to:
  Interact R&D
  Arctic Sciences Ltd.
  Seakem Oceanography
  Solo Micosystems

* allows the user to search for data stations or survey transects,

  by:
  -geographic area
  -discipline
  -data type (measurements)
  -sampling depth
  -year and month
  -sampling or analysis method
  -data quality rating

* permits plotting/printing of stations and transects
  on a computer-drawn map.

* provides a custom Station report and general Data Set report
  pertaining to the data searched and selected.

* output can be routed to:

  -- a printer connected to the user's terminal
  -- downloadable files
  -- laser printer at IOS

* enables the user to quickly refer to the catalogues
  using the unique dataset ID numbers

* a combination of:

  ORACLE database management system
  Sequentially indexed files (accessed through FORTRAN routines)
  DISSPLA mapping/plotting software

* resides on Digital MicroVax II computer.

# APPENDIX 6

# TRADITIONAL KNOWLEDGE RESEARCH PROPOSAL

## 1. KNOW-TEK - A Research Proposal

A proposal to develop knowledge based systems for traditional environmental knowledge.

## 2. Background and Objectives

For thousands of years, aboriginal peoples around the world have utilized the natural resources of their local environment in an ecologically sustainable manner. Only recently, has this knowledge, built up over generations of careful observation and experience, become recognized among the western scientific community as a valuable source of ecological information. Variously labelled as folk or ethno-ecology, traditional environmental/ecological knowledge or customary law, a growing body of literature attests not only to the presence of a vast reservoir of information regarding plants and animal behaviour, but also to the existence of effective indigenous systems of self-management which rely upon a sophisticated data base to determine strategies for conserving natural resources.

Within Canada, research incorporating traditional knowledge was part of several land use and occupancy studies in the Northwest Territories and Labrador during the late 1970's. Since the late 1970's, research in the Canadian North has turned to understanding indigenous systems of self-regulation and conservation practices, and to investigating the possibilities of indigenous self-management of fish and game resources. Much of this interest has stemmed from the increasing conflict and competition between Native and non-Native interests in resource use, particularly hydro-electric power development in Northern Quebec.

Recognition of traditional knowledge at various levels of government is also beginning to happen. for example, the Government of the Northwest Territories (1988) recently affirmed that decisions about resource management and development "will reflect the traditional knowledge which can be found in our Northern communities". In keeping with this policy, the territorial Department of Renewable Resources (1988) has identified one of its goals as "maximum involvement of local residents and the maximum use of their knowledge in renewable resource programs".

On the international scene the 1980 World Conservation Strategy followed by the 1987 Brundtland Report focused worldwide attention on the global environmental crisis and called for sustainable development. Part of the means to achieve this goal is to involve local people in the creation of a resource management system that would integrate traditional knowledge and western science.

The Dene Cultural Institute has taken steps to preserve the traditional environmental knowledge of its people through the development of a community-based research project, The Dene Traditional Environmental Knowledge Pilot Project. Community-based research involves the active participation of community members in setting research priorities and the training of local people to carry out all phases of the research process. In carrying out this research the Institute hopes to demonstrate ways in which traditional environmental knowledge can be effectively integrated with western science and utilized at the community level for resource management.

An underlying premise of the research is that an adequate understanding of the natural and social environment is necessary for the achievement of sustainable development. Assessing changes in the environment and predicting impacts on the environment from human activities requires access to information acquired over many years. The people best able to assess these impacts are those who have for generations depended upon the natural resources of an area for their livelihood. Whether the process is land use planning, environmental assessment or wildlife management, there is a need for an up-to-date data base within each community to provide ecological information about the area. Local residents must have ready access to this information in order to make informed decisions about industrial development and environmental management. Further, once a proposed activity goes ahead environmental impacts must be monitored. Again, this responsibility is best carried out by the community who can observe impacts first hand and update the data base as required.

The documentation and application of Dene traditional environmental knowledge is a formidable undertaking given the extent of the knowledge, the vast area that must be covered and the different languages and sub-cuttures involved. Despite research efforts to date, there remains a limited understanding of how indigenous systems of resource management operate today. Further, attempts to apply traditional knowledge exist primarily at the level of consultation (i.e., the participation of hunters and trappers on wildlife management boards) where western science remains the dominant paradigm and control of the information rests primarily with government organizations. For these reasons, the Dene Cultural Institute has established a pilot project in the community of Ft. Good Hope to develop methodology for both the documentation and the application phases of research before expanding into the other regions of Denendeh.

The first phase of the pilot project focuses on developing the methodology for gathering the information (i.e., interview techniques and questionnaire design). The results of this preliminary data collection should provide a basic understanding of the extent of traditional knowledge that exists in the community today including how the system of traditional management operates. This stage of the pilot project has been underway in the community since August 1989 and is intended to last one year. Questionnaires have been formulated about the ecology and traditional rules for hunting beaver, marten, caribou and moose. Local researchers have received training in basic ecology and social science research.

**Objectives**

The problem to be addressed after the first phase has several dimensions:

- How does one manage, maintain and access the knowledge and data captured through questionnaires and interviews;
- How does one extract knowledge from text and anecdotal sources; and
- How does one access information and knowledge in a cultural setting that is largely based on verbal communication.

The second phase of the research will examine the application of computer technology, specifically artificial intelligence (AI) and geographic information systems (GIS), to the management of traditional knowledge data. The objectives of the second phase are:

- To understand and classify traditional knowledge in a limited domain (Ft. Good Hope, one species of wildlife);
- To design appropriate knowledge representation methods and to design software or employ commercial tools to capture, maintain and access a limited domain of knowledge;
- To investigate user interface methods likely based on iconic principles and GIS technology;
- To integrate this research into a proof of concept system which will couple expert systems technology to GIS presentation methods in a limited domain; and
- To draw general conclusions from the experience and develop a strategy for further implementation of the system in other domains and northern communities.

3. **Government Operations**

The improved application of traditional environmental knowledge to sustainable development and environmental management in the North is an objective of all levels of government. This project may serve to dramatically improve the accessability of this knowledge and greatly improve the efficiency with which community groups can apply their knowledge. Indeed, the very survival of traditional environmental knowledge may be at risk without projects of this nature. The ability to improve the understanding of traditional knowledge will assist all departments involved in native affairs and may enhance our understanding of other cultures, potentially of interest to CIDA and External Affairs.

4. **Industrial Competitiveness**

The potential to enhance industrial competitiveness falls in two areas. There will be improvement in the ability to produce project designs which are more likely to meet sustainable development objectives through the application of fundamental and frequently unavailable, disregarded or misunderstood traditional knowledge. The growing international concern for the preservation and management of traditional environmental knowledge provides a **ready** market for Canadian services and products which will derive from this project and provides an opportunity for a leadership role for the native participants. It is significant that the Dene Cultural institute will be hosting an international conference in July, 1990 to discuss the presentation of traditional knowledge with international native groups.

Interest in the project has also been expressed by several corporations in the oil and gas sector. There is recognition that improved access to traditional knowledge on the part of the community may lead to faster and more consistent decision making, with a reduction in proposal costs to proponents of projects. Furthermore, if traditional knowledge and decision making logic were released to industry, projects could be pre-screened against these factors, resulting in improved project design.

**5. Canadian Economy**

In addition to the export potential described above, the use of expert system technology, with its explanation capabilities, provides a facility to pass on to the younger generation the traditional knowledge which is essential to the richness and uniqueness of the culture. Traditional knowledge is gaining rapid

recognition as an essential component of the comprehensive base of knowledge required for effective natural resource management.

## 6. Description of the AI System

The proposed project will produce a proof of concept expert system which will permit the capture, management and application of traditional environmental knowledge in a limited domain (say caribou, Ft. Good Hope area) to environmental impact assessment questions. The system will, to the maximum degree practical, permit the display of its advice and conclusions in iconic or map based formats.

The AI component will aid the extraction of rules or the development of frames from anecdotal and questionnaire based information. It will permit the application of this knowledge to situations of environmental impact (if this happens, what will be the impact on the caribou and why) and it should allow for the presentation of these conclusions using icon and map based methods.

AI is felt to be the critical component of the required technology because the problem involves recognized expertise, which is largely based on heuristics and anecdotes which is rapidly becoming scarce, which has recognized experts in the elders of the communities and which is not easily passed on. Conventional algorithmic methods would likely fail.

The project involves state of the art technology in that no previous attempts have been made to understand, classify, and capture traditional knowledge which is distinct from the formalisms of scientific environmental knowledge. Significant challenges also lie in the development of an effective user interface which will respond to a user with limited computer exposure and limited comfort with text based communication.

The technology targets and anticipated milestones are:

| | |
|---|---|
| Month 1 | Workshop to launch project, refine objectives, confirm methods. |
| Month I-3 | Analysis of Phase 1 questionnaires and interviews, second pass of interviews to identify environmental impact assessment requirements. |
| Month 4-6 | Detailed knowledge engineering, analysis of knowledge representation methods, selection of software environment. Initial user interface definition. |
| Month 7-8 | Generation of system design, GIS interface specification, user interface specification. |
| Month 9 | Workshop to review design. |
| Month 9-14 | Development of expert system, test and demonstration sequences. |
| Month 15-l 8 | Completion of user interface, GIS integration. |
| Month 19-21 | Prototype testing, demonstration and refinement. |
| Month 22-24 | Evaluation of experience, development of next stage strategy. |
| Month 24 | International workshop to present results. |

**7.** Delivery Capability

The project could be contracted out to a consortium of environmental and technology consultants. A potential team would be Thomas International/Price Waterhouse/Rawson Academy-Resource Futures International. This group has strong technology credentials, extensive northern experience and the international base from which to exploit the experience. The Dene Cultural Institute would provide domain expertise and would coordinate the extensive community involvement required. It is likely that specific knowledge representation research would be referred to a Canadian university such as the University of Toronto. Similarly, the extensive user interface experience of Carleton University would be applicable.

**8.** Domain Expertise

Domain expertise exists within the Dene Cultural Institute and the pilot community of Ft. Good Hope. The Institute will assign its Research Director full time to the project.

Considerable AI expertise exists within Environment Canada although availability would be only part time for review purposes. AI expertise will be drawn from the private sector.

## 9. Costs and Funding

Estimated costs for the project over the anticipated two years are as follows:

| | |
|---|---|
| Project management | $200,000 |
| Knowledge engineering | $200,000 |
| Systems specialists (DBMS,GIS) | $200,000 |
| Domain specialists and honoraria | $200,000 |
| Contracted research | $ 50,000 |
| Travel | $150,000 |
| Computer hardware and licences | $100,000 |
| Workshops | $ 60,000 |
| Administration | $ 40,000 |
| TOTAL (over two years) | $1,200,000 |
| or $600,000 per year. | |

The Dene Cultural Institute is at the forefront of research in the area of traditional environmental knowledge. The successful application of a prototype expert system to capture this fast disappearing reservoir of valuable information has important implications from a cultural, environmental and technological standpoint. Not only does it recognize the contribution a non-western worldview can make to our better understanding of the environment, but it puts management of local resources in the hands of the users through the use of modern innovative technology. This marriage of old and new knowledge and its application at a grass-roots level represents a bold step forward for sustainable development.