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THE CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING

1980 REPORT

Dr. K. Whitham
Chairman
Interagency Committee on Remote Sensing
Department of Energy, Mines and Resources
Ottawa, Ontario

Dear Dr. Whitham,

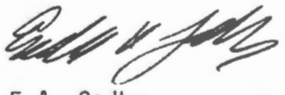
A particularly important result of the 1980 CACRS meeting was the formation of a CACRS Executive with representation from the provincial subcommittee of CACRS, IPTASC, and from the Chairmen of the Working Groups. The Executive is providing a mechanism by which CACRS can be much more involved in the serious issues now facing the remote sensing program: the means of coping with increased costs of services; the better transfer of technology to the provinces; and Canadian involvement in the programs of other countries, considering the number of new satellite systems which will appear in the next decade.

It is worth noting that the theme of the 1980 meeting centered on the provincial input to the national program, rather than concentrating on the federal program as has been the case in the past. This provincial aspect of the program is of increasing importance since it is mainly by the provinces that remote sensing is used for resource management.

This year an attempt was made to provide better communication between IACRS and CACRS. An executive summary of the CACRS report was prepared and officially presented to IACRS, along with the recommendations appropriate for IACRS attention. A follow-up to this CACRS meeting was a presentation to IACRS by a member of the provincial subcommittee, IPTASC.

It is evident that the next decade in remote sensing is going to be far different from the last, with many issues to be resolved. In Canada we are fortunate in having the national organization in place (in the form of IACRS and CACRS) which will allow us to deal with these issues on a truly national basis.

Yours sincerely,



E.A. Godby
Chairman, Canadian Advisory
Committee on Remote Sensing

4 January 1982

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

The following is a summary of the discussions that took place at the annual meeting of the Canadian Advisory Committee on Remote Sensing, which took place in Arnprior, Ont., between April 13-16, 1981.

1.1 OBJECTIVES OF MEETING

1. To examine the role of the Provincial/Regional Centres in the application of remote sensing to resource management.

2 To table and discuss the Recommendations from the Working Groups and IPTASC concerning the Canadian remote sensing program.

3. To complete the process of CACRS reorganization initiated at the 1980 meeting.

- Revised terms of reference

- Establishment of CACRS Executive.

1.2 ORGANIZATION

The participants (see Section 8), representing the Provincial and Federal governments, industry, and the universities, formed five teams (Atlantic, Québec, Ontario, Prairies, British Columbia) to better reflect provincial/regional interests in the area of natural resource management. The major part of the meeting took the form of workshops, during which the teams addressed the various issues from the point of view of their province or region. Results were presented and discussed at plenary sessions.

1.3 RESULTS

Role of the Provincial/Regional Centres

The Atlantic team recommended that a region-wide Maritime Remote Sensing Coordinating Committee be established, to which the Province of Newfoundland would be invited. The region-wide committee would supplement the work of the provincial committees in the areas of applications demonstration, technology transfer, and dissemination of information on federal remote sensing activities in the region.

The Québec team saw for its provincial centre an increased role in the transfer of proven applications techniques to the user community, particularly in the areas of forestry and land use to protect agricultural resources, the development of R&D in universities (particularly in preparation for LANDSAT-D and SPOT), the encouragement of private applications services firms, and on-going user training. The major application areas included forestry, large engineering projects, agriculture and land use in the south (likely to require satellite data with the resolution expected from LANDSAT-D and SPOT). The team also noted the small number of R&D contracts awarded to Québec and suggested political pressure may be required to correct the situation.

The Ontario team was satisfied with the role played by the Ontario Centre for Remote Sensing, but felt that additional resources should be made available to the Centre to improve its ability to carry out R&D, technology transfer and training, in order to meet provincial needs. The team priorities for application plans paralleled the contribution of the main natural resources to the provincial economy, namely forestry, minerals, agriculture and engineering projects, inland waters and fisheries.

The Prairie team felt that the main goal of provincial Centres should be the coordination of provincial activities; the provision of services, advice and training to users; the transfer of technology to government agencies and private industry; assistance to universities in establishing remote sensing courses; the encouragement of R&D. The team noted that the current goals of the Manitoba and Alberta Centres are to keep current on new developments, obtain the necessary data processing equipment and transfer the technology to users. Saskatchewan will attempt to activate a provincial remote sensing committee. The resource information requirements for the Prairies were established as follows: agriculture, mineral exploration, forestry, land information, environmental monitoring. The team recommended specifically that a crop reporting information system be implemented using remote sensing techniques by 1984/85.

The British Columbia team noted that B.C. uses a coordinating committee rather than a Centre. The team felt that some of the roles that would be performed by a Centre are carried out by provincial and federal government departments, universities and private industry in the province. The team stressed the need, however, for a stronger coordinating role for the B.C. Committee, including the employment of at least one person as full-time coordinator and source of technical advice to provincial users.

The team felt that forestry is clearly the prime area of application in the province, followed by mineral exploration, fisheries, engineering projects, agriculture and land use.

1.3.2 MAJOR RECOMMENDATIONS

IPTASC recommendations (in extenso)

a) that CCRS give high priority to arranging for Canadian participation in the SPOT program;

b) that CCRS submit a feasibility study to the CACRS Executive Committee regarding the inclusion of an optical sensor on RADARSAT;

c) that a more equitable ferry charge be applied to the lease arrangement of CCRS aircraft. Further, that the OCRS charge-back formula be investigated as such a mechanism for feasibility and cost recovery;

d) that IPTASC be kept informed on any action taken toward technology transfer with present approved funding and that a method be established whereby this group can have input into future planning;

e) that CCRS bring the MOSAICS system up to an operational stage.

Arnprior workshops and CACRS reports

a) that a crop reporting information system be implemented using remote sensing techniques by 1984/85 (Prairies Workshop);

b) that increased emphasis be placed on applications of remote sensing to oceanographic and near-shore phenomena (Ocean Working Group);

c) that CCRS set up a Maritime (Atlantic) Region office jointly with the proposed Maritime (Atlantic) Remote Sensing Coordinating Committee (Atlantic Workshop);.

d) that decisive action be taken to involve industry in those remote sensing developments which are ready for application (Ontario report).

Organization and administration

a) that a study on Canadian remote sensing programs be carried out and a report prepared (General);

b) that with regard to human resources and representation, issues such as the following be studied:

- equitable regional representation
- women's participation
- mix of experienced members/up-and-coming new members
- regular rotation of members/-chairman - concept of vice-chairmen for continuity (General)

c) that future CACRS meetings concentrate more on exchange of information and ideas, rather than the politics of technology transfer to the provinces and to industry (Specialty Groups).

1.3.3 CACRS REORGANIZATION

Terms of Reference

CACRS adopted new terms of reference, essentially accepting the mandate to provide advice to all participants in the Canadian remote sensing program, in addition to the advice provided to the federal department of Energy, Mines and Resources.

The new terms of reference also allow the Working Groups who so desire to carry out the planning and coordination of R&D and demonstration programs, in addition to their responsibility for scientific/technical advice and information exchange.

The wording of the new terms of reference is given in Section 2.

CACRS Executive

CACRS approved the establishment of an Executive with the following functions:

- To analyze and set priorities for the recommendations of CACRS;
- To decide on realistic methods of implementing these recommendations;
- To review and approve the work plans of the working groups and to provide guidance to improve effectiveness;
- To approve the establishment and terms of reference of limited-life working groups to meet specific needs;
- To oversee special studies;
- To prepare plans for and to oversee

the reorganization or evolution of CACRS;

- To plan and co-ordinate the organization of the annual CACRS meeting;

- To approve a summary of the results and recommendations of the annual CACRS meeting for transmittal to higher authority (i.e. IACRS in the case of the federal government);

- To review the above-listed Terms of Reference at the CACRS meeting annually.

The representation on the CACRS Executive is as follows:

Chairman: Director General, Canada Centre for Remote Sensing;

Provinces: Chairman, Vice-Chairman, and Past Chairman, Interprovincial-Territorial Advisory Subcommittee of CACRS;

Working Groups: Two representatives elected by the working group chairmen, appointed for a two-year term. Also the Chairman, Education Working Group, to represent universities.

Industry: A representative of Canadian industry may be invited on an as-required basis to address a particular agenda item at an Executive Meeting.

2.0 THE CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING (CACRS)

2.1 Introduction

The Canadian Advisory Committee on Remote Sensing (CACRS) was established in January 1972 to effect the development of a national program of remote sensing. Membership in the committee comprises representatives of provincial and federal organizations, industry and universities. Most members represent a government agency or national working group and thus ensure a broad representation of users, scientists and technologists. Annual meetings are held early in the calendar year to review programs and make recommendations.

2.2 Terms of Reference

The Canadian Advisory Committee on Remote Sensing has the following purposes:

1. Advising and assisting the Government of Canada, through the Minister of Energy, Mines and Resources, in meeting the objectives of the national program of remote sensing, by assessing national needs and capabilities, and making recommendations regarding existing and proposed programs funded by EMR.

2. Advising and assisting all participants in the national program of remote sensing in the application of remote sensing techniques to the nation's resource management systems by:

   - studying the need for technology transfer to the end-user and industry;
   - promoting the active participation of interested parties in the execution of such transfer, and facilitating the coordination of their efforts;
   - evaluating the results.

3. Promoting the development and diffusion of remote sensing methods and applications by:

   - promoting Research and Development activity
   - exchanging scientific and technical information
   - organizing conferences, seminars and training courses.

2.3 Structure

The Canadian Advisory Committee on Remote Sensing has the following structure:

Chairman:	Director General, CCRS
Executive:	An executive committee was established in 1981 with terms of reference and structure described in section 1.3.3.2 above.
IPTASC:	The Interprovincial/ Territorial Advisory Subcommittee of CACRS is a body of representatives appointed to CACRS on the recommendation of the provinces and territories.
Working Groups:	CACRS establishes such working groups as it deems necessary to carry out its work. Some of the groups may operate on an ongoing basis, while others may be ad-hoc groups appointed to carry out a specific task and then disbanded upon completion of the task.
Secretariat:	Provided by CCRS.

3.0 RECOMMENDATIONS

These recommendations have been extracted from the Working Group and Provincial reports and from the reports of the regional workshop groups meeting at CACRS. They are presented here, arranged generally by topic, with comments from CCRS on what action has been or is being taken.

1. Future program planning and development

1.1 that CCRS give high priority to arranging for Canadian participation in the SPOT program;

-IPTASC

Comments on 1.1

The Canada Centre for Remote Sensing is much interested in the possibility of acquiring and disseminating SPOT data, subject to approval of the necessary funding by the financial authorities. In addition, CCRS has asked CNES (the French Space Agency), to make its policy known with regard to the SPOT read-out fees. (same as 1.3 below).

1.2 that the federal program begin preparations as soon as possible for technological expansion to receive and process Landsat D data;

-Ontario

Comments on 1.2

Funding for minimal station upgrade to receive and process a limited amount of Landsat-D and TM data has been approved, and additional funding has been requested to provide geometrically and radiometrically corrected TM data.

1.3 Que le Centre canadien de télédétection établisse et fasse connaître le plus rapidement possible sa politique vis-à-vis l'acquisition et la diffusion des données du satellite français SPOT.

-Québec

Comments on 1.3

Le Centre canadien de télédétection est fortement interessé par la possibilité d'acquérir et diffuser les données SPOT, sous réserve d'approbation par les autorités des crédits nécessaires. De plus, le CCT a demandé au CNES de faire connaître sa politique au sujet des redevances à payer pour la lecture des données SPOT.

2. Organization

2.1 That the three Maritime Provinces and their Remote Sensing Committees recommend to the Council of Maritime Premiers the establishment of a Maritime Remote Sensing Coordinating Committee comprised initially of the Provincial Remote Sensing committee executives and appropriate Council representatives and that a program for remote sensing applications demonstration and appropriate technology development be initiated and enhanced with the Region;

-Atlantic Region Workshop

Comments on 2.1

CCRS is delighted to learn of the formation of a Maritime Remote Sensing Coordination Committee in November 1981 and has written to this Committee to ask what help might be provided by CCRS.

2.2 That the Provincial Remote Sensing Committees and the Provinces ensure through an appropriate organizational structure and program that the Maritime Remote Sensing Coordinating Committees' activities and programs serve the needs and interests of each Maritime Province and their resource managers.

-Atlantic Region Workshop

Comments on 2.2

See response to 2.1

2.3 That the Province of Newfoundland be invited to send observers if not participants to the Maritime Remote Sensing Coordinating Committees' meetings and that the possibility of an "Atlantic" committee be left open at this time.

- Atlantic Region Workshop

Comments on 2.3

See response to 2.1

2.4 Since data collection and platform location are an important part of "oceanography from space", that increased liaison is required between the ocean and the data collection platform (DCP) working group. Garrett and Elliott (DFO), Catlin (Bristol Aerospace) and Duffield (Hermes) were suggested as possible members.

-Oceanography

Comments on 2.4

Considerable correspondence has been carried on with the Water Resources Working Group on the subject of Data Collection Platforms, and the Chairman of the Oceanography Working Group will be copied on all such correspondence in the future. DCP's are not, however, a primary interest of CACRS and the Data Retransmission Working Group was absorbed into the Water Resources Working Group some years ago.

2.5 That action be taken on the reorganization of CACRS.

-Ontario

Comments on 2.5

With the formation of the CACRS Executive Committee, action has already commenced on this recommendation which will be an on-going activity.

2.6 That CCRS establish a plan for the reorganization of CACRS and submit it for comment to the provincial representatives.

-Ontario

Comments on 2.6

It was suggested that members should bring specific recommendations on the reorganization of CACRS to the CACRS Executive, which will continually review the organization and will be receptive to any suggestions and specific recommendations.

At the IACRS meeting in September 1981, the Vice-Chairman of IPTASC made a presentation representing the provincial point of view.

2.7 That a study and report on Canadian Remote Sensing Programs be carried out.

-Plenary Session

Comments on 2.7

IACRS has formally asked CCRS to carry out such a study. This is being done.

2.8 Regarding human resources and representation, Executive consideration of the following items is requested: -equitable regional representation
-women's participation
-mix experienced members/ up-and-coming new members
-regular rotation of members/ chairman - concept of vice-chairmen for continuity.

-Plenary Session

Comments on 2.8

That CACRS Executive indicated that they were receptive to any recommendations which will provide equitable regional

representation. Copies of the CACRS membership list have been given to the Executive in order that they may review the current status of the membership and note any areas where improvements can be made.

3. Applications Development

3.1 Animation du domaine privé par une préparation conjointe de projects de démonstration (C.Q.C.T., A.Q.T., Universités) en particulier pour l'utilisation des sols (O.P.D.Q.) et le zonage agricole.

-Atelier de Québec

Comments on 3.1

We would welcome any proposal submitted by or through the coordination of the CQCT or AQT which would involve the cooperative project. Likewise, we would be willing to participate in a workshop organized by AQT or CQCT.

3.2 That a crop reporting information system be implemented using remote sensing techniques by 1984/85.

-Prairie Region Workshop

Comments on 3.2

See 3.5(a) and (b) below.

3.3 That CCRS designate an oceanographic liaison scientist from its Applications Division to attend ocean working group meetings and work on oceanographic uses of RADARSAT and other data for oceanography.

-Oceanography

Comments on 3.3

The Applications Development Section could accommodate this request; however, in view of the specific expertise required, a delegate from RADARSAT might be more appropriate and constructive. An appointment will be made after further consultation.

3.4 That demonstration projects and cost-benefit assessments be conducted.

-Ontario

Comments on 3.4

This will indeed be one of the objectives of the Technology Transfer Office.

3.5 Whereas past efforts to develop a crop information system that utilizes remote sensing data have been generally underfunded and/or conducted on a piece-meal basis by various agencies; and whereas the development and testing of a complete Canadian crop information system is considered to be overdue; that

(a) A lead agency be identified to assess the various needs of potential paying users of data generated by a crop information system, especially those users concerned with the growing and marketing of crops.

Comments on 3.5 (a)

The Agriculture Working Group has been informed of a project being undertaken by the Wheat Board and Statistics Canada, and has been requested to put forward specific proposals and recommendations.

(b) Consideration be given to the establishment of a Canadian Crop Information Center which would be a center of excellence for the design and testing of a complete crop information system(s). Specific data are already required regarding summerfallow acreages in the prairies, winter wheat acreages, phenological modelling, and the use of remote sensing data to fine tune existing yield models that are based on meteorological data.

Comments on 3.5 (b)

as above

(c) NSERC recognize Agricultural Remote Sensing as an area of or having national importance when considering research grant applications.

-Agriculture

Comments on 3.5 (c)

See response to 12.3

4. Sensors

4.1 that CCRS submit a feasibility study to the CACRS Executive regarding the inclusion of an optical sensor in RADARSAT.

-IPTASC

Comments on 4.1

CCRS submitted the CACRS request for a feasibility study regarding an optical sensor on RADARSAT Office to IACRS, who approved the request and asked the RADARSAT Office to carry out the study, as part of an examination of possible secondary payloads.

4.2 That plans for a radar satellite maintain the option for inclusion of an optical high resolution sensor such as the Thematic Mapper or SPOT's push-broom scanner.

-Data Handling

Comments on 4.2

The option for inclusion of an optical high resolution sensor is being actively studied by the RADARSAT Project.

4.3 That a systematic evaluation of the three frequency channels of the SAR be undertaken; while acknowledging that CCRS now provides in the SAR-580 one of the most advanced facilities in the world for research and development into microwave remote sensing, ground and airborne testing is recommended in order to study the limitations due to system noise, saturation, non-linearities and stability of the various parts of the radar. Such a study is a prerequisite to establishing a relative calibration and, possibly, a limited absolute calibration for an output image product. Also, such a study should help with the problem of establishing what aspects of a final image reflect terrain backscatter levels and contrasts and what aspects reflect radar system limitations and characteristics.

-Ice

Comments on 4.3

This is an extensive undertaking, part of which will be accomplished by the Europeans in support of their 1981 experiments. However, the present facility is still undergoing modifications (e.g. antenna changes and power levels for C-band) that will alter the radar performance. CCRS feels that it is more worthwhile to invest in calibration features for a new airborne SAR radar than to spend considerable effort on the current system.

4.4 That land ice (glaciers and fresh water ice, both on lakes and rivers) be considered in any studies for RADARSAT. The expected improved resolution will increase potential usefulness of radar for such targets and sorties planned for the airborne SAR (X, C) should include overlights of land ice test areas.

-Ice

Comments on 4.4

The RADARSAT project plans to acquire fresh-water ice data over the Great Lakes in March 1982 and will analyse some of the glacier data obtained from the European 1981 campaign.

5. Quality of products and services

5.1 Recently a number of private

companies have appeared in the market place offering remote sensing image acquisition services. During the 70's the bulk of this imagery was acquired through the airborne operations section of CCRS. Under this former arrangement CCRS provided technical advice on mission specifications, as well as cameras, lens, filters and films suitable to achieve the users requirements. In addition, the rigorous quality control standards required by CCRS assured the user of a top quality image product.

As operational image acquisition must now be placed with the private sector and as many users do not have the technical expertise for detailed mission planning and quality control and inspection, it is recommended that

(a) CCRS formalize a prcedure by which users may obtain technical assistance and detailed mission specifications suitable for tender generation.

Comments on 5.1 (a)

This information is available from the Interdepartmental Committee on Aerial Surveys.

and

(b) CCRS provide quality control and inspection of imagery obtained to ensure that it meets tender specifications.

-Nova Scotia

Comments on 5.1 (b)

CCRS cannot provide a quality control and inspection specialist on an on-going basis, but consultation on an occasional basis is available.

5.2 That CCRS not implement cost recovery for imagery, until it is in the position to meet user demand within an operational time frame. It has been reported that orders for large scale Landsat imagery of Saskatchewan from CCRS have been delayed by up to six weeks and that indexing (cloud cover) was sometimes in error.

-Water Resources

Comments on 5.2

Users are now automatically notified when delays beyond the promised schedule are encountered. The letter on cost recovery will await the announcement of NASA's plans regarding station fees.

5.3 That CCRS be commended for the recent improvement in the quality of Landsat imagery production.

-Ontario

5.4 That the necessary action be taken to reduce the time required to receive an imagery order.

-Ontario

Comments on 5.4

The average turnaround time from receipt of an order for imagery to delivery has been reduced for 'new' colour imagery by installation of a production line at PASS.

6. Training and education

6.1 Formation des adultes et des professionnels sous forme de stages courts/certificats (A.Q.T., Universités).

-Atelier de Québec

7. Cost of services

7.1 that a more equitable ferry charge be applied to the lease arrangement of CCRS aircraft, and further, that the OCRS charge-back formula be investigated as such a mechanism for feasibility and cost recovery.

-IPTASC

Comments on 7.1

Mr. Zsilinszky has forwarded a copy of the OCRS cost recovery plan to Mr. Godby for review, and a study of the feasibility of a more equitable ferry charge will be prepared by the Data Acquisition Division of CCRS.

7.2 That with respect to the airborne program, CCRS review the successful completion rate (in percent) of airborne remote sensing assignments to its contractor, and review line mileage and ferry charges for customers located some distance away from Ottawa.

-Water Resources

Comments on 7.2

CCRS will review the successful completion rate of airborne remote sensing assignments to its contractors.

8. Data reception and production

8.1 In recognizing the fact that most engineering applications require relatively large scales, that the routine production of enlarged, digitally enhanced LANDSAT imageries to, for example 1:50,000 or larger, be investigated.

-Engineering Applications

Comments on 8.1

The specialized nature of such applications precludes the "routine" production of such products. Geometrically accurate images from the DICS and CIR production lines have been used very successfully at very large scale. Products have been enhanced on systems such as the CIAS for specific applications and then produced on the accurate film recorders as required. CCRS is happy to consult with users on an individual basis and provide products, whenever possible, that are most suitable to individual applications.

8.2 That CCRS operationalize the "MOSAICS" project as soon as possible.

-IPTASC

Comments on 8.2

CCRS is proceeding with the design and construction of "MOSAICS" with anticipation of delivery in 1985. A research contract has been let for initial system design.

8.3 Whereas the current production level of LANDSAT computer compatible tapes (CCTs), especially for DICS products, is not sufficient to meet current and projected requirements of agricultural users; and whereas the current production process for DICS products utilizes a "single thread" and apparently aging system at Prince Albert; that the production of DICS products be moved "off line" and that a production system be devised with the capability of producing at least 4 DICS products per day, with a 7 day turn around time, for agricultural users. This production capability would be most desirable during the growing season.

-Agriculture

Comments on 8.3

CCRS upgraded the Prince Albert facility's CCT capability. This project was completed in June of 1981, ready for the 1981 growing season. There have been no complaints received from users concerning delivery of CCTs for DICS for 1981.

DICS is also undergoing an upgrade to add a second station which will greatly enhance its throughput. The DICS throughput of 4 DICS products per day has been generally met through the 1981 summer season.

9. Technology transfer

9.1 That CCRs and the Maritime Provinces jointly provide human

and technical resources to the Maritime Committee for the purpose of initiating a Maritime Region program for remote sensing trechnology transfer and applications development, that in the early phases, CCRS set up a Maritime (Atlantic) Region office jointly with the Maritime Remote Sensing Coordinating Committee.

-Atlantic Region Workshop

Comments on 9.1

This request has been referred to the Technology Transfer Office for coordination with the Maritime Committee.

9.2 L'assistance aux utilisateurs sous forme de recettes simples et éprouvées (classification forestière)(C.Q.C.T.).

-Atelier de Québec

9.3 Assistance aux compagnies québécoises susceptibles d'offrir des services de consultation et/ou d'application (C.Q.C.T., gouv. fédéral).

-Atelier de Québec

Comments on 9.3

Quebec companies will be notified, through their IPTASC member, of funding available, i.e. Unsolicited Proposals, etc. The Technology Transfer Office may be able to provide assistance as well. This item will be discussed more fully at the next IPTASC meeting.

9.4 Pressions au niveau politique provincial, en insistant sur le petit nombre de contrats de R&D accordés au Québec par rapport aux autres provinces (A.Q.T.).

-Atelier de Québec

9.5 That IPTASC be kept informed on any action taken toward technology transfer with present approved funding and a method be established whereby this group can have input into future planning.

-IPTASC

Comments on 9.5

A letter has been sent to IPTASC members bring them up-to-date on the Technology Transfer program and asking for an indication of their interest.

9.6 Whereas there are numerous and ever-increasing hardware/software systems in the Canadian remote sensing community; and that these system often redundantly develop software capability; and that there is no convenient and efficient means for the transfer of remote sensing software among these systems; and since it is to the benefit of technology transfer interests to minimize the wasted manpower involved in software duplication: it is recommended that in future development of image analysis software by federal government agencies (such as that for the upcoming Image 200), that a primary and integral design feature be the transportability of the software to other computer systems. It is further suggested that at the planning and development stages of a new software package where the architecture of the software has been designed, but where changes may still be implemented, the developer of such package report on the transportability features of the software to IPTASC.

-Nova Scotia

Comments on 9.6

A lengthy report commenting on this recommendation is available for Dr. David Goodenough, Head, Methodology Section.

9.7 There is a need for a quality demonstration project in Atlantic Canada. Recent activities by various remote sensing groups interacting with

potential clients have shown that the interest is there but there is a certain degree of cautiousness caused by previous failures or conflicting statements. Newfoundland thus recommends that consideration be given to a pilot project geared for users in Atlantic Canada. This project should be of a magnitude that technology transfer can be facilitated to those interested local remote sensing concerns and in a manner that will satisfy the needs of the many potential small users in this area.

-Newfoundland

Comments on 9.7

The regional focus of the federal technology program will be determined largely upon the strength of proposals from the regions as indicators of need and potential for successful transfer. Provincial representatives within the Atlantic region may, therefore, wish to coordinate any forthcoming proposals or request so as to make best use of the limited resources available to the Technology Transfer program.

9.8 That a mechanism be established whereby provincial representatives to CACRS may make input to the planning of the federal technology transfer program.

-Ontario

Comments on 9.8

See response to 9.5

9.9 That decisive action be taken to involve industry in those remote sensing developments that are ready for application, and that a strong program be implemented to transfer new remote sensing technology to the end user.

-Ontario

Comments on 9.9

CCRS agrees with the recommendation. The setting up of the recommended mechanism will be the first priority of the Technology Transfer Office. The Director General of CCRS will write to the provincial representatives to initiate the process of consultation as soon as possible after the Technology Transfer project has been approved by Treasury Board.

10. Availability of Data

10.1 As engineering applications of satellite imagery generally require greater spatial resolution than that presently available, that CCRS give continuing high priority to arranging for the availability of the highest resolution satellite imagery of Canada to be remotely sensed in the future by orbital platforms operated by other countries.

-Engineering Applications

Comments on 10.1

CCRS is committed to the reception and processing of LANDSAT-D imagery (at 30m resolution) and is actively discussing SPOT, with the potential for even higher resolution data, with France. In addition, for a longer term, the application and economic trade-offs for a secondary (optical) sensor for RADARSAT are being investigated.

10.2 Imagery from the weather satellites is being used in many remote sensing applications in operational water management. However, there is still confusion among users from where such imagery is to be obtained. Does CCRS provide or intend to provide NOAA data from Prince Albert? Can users obtain imagery from Atmospheric Environment Service? It is recommended that CCRS take the necessary steps to clarify this confusing situation.

-Water Resources

Comments on 10.2

It is assumed that weather satellite data is meant to refer to NOAA which is received at both Prince Albert and Shoe Cove stations. NOAA data has been routinely received and archived at the Shoe Cove Station since 1976. NOAA data from Shoe Cove are presently available as imagery and CCTs of recent and archive data, now being evaluated as a standard product.

NOAA imagery is now routinely available from Prince Albert but recording and archiving of the data has not yet been implemented, but is planned to be initiated during the spring of 1983 along with CCTs.

11. Information

11.1 That in support of the Maritime Committees' activities and programs, CCRS continually endeavour to provide coordination of information about the remote sensing activities of all federal agencies in the Maritimes and that when possible CCRS assist the Maritime Committee in gaining access to other federal government remote sensing resources and programs with the Maritimes.

-Atlantic Region Workshop

Comments on 11.1

An effort will be made to improve the coordination of information through the Technology Transfer Office.

11.2 That OCRS be kept informed of new types of data which will be available, their characteristics and schedule (LS-D, SPOT, RADARSAT) and the hardware and software characteristics appropriate for the new data, and also of federal government plans beyond 1983-84.

-Ontario Workshop

Comments on 11.2

As CCRS programs are confirmed and funded, information on data products, formats, etc. will be made available to everyone. If speculative information is required, before the specifications are confirmed, CCRS can not "issue" hypothetical data but would welcome discussions and meetings with OCRS.

11.3 Whereas recent CACRS meeting have concentrated more and more strongly on the politics of technology transfer to the provinces and to industry, and whereas such transfers occur very fast once a new technique is demonstrated to be viable, and whereas an extremely valuable role of CACRS in the past has been to exchange and promote ideas leading to such techniques, that future CACRS meetings concentrate more on exchange of information and ideas.

-Working Group Chairpersons

Comments on 11.3

The CACRS Executive suggest that the Chairman of the Organizing Committee for the Annual CACRS meeting include relevant presentations (in the form of executive summaries) from invited speakers, but that a full exchange of information and ideas of a technical nature was best carried out at symposia.

11.4 That Workshops particularly oriented towards engineering applications be arranged and coordinated by CCRS, on a regular basis, in conjunction with the Working Group on Engineering Applications of Remote Sensing.

-Engineering Applications

Comments on 11.4

The Working Group on Engineering Applications is holding a

national workshop on engineering applications in February 1982 and CCRS is providing some financial support for it through CACRS.

11.5 That an audio-visual presentation on the engineering applications of remote sensing, accompanied by reproductions of the appropriate imagery be prepared by CCRS for distribution to the user groups, such as government agencies, private industry, and universities and colleges.

-Engineering Applications

Comments on 11.5

The CCRS User Assistance and Marketing Unit would be glad to consult with the Working Group on Engineering Applications to discuss their needs.

11.6 That integrated information on the availability of remote sensing data be provided, incorporating provincial and national collections.

-Ontario

Comments on 11.6

Both CCRS and NAPL publish catalogues regarding national collections. The User Assistance and Marketing Unit can assist users in their search. This could be extended to provincial collections if provincial catalogues were available to CCRS.

11.7 That a directory be produced of remote sensing-related facilities available in government, private industry and universities, of research undertaken and of jobs available in all three sectors.

-Ontario

Comments on 11.7

The Applications Division, CCRS, will design a questionnaire for submission to the Chairman of IPTASC. After review, the questionnaire will then be sent out by IPTASC, who will review, collate, and return relevant replies to CCRS. The availability of these directories will be advertised in the CCRS Newsletter and various provincial publications and will be sent out on request only.

11.8 Better access to new data, methods and instruments, a more active exchange of information with the federal program, and better coordination of education and training.

-Ontario

Comments on 11.8

The originator of this recommendation has been advised that we are unable to respond with the information provided, but will be pleased to take action on specific suggestions.

11.9 That CCRS take action on the recommendation made to CACRS in 1979 for production of a brochure on operational remote sensing techniques.

-Ontario

Comments on 11.9

Two brochures have been published so far, covering Forest Fire Mapping and Geological Expoloration. A third brochure is being prepared on Agricultural applications.

11.10 That CCRS through the New Brunswick Remote Sensing Committee make available as much equipment and material as possible in order to support and sustain the development of the capability in New Brunswick. That CCRS ensure that the New Brunswick Committee and the technical liaison officer are fully informed of all activitied from CCRS to the New Brunswick Committee which may impact the New Brunswick situation. That

the New Brunswick Committee be informed of all activities or overtures relevant to the realm of Remote Sensing in the Province of New Brunswick.

-New Brunswick

Comments on 11.10

Equipment and material could be made available on a loan basis, subject to the limitations specified by the federal Treasury Board.

CCRS will undertake to keep the New Brunswick Committee informed of activities relevant to the Province.

12. Research

12.1 Développement de la recherche dans les universités, en particulier pour la préparation de Landsat D et SPOT, par une action concertée F.C.A.G./MER.

-Atelier de Québec

12.2 Whereas there is a serious deficiency in significant research being carried out in Canada on the applications of remote sensing to the study of oceanographic and near shore phenomena and whereas Canada has developed a significant capability in the development of a high technology remote sensing industry including satellite hardware, sensor technology, data collection and image analysis systems, that an amount roughly equivalent to 5% of CCRS' technology budget be devoted to a research subvention fund to sponsor appropriate applications research studies in Canadian Universities and industrial organizations, and CCRS approach NSERC about making such a fund available.

-Oceanography

Comments on 12.2

CCRS will contact the NSERC and report on their comments. See response to 12.3.

12.3 That more remote sensing research be commissioned by universities; in some cases, minimal initial funding would be required, and supplementary funding could be considered as results were produced.

-Ontario

Comments on 12.3

Neither CACRS nor CCRS have grants available to support research in universities. In some cases, however, CCRS does issue contracts to university faculty or industry, as appropriate, to undertake specialized tasks where CCRS does not have the in-house expertise. These contracts are issued through DSS in accordance with their policies.

It is understood by CACRS that the major source of research funding for university faculty is the Natural Sciences and Engineering Research Council of Canada (NSERC). The method used by NSERC for deciding on the disbursement of its funds is peer evaluation of research proposals. In this process, a major emphasis is on the research record of the applicant, particularly the publication of papers in refereed journals. New faculty are usually given support to get their research programs started and then it is up to the individual to demonstrate that he or she is worthy of continued support. An interesting article on the topic of research support entitled "NSERC Earth Sciences Grants: Policies, Procedures and Problems" was recently published in Geoscience Canada.

13. Geocoded data

13.1 Whereas the development of Geographic Information Systems that allow full integration of raster and polygon data sets offers the resource manager the promise of an operational management tool, that CCRS pursue an active development

policy with respect to such GIS technology be developed in such a way as to maximize its transferability and minimize the cost of conversion to the Canadian remote sensing user community.

-Nova Scotia

Comments on 13.1

All new software systems will be written with transportability a key design goal. The appropriate transfer mechanism may be through licensing of the software to private industry.

13.2 That CCRS give more emphasis to systems and methods that handle geocoded data.

-Data Handling

Comments on 13.2

CCRS has placed a high priority on developing systems and methods for efficiently handling geocoded data.

4.0 REPORTS OF THE CANADA CENTRE FOR REMOTE SENSING

4.1 Historical Highlights

1968

May: Meeting of Interdepartmental Committee on Remote Sensing of Earth Resources from Aircraft Satellites convened by Dr. L. W. Morley to discuss advantages of joint programs in remote sensing.

1969

July: The Program Planning Office officially established with Dr. L. W. Morley as Director.

1970

Feb.: First Montebello meeting to form the working groups of the Program Planning Office.

May: Cabinet Committee on Science Policy and Technology gave approval for EMR to negotiate a memorandum of understanding between EMR and NASA.

1971

Jan. 16-20: Second Montebello meeting to review reports of the working groups.

April 1: Canada Centre for Remote Sensing officially established.

May: Agreement with NASA signed.

Nov.: Purchase of Falcon Fanjet aircraft.

1972

Feb. 22-24: First CACRS (third "Montebello") meeting at Montebello, Québec.

July 23: LANDSAT-1 launched.

1973

February 7-9: First Canadian Symposium on Remote Sensing (Ottawa).

February 19-22: Second CACRS meeting, Montebello, Québec.

April: Manitoba Remote Sensing Centre established in Winnipeg.

September: Ontario Remote Sensing Centre established in Toronto.

1974

February 18-21: Third CACRS Meeting, Montebello, Québec.

April 2 - May 1: Second Canadian Symposium on Remote Sensing (Guelph, Ontario).

April: Image-100 interactive image analysis system delivered to CCRS.

June: Convair 580 long-range turbo-propellor remote sensing aircraft acquired by CCRS.

June: Alberta Remote Sensing Center established in Edmonton.

1975

January 23: Launch of LANDSAT-2.

March 31 - April 3: Fourth CACRS meeting, Montebello, Québec.

September 22-24: Third Canadian Symposium on Remote Sensing (Edmonton).

1976

March 29 - April 1: Fifth CACRS meeting, Arnprior, Ontario.

1977

April 4-7: Sixth CACRS meeting, Arnprior, Ontario.

May 16-18: Fourth Canadian Symposium on Remote Sensing (Québec, Québec).

July: Opening of the Shoe Cove Satellite Station in Newfoundland and subsequent reception of LANDSAT data.

1978

January 7: Closedown of LANDSAT-1 after 5½ successful years.

March 5: Launch of LANDSAT-3.

April: Launch of HCMM.

April 10-13: Seventh CACRS meeting, Arnprior, Ontario.

June 27: Launch of SEASAT.

July: ERIM SAR installed and operational in the Convair 580 as part of the SURSAT program.

August 28-31: Fifth Canadian Symposium on Remote Sensing (Victoria, B.C.).

October 10: Failure of SEASAT.

December: Signing of the Co-operative Agreement between the European Space Agency and Canada, to take effect January 1, 1979.

1979

April 9-12: Eighth CACRS meeting, Arnprior, Ontario.

October: Digital Image Correction System (DICS) became operational at CCRS.

December: Cabinet approved Canada's participation in ESA's Preparatory Program for a Remote Sensing Satellite, expected to be launched with a radar in 1987.

1980

May: Cabinet approved the arrangement under which CCRS aircraft may be leased by private industry for blocks of time.

August: Dr. L. W. Morley, who had been Director General of CCRS from its earliest days, resigned to become Science Counsellor at the Canadian High Commission in London. Mr. E. A. Godby, formerly Associate Director General, was appointed Director General.

September: Publication of the executive summary of the SURSAT Project Report, summarizing results received. Recommendation made to establish follow-on RADARSAT Project.

4.2 Airborne Program

Perhaps the most significant occurrence during 1980 was a clear trend in the airborne program towards all-weather remote sensing, that is, the development of technology and applications utilizing sensors operating in the microwave region of the electromagnetic spectrum. Although the Convair 580 aircraft was originally configured as a multi-sensor general purpose platform, it is now virtually committed to the collection of microwave data using the synthetic aperture radar and microwave scatterometer. Not only that but the vast majority of the application development and demonstration projects conducted with this aircraft have not even relied on sensors operating in the visible or IR portion of the spectrum and therefore have been able to be conducted irrespective of daylight or cloud cover conditions.

The major application area for the microwave sensors has been that of ice classification and of ice imaging in support of ice modelling programs. In the former case, ice imaging has been conducted mainly in the Beaufort Sea area in support of resource development applications and in many cases this has involved downlinking of real time imagery to ships directly involved in drilling operations. In the latter case, ice modelling activities have involved collection of both large scale and site-specific imagery in support of AES ice forecast models currently being developed.

To date all of the imagery collected with the SAR system have been at X and L bands; however, the development of a C-band capability is nearing completion and this will provide Canada with a unique multi-band SAR system for airborne data acquisition.

In the visible and infrared regions, CCRS has been involved in a number of application development and demonstration projects. The MSS installed in the Falcon has been used extensively in SPOT and LANDSAT-D simulation work, particularly as relates to agriculture and land use applications. The CCRS DC-3 containing the integrated hydrography package with the photo-inertial system and the lidar bathymeter continues to support the CHS coastal hydrography program. In the past summer a pilot survey was conducted in Georgian Bay just off the Bruce Peninsula, an area considered typical of clear water coastal areas containing many shoals. The second CCRS DC-3 has been configured mainly with the dual channel infrared line scanner as well as a variety of photometers, spectrometers and photographic sensors. This aircraft has also been used as a platform on which other government department sensors have been installed, including AES air pollutant monitoring equipment and the DREO lidar profiler.

The following table provides a brief summary of the scope of airborne operations conducted during 1980 by the CCRS Data Acquisition Division.

CCRS Airborne Operations - Applications Development

i) By Discipline

	No. of Projects	Line Miles Flown
Agriculture	7	681
Forestry, Wildlife	12	544
Geography	2	265
Geology	1	22
Glaciology	4	10
Hydrology	4	2600
Limnology	3	288
Oceanography	4	65
Miscellaneous	8	300
	Total	4775

ii) By Province

	No. of Projects	Line Miles Flown
British Columbia	7	343
Alberta	3	167
Saskatchewan	1	2305
Ontario	20	1326
Quebec	4	107
New Brunswick	4	447
Nova Scotia	5	80
	Total	4775

During 1980 CCRS was able to initiate the program of making its aircraft available to Canadian firms and persons engaged in the business of providng remote sensing services. Under this arrangement the CCRS aircraft and sensors were leased to Innotech Aviation Limited, the airborne services contractor, and Innotech in turn then entered into data acquisition contracts with the various companies in Canada wishing to collect remote sensing airborne information. Since the inception of the leasing program in May 1980 a total of 7 projects involving lease operations throughout Canadian territorial and coastal waters have been conducted. In all of the cases the availability of the CCRS aircraft and sensors allowed Canadian companies to offer remote sensing services which would not otherwise be available to them from commercial sources. Each of the projects was conducted on a non-interference basis with the regular user projects and in each case the company wishing to use the CCRS aircraft was required to demonstrate that the CCRS facilities were not being used in competition with commercially available facilities. Even though this leasing program has only been in place for less than one full year it has clearly demonstrated the benefits which it can provide to the national remote sensing program and Canadian industry in the development of operational uses for remote sensing information.

Research and development activities in the Data Acquisition Division are continuously aimed at updating the airborne facilities to respond to the large variety of user demands. Some of the R&D programs currently underway in DAD which are expected to result in additional airborne facilities in the next year or so include: the addition of a C-band capability to the present X and L band synthetic aperture radar, the development of a solid state pushbroom scanner operating in the visible spectrum, the development of a second generation digital data acquisition system to integrate multi-sensor data with navigation and housekeeping data, the development of a real time on-board display to expand the capability of the laser fluorosensor and imaging sensors, as well as the development in collaboration with DREO of a SAR optical processing facility.

4.3 Satellite Program

In June 1980 ISIS Limited retired from the generation, sale and distribution of Landsat and other satellite products and CCRS assumed the full responsibility for the generation and delivery of Landsat satellite products to Canadian users. The transition required some time to effect but is now considered to be complete.

During the transition, CCRS established and placed into effect new ordering and user contact procedures in an attempt to better inform users of the status of the satellite system, through the Landsat Alert system, and of the status of orders and product flow by personal order-clerk contact at the time of order and by follow-up if the order is delayed. For mail orders an order acknowledgement has been instituted containing expected product delivery information.

CCRS has established a monitoring committee responsible for the CCRS Landsat system from reception to product distribution. All problems concerning the Landsat satellite system should be addressed to the CCRS User and Marketing Assistance Unit located at 2464 Sheffield Road, Ottawa.

The Return Beam Vidicon (RBV) data is received only from Landsat-3 and is being recorded in Canada as a film archive only. This decision was made prior to the launch of Landsat-3 by CCRS, in response to a national

user survey identifying a very low preference for RBV data in general. Sales of RBV data have borne out this decision being only 1% to 2% of all satellite products. RBV is presently being recorded during a six month period of the year, April through September. Users may request unique area coverage at any time of the year and CCRS will respond to these requests within the constraints of the station and the Landsat satellite system.

Colour image products from the CIR and the LBIR were established as a product line this year. The colour image recorder (CIR) product is a superior colour product which is produced on user demand only. It requires more time to produce due to the requirement for a CCT of the scene which produces the first generation colour master negative. CCTs are generated in the Prince Albert facility and transmitted to Ottawa where the CIR is located. The LBIR colour product, also known as Single Band Image (SBI), is a hand registered product produced using the Cibachrome process. Investigations and studies have been carried out at Prince Albert to improve the handling and contrast problems inherent in the Cibachrome process and have resulted in the use of new paper bases and digital system enhancements which it is hoped will produce a superior Cibachrome image product.

In March 1981 CCRS received approval by Cabinet of the Landsat-D program covering the reception, recording and production of Landsat-D data. Landsat is presently scheduled for launch in the third quarter of 1982 and will carry the familiar multi-spectral four-band scanner (MSS) and the new high resolution seven-band Thematic Mapper (TM). CCRS has undertaken planning and is laying out a program to receive and record both the MSS and TM data at both the Prince Albert and Shoe Cove stations. Processing systems for the MSS are planned to be upgraded soon after launch with TM processing at the stations planned for about a year after launch of Landsat-D.

The radiometric calibration technique for MSS has been improved to eliminate possible residual striping in high contrast scenes such as those containing water, land and snow or clouds. The striping is caused by non-linear characteristics of the detectors going into saturation.

Landsat MSS CCTs are now available in two formats: the CCRS universal format and the international format developed by the Landsat Ground Stations Operator Working Groups to facilitate international exchange of remote sensing data.

To facilitate the utilization of data from multiple complementary sensors such as Landsat-D Thematic Mapper and SPOT High Resolution Visible sensors and their integration with geocoded data bases, CCRS has identified the requirements for an advanced precision processing facility to be located at the two Canadian receiving stations. MOSAICS (Multi-Observations Satellite Image Correction Systems) will offer resource managers platform- and sensor- independent digital and film products in the UTM projection. These products will have a sub-pixel accuracy both in multitemporal registration and in absolute geodetic control. Plans and funding levels have been established in order to have these two systems in operation at Prince Albert and Shoe Cove by 1984 and 1985 respectively.

The demand for geometrically corrected high precision Landsat MSS products increased rapidly in 1980/81 to the point where they are now the main digital products requested by users. In particular, there were two orders for systematic coverage of large areas in Québec and in British Columbia. For each DICS image, a high quality colour negative is now created on the Color Image Recorder (CIR) at a 1:500,000 scale. Print copies of these high quality images are available for consultation in the User Assistance Unit at Belfast Road in Ottawa and reprints can be obtained for the reproduction cost. To meet the growing demand for DICS products a second image terminal is being added to DICS in order to correct in parallel two images.

4.4 Applications Program

During 1980, the Applications Division continued to work in conjunction with other Canadian agencies to find new and better ways to assess and monitor environmental change.

In one project, CCRS joined forces with the New Brunswick Department of Agriculture to establish procedures for mapping soil erosion in potato cropland. Procedures which were successfully developed included the use of an erosion model in conjunction with visual interpretation of medium scale colour infrared aerial photography to predict average annual soil loss for individual fields. The potential for erosion monitoring on a farm scale using existing and future satellite digital data (Landsat-D and SPOT-1) was also investigated.

Another joint project carried out with a Statistics Canada team generated an acreage estimate for potatoes in New Brunswick, using

the CIAS for analysis of Landsat digital DICS data. The estimate, generated ten days after a satellite pass, was 51,379 acres. The three independent Statistics Canada estimates were 50,800, 53,854 and 49,129 acres. The published estimate of 52,000 was closer to the satellite estimate than the traditional methods.

An experiment to determine whether Landsat multispectral imagery could be used to assess range conditions was carried out with the Alberta Energy and Natural Resources and Alberta Environment. An enhanced colour image product was developed (scale 1:50,000) which reliably separates the poor and good range areas in the mixed grass prairie. Work is continuing on refining the techniques, extending the analysis to the Fescue Prairie, and transferring the technology to interested agencies with a rangeland mangement mandate. Rangeland inspectors can now confidently use the imagery to direct their field operations and increase their efficiency in developing rangeland management plans.

Two demonstration projects were undertaken under the general heading of construction monitoring. In British Columbia, a proposed expansion of port facilities at Roberts Bank some 25 km south of Vancouver, led to concern about the impact of the new facilities on marine vegetation. Landsat data were analysed to illustrate the impact that the existing port facilities had had on this vegetation. This information, acquired from seven successive years of Landsat over-passes, was both timely and unique. Also in British Columbia, two-thirds of original wetlands in the Fraser Estuary have been lost to agricultural, port and industrial development. Landsat digital data and simulated Thematic Mapper data have been evaluated for their potential role in an operational wetland monitoring program for the estuary.

The Applications Division also continued work on multisensor integration and image rectification, using terrain information derived from digital terrain models. The work is important for our future RADARSAT programs in that the methods have been developed and implemented on the CIAS to geometrically correct synthetic aperture radar data, and overlay the extracted information on a map sheet. These methods were developed as part of a comparative study of the relative value of Landsat MSS, airborne MSS and airborne SAR imagery for forestry and agriculture applications.

During 1980, two output devices were linked to the CIAS. One of these is the Applicon Ink Jet Plotter, which can produce large (100cm x 100cm) colour outputs of images or classified results. Another device with even greater potential utility, is a colour camera which uses the analogue signal inputs to the CIAS display to produce a polaroid photograph of the display screen. Since the equipment can produce as many as twenty-five images in various formats on one sheet of polaroid film, it can be effectively used to output time sequence and multi-sensor data in an easily comparable mode.

In early 1979, CCRS planned to connect a remote image analysis station at the Alberta Remote Sensing Center (Edmonton) to the CCRS Image Analysis System (CIAS) in Ottawa via the telecommunications satellite, ANIK-B. Although delays and problems finally caused this plan to be set aside, we did continue the training workshops, in Edmonton and Calgary, under the sponsorship of the Alberta Remote Sensing Center. The workshops were attended by a total of forty-four potential users of digital image analysis facilities. Since several digital analysis systems now exist, or are planned, in eight provinces, the number of users will expand rapidly. CCRS will be supporting company, provincial and university initiatives to expand the opportunities for digital image analysis training in Canada.

Two major international development projects are currently being carried out with CCRS coordination and technical support, and CIDA funding. Project PERCEP, now nearing completion, has exposed Peruvian experts to operational remote sensing through on-the-job experience with Canadian counterparts at CCRS. The project has provided over 60 man-months of intensive research and training experience to members of the Peruvian project team, funded the outfitting of a remote sensing interpretation Laboratory. A comprehensive English-Spanish remote sensing glossary was also compiled during the project.

The second major international program involves the countries of the Sahel region of west African. To date, Canada has assisted in the establishment of a Regional Training Centre in Ouagadougou, Upper Volta, and has provided the full time services of a Deputy Director to assist the African Director of the Centre. In the second phase of the project, Canada will establish a regional satellite facility to complement the Training Centre.

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5.1 REPORT OF THE WORKING GROUP ON AGRICULTURE

AIRBORNE REMOTE SENSING

A variety of small and large format airborne photography was used in 1980 for crop production, crop management and land resource studies. For example, in the Maritime provinces, 70-mm infra-red and panchromatic photographs were used to assist inventorying farm lands and extent of soil erosion under intensive potato production (N.B. Dept. of Agriculture). In Ontario several studies were carried out to assist inventorying farm land (Eastern Ontario), field crops and orchards (Economics Branch), and soil erosion with time-lapse photography (University of Guelph).

In the prairie provinces, 70-mm infra-red color film was used to illustrate uniformity of various farm operations (eg. fertilizer and herbicide applications by Prairie Agri-Photo Ltd.). Several formats were used to assess crop damage in Saskatchewan by grasshoppers emerging from their roadside habitat and moving into fields and yield losses from hail damage to rapeseed fields (Saskatoon Research Station, CDA). An intensive application of using aerial photography for classifying agricultural land uses was undertaken in Saskatchewan based on representation photos from over 40 areas. Airborne photographs were obtained from the Kinsella Ranch (University of Alberta) to assess long-term effects of previous management practices. Small format photography (70-mm) was used to record crop growth and field locations for the 10 Main and 15 Supplementary (out of 30) Test Sites of the Crop Information System program as part of the data set for analyzing Landsat multi-band imagery (Research Branch, CDA). In B.C. several formats were used in various rangeland programs. An intensive study for classifying rangelands and assessing their productivity is being carried out using single frame and stereo photos from a single 35-mm camera system (International Remote Sensing Ltd./ Kamloops Research Station, Kamloops). Helicopters carrying 70-mm cameras were used for inventorying rangelands in the Williams Lake area, B.C. Large format camera (188 mm) were used for a variety of infra-red color studies in various regions.

Sensimetric measurements of the individual dye layers on pre-exposed film for establishing correct color balance has greatly improved reliability of obtaining infra-red imagery. However, procedures used by commercial airborne photographers still result in improper exposure settings. The unreliability of receiving properly exposed film still seriously restricts its wide spread applications for assessing crop conditions.

SPACEBORNE REMOTE SENSING

Landsat imagery, complemented by airborne photography for training and verification, was analyzed to provide information on soil erosion, potato acreage and for land inventory (New Brunswick). Acreage estimates of canola were made for selected areas of the prairies, land inventory and soil erosion studies involving Landsat were initiated in Ontario. Preliminary studies at University of Guelph indicated that Landsat imagery has the potential for the identification of areas contributing to the sediment in large water-sheds.

Productivity assessment of rangelands requires vegetation types to be first mapped. Extensive studies were underway in Alberta (CCRS, Intera Consultants, Alberta Remote Sensing Centre) and an intensive study involving classifying keys were carried out near Kamloops, B.C. (Kent Watson, Research Station, CDA).

TECHNICAL AND SCIENTIFIC DEVELOPMENT

Cartographically corrected and special radiation-enhanced digital imagery, produced as DICS products by CCRS, greatly facilitates integration of Landsat imagery with other land resource information. Other information such as land classification and legal survey coordinates may now be integrated or overlayed onto Landsat photo bases. Multiband microwave imagery from the Sursat Program (Airborne) indicates that a high correlation exists between the classifying of crops on the images with kinds of crops recorded from ground observations. Data were analyzed for studies previously conducted at Lethbridge, Alta., Melfort, Sask., Simcoe, Ont., Grand Falls, N.B. and several sites in Quebec. Single band imagery classified in groups of features depending on the band (eg. L, X or polarization). Spectroscopic analyses of cereal crops from ground based systems was conducted at the University of Manitoba, and of rangelands by Canada Center for Remote Sensing. The results of these studies and of data obtained in 1979 at the Melfort Test Site showed the optimum and sub-optimum stages of plant growth for separation of crops. The spectral data showed the threshold boundaries for selection of bandwidths for use in assessing crops and crop conditions.

USER LIAISON AND TRAINING

The CCRS actively supported projects in agriculture for assessing potato acreage in cooperation with Statistics Canada and for assessing rangeland conditions in southern Alberta in cooperation with Lethbridge Research Station, and provincial range specialists. A cooperative study was conducted by Alberta Energy and Natural Resources, Alberta Remote Sensing Center and University of Calgary. In February a rangeland remote sensing meeting was held at Edmonton at the Alberta Centre for Remote Sensing.

The Ninth Annual meeting of the Working Group was held at the University of Saskatchewan, Saskatoon, November 3 and 4. Papers on the "Application of remote sensing in Agriculture land-use classification Studies" and on "Remote Sensing for integrating production in a Parkland Pasture near Pathlow, Saskatchewan" were presented and reproduced in the Proceedings of the meeting.

RECOMMENDATIONS

1. Whereas the current production level of LANDSAT computer compatable tapes (CCT's) especially DICS products is not sufficient to meet current and projected requirements of agricultural users; and

Whereas the current production process for DICS products utilizes a "single thread" and apparently aging system at Prince Albert;

The Agriculture Working Group recommends that the production of DICS products be moved "off line" and that a production system be devised with the capability of producing at least 4 DICS products per day, with a 7 day turn around time, for agricultural users. This production capability would be most desirable during the growing season.

2. Whereas past efforts to develop a crop information system that utilizes remote sensing data have been generally underfunded and/or conducted on a piece-meal basis by various agencies; and

Whereas the development and testing of a complete Canadian crop information system is considered to be overdue;

The Agriculture Working Group recommends that:

a) A lead agency be identified to assess the various data needs of potential paying users of data generated by a crop information system, especially those users concerned with the growing and marketing of crops.

b) Consideration be given to the establishment of a Canadian Crop Information Center which would be a center of excellence for the design and testing of a complete crop information system(s). Specific data are already required regarding summerfallow acreages in the prairies, winter wheat acreages, phenological modelling, and the use of remote sensing data to fine tune existing yield models that are based on meteorological data.

c) NSERC recognize Agricultural Remote Sensing as an area of or having national importance when considering research grant applications.

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APPENDIX II. LIST OF GROUP MEMBERS (APRIL 1980)

1. Dr. A.R. Mack, (Chairman), Land Resource Research Institute, Agriculture Canada, Arboretum Bldg. #74, Ottawa, Ontario K1A 0C6 (613-995-9039) April 78 - March 81.
2. Mr. P. Crown, (Secretary) Alberta Inst. of Pedology, Univ. of Alberta, Edmonton T6G 2E3 (403-432-2886) April 78 - March 81.
3. Mr. E. Brach, Engineering and Statistical Research Inst., Agriculture Canada, Ottawa K1A 0C6 (613-995-9671) April 78 - March 81.
4. Mr. John Buchan, Plant Industry Branch, Saskatchewan Dept. of Agriculture, Administration Bldg., Regina S0S 0B1 (306-565-4665) April 79 - March 82.
5. Mr. O. Code, Crops Section, Statistics Canada, Ottawa, Ontario K1A 0L7 (613-995-4877) April 78 - March 81.
6. Mr. R. Karamanos, Dept. of Soil Science, Saskatchewan Inst. of Pedology, Univ. of Saskatchewan, Saskatoon S7N 0W0 (306-343-5184) April 79 - March 82.
7. Dr. E. Derenyi, Department or Survey Engineering' Univ. of New Brunswick, Fredericton E3B 5A3 (503-453-4698) April 79 - March 82.
8. Dr. A. Johnston, Research Station, Agriculture Canada, Lethbridge, Alberta T1J 4B1 (403-327-4561) April 78 - March 81.
9. Dr. J.F. Benci, Canadian Wheat Board, 7th Floor N., 423 Main St., Winnipeg, Manitoba R3C 2P5 (204-949-2633) April 78 - March 81.
10. Dr. R. Paquin, Chercheur Scientifique, Station de Recherches, 2560, chemin Gomin Ste. Foy, Québec G1K 7P4 (418-694-4814) April 77 - March 80.
11. Dr. T. Gillespie, Dept. of Land Resource Science. Univ. of Guelph, Guelph N1G 2W1 (519-824-4120) April 79 - March 82.
12. Dr. Awni Raad, Director, Technical Services Dept. of Agriculture and Forestry, P.O. Box 1600, Charlottetown, PEI (902-892-5465) April 78 - March 81.
13. Mr. Nick Roller, Economics Br., Crop Stat. Ministry of Agriculture and Food, 1200 Bay St., Toronto, Ont. M6A 1B6 (416-965-1064) April 79 - March 82.
14. Mr. G. King, Commodity Market Analysis Policy Planning & Economics Br., Room 335, Sir John Carling Bldg., Ottawa, Ontario K1A 0C6 (613-995-9554) April 79- March 82.
15. Mr. Jim Hilton, Range Management Branch, B.C. Forestry Dept., 540 Borland St. William's Lake, B.C. V2G 1R8 (604-392-6261) April 79 - March 82.
16. Dr. R. Ryerson, Canada Center for Remote Sensing, Energy, Mines and Resources, 717 Belfast Rd., Ottawa, Ont. K1A 0Y7 (613-995-1212) April 78 - March 81.
17. Mr. J. Wright, Palliser Wheat Growers Assoc. 219-3806 Albert St., Regina, Sask. S4S 3R2 (306-586-5866) April 80 - March 83.
18. Mr. J. McKinnon, Prairie Agri-Photo, P.O. Box 816, Carman, Manitoba R0G 0J0 (204-745-2479) April 78 - March 81.
19. Dr. C. Shaykewich, Dept. of Soil Science Univ. of Manitoba, Winnipeg R3T 2N2 (204-474-8153) April 78 - March 81.
20. Vancant

Honorary Life Member

Mr. L.E. Philpotts, 7 Philips Drive, Ottawa Ontario K2E 6R6 (613-224-7157) September 75.

5.2 REPORT ON CARTOGRAPHY AND PHOTOGRAMMETRY

EARSEL Working Group 9 on Space Cartography

At the 4th General Assembly of the European Association of Remote Sensing Laboratories (EARSEL), July 19, 1980, a new Working Group of Space Cartography was established under the Chairmanship of Dr. G. Konecny. Canada is maintaining representation in this working group. The October meeting of the W.G. was held in Paris and was attended by E. Fleming, Topographical Survey and Jack Gibson representing CCRS. The major topics for consideration by the W.G. are the films to go in the cartographic camera in Spacelab, the SAR-580 program in Europe in 1981 and the sensor packages to be carried on the ERS-1 and succeeding satellites in the series. Canadian experience resulting from the SURSAT project was discussed and sample imagery from this project was offered to the W.G. to give members a feel for the product prior to obtaining imagery from the European Program. Canadian experience in the selection of colour infrared emulsion for high altitude work was discussed, as this should be considered in the selection of a film for Spacelab. Film selection for the Zeiss 30/23 camera has been made (Kodak 2443 and Kodak 2405) but airbrone tests are continuing. A second meeting of the W.G. was held in Paris in February and was attended by E. Fleming, Topographical Survey. Concern was expressed at the meeting that ERS-1 has taken the form of an oceanographic satellite rather than an "earth resource" satellite. It is intended to promote a "land" sensing package for any follow-on satellite. The cartography camera is now ready for final interfacing to the Spacelab module. The number of films to be carried on the mission has been reduced from 3 to 2, and the number of "sites" to 36. If other scheduled experiments fail to be ready in time, it is possible that the 3rd film cassette may come back on.

SEASAT Altimeter

In conjunction with Mr. Ron Brooks of the Geoscience Research Corporation Maryland, one track of the SEASAT altimeter over Barnes Ice Cap in Baffin Island was analyzed.

Traveling in a SE-NW direction the altimeter tracked well over Baffin Bay, losing track at the rugged Baffin Island shoreline. Once over the Ice Cap, the altimeter started tracking in a continuous manner for 55km, and the distance between successive surface elevations was about 700m.

The altimeter profile was compared with the same profile obtained from 1:50 000 maps. It was found that although the agreement was better than 5m at the crest of the ice cap, the profiles departed by more than 70m at one end and 27m at the other, placing the satellite outside even 1:250 000 map standards for over half its length. The technology is apparently not yet at a level which would be useful for mapping ice caps.

SAR-580

A research agreement is continuing with Dr. E.E. Derenyi of the University of New Brunswick to proceed with further metric evaluation of SAR data which was obtained on the SURSAT project. In addition it is intended to develop and test algorithms for digital image processing, whereby images produced by various sensors can be transformed to a common geometric base.

Assessment of Revision for Topographic Maps at 1:50 000

Maps in the National Topographic Series of Canada are subject to revision at periodic intervals and this revision cycle varies according to the location of the map. In fringe areas immediately north of the populated zones in Canada this period is set at 15 years, and in the more remote unpopulated areas the period becomes 30 years. Currently there are thousands of maps that are overdue on their revision cycle in these areas. In order to bring as many of these maps as possible "on cycle" at minimum cost, Landsat imagery is being used to detect change and determine for each map subject to revision, whether:

a) There is no evidence of change.
b) Changes are limited to localized activities or linear features such as roads or pipelines.
c) There are many changes and rephotography of the area is required.

The reliability of this technique was tested in 1979 and reported to CACRS last year. In 1980 Topographical Survey awarded a development contract for $20,000 to Gregory Geoscience to assess the status of 491 maps. It was determined that 222 maps evidenced no change and could therefore have their validity date changed to that of the Landsat images used in the assessment. It was similarly established that 70 maps required partial aerial photography to record linear and localized changes, and the remaining 199 maps required complete rephotography.

This approach to map revision assessment is enabling Topographical Survey to move rapidly

in bringing maps into their proper revision cycle at minimum cost. It can be roughly estimated that the cost of photography for a 1:50 000 map is $1300. By concentrating photography only on areas of change and avoiding massive rephotography of unchanged areas, savings of close to $300,000 in photography costs have been achieved in 1980 for the price of $20,000 of pre-assessment using Landsat imagery.

The program is continuing its development stages with the assessment of a further 500 maps in 1981 by Gregory Geoscience.

Revision of 1:250 000 Maps

During 1980 revision techniques based on combining Landsat imagery and conventional sources of information were evolved as part of a development and technology transfer contract between Topographical Survey and Gregory Geoscience. Personnel from Topographical Survey provided the necessary input with respect to compilation requirements, auxiliary data, and field checking techniques and in turn learned to use Landsat information to provide overall revision information. Two maps were used in the pilot project to evaluate techniques and in the 1980/81 program 60 maps will be used to refine the techniques and delineate those areas of the country that maps can be most profitably revised in this manner. This approach is expected to free funds for revision of maps in the more difficult urban and rural areas where Landsat is less effective.

Short-comings in the Use of Landsat for Revision

One of the problems encountered in the use of Landsat data is that it is often necessary to go back as much as 3 years to obtain suitable imagery, so that even a revision done in 1980 can still be 3 years out-of-date. If this is the practical experience in the mapping field, one wonders how the "environment monitoring" aspect, that is promoted so highly for the use of Landsat, can be more current in providing other types of information.

Not all change detected on Landsat can be identified even for 1:250 000 mapping. Field checking and supplementary information is still required. Lack of a recent image in a rapidly changing area can unexpectedly overload the field check and call into question the validity of revising the map at that time.

Isolated cabins and buildings have traditionally been mapped in remote areas. However when Landsat imagery is used to establish that there has been "no change" and the validity date of the map is changed to the date of the Landsat coverage, it is recognized that these small features may well have changed. There will therefore be a cautionary note on the map to this effect.

Proposal for a National Library of Current Landsat Images

As part of the development study on map revision techniques carried out by Gregory Geoscience, the methods of image acquisition and associated cost to facilitate change detection for 1:50 000 were reviewed. From this review comes the proposal for a library of images.

A hypothetical standing order of images was devised for each geographic region to ensure acquisition of images of a uniform rate across the country. The components of the image "package" were defined (MSS, RBV, transparencies).

Coverage of all of Canada using images of good quality would cost about $120,000 annually. Such a national reference library would serve people in many disciplines. A package with less variety but good quality and with emphasis on change detection would cost about $70,000 annually. Further deletion geographically and in image variety could reduce costs to a minimum of about $35,000.

An updated regional library is a second, different approach to acquisition of images. Canada would be divided into 5 segments based on selected longitudes. Images would be acquired in each segment only for one year and in the 6th year accumulation would begin again in the first region. Map revision would be done for one segment only during the year following acquisition. Cost annually would be in the order of $15,000. This system precludes a quick response for timely information outside the segments of recent acquisition and may not readily serve the needs of other disciplines or map revision in other segments.

Libraries of Landsat images exist in some other departments of the government. For example, CCRS has an extensive though incomplete library of images (including transparencies) acquired up to mid-1976. The Geological Survey of Canada (Mr. Roy Slaney) has selected images for about 70% of the image centres for Canada. All data are in print format. The library is not kept current.

The Ecological Land Evaluation and Classification Environment (Mr. Clay Rubec) also has selected Canadian coverage in colour transparency. The collection includes about 900 scenes providing complete coverage of the Canadian landmass but current images are acquired only on a need basis.

The fundamental decision concerning a library of Landsat data is whether several departments should get together to fund a national library for multidisciplinary use and open access or whether the Surveys and Mapping Branch should fund a library specifically related to map revision with restricted access. In either case, the essential requirement for transparencies in change detection is emphasized.

LANDSAT Archive

As a result of the recommendations presented to the CACRS meeting last year by the Geoscience Working Group and the Cartography and Photogrammetry Working Group a study was set up to explore the feasibility of creating a selected set of best images covering all Canada that could be marketed as a unit, or in sub-units, which could make first-time access to Landsat imagery easier for people unfamiliar with the products.

Several individuals have worked on the selection of "best" images over the years and the best collection now exists with C. Rubec of the Department of the Environment in the form of colour transparencies.

It has been proposed that copying these transparencies, on to 35mm or 70mm strip film would provide a master negative file that could be reproduced in bulk as required. Using current NAPL/RC reproduction prices for continuous contact transparencies, a complete set of Landsat scenes, in colour at a 70mm size, would cost about $650. Mounting in frames would be extra. Regional groupings of images could be arranged to provide smaller "packages". Studies are continuing to establish good reproduction techniques so that image quality could be maintained.

Appendix I-Current Bibliography

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Derenyi, E., El-Hakim, S.F., and Szabo, L. "Planimetric Adjustment of SAR Imagery Using a Harmonic Function", 46th Annual Meeting of the American Society Photogrammetry, March 1980.

Fleming, E.A. "Determination of the Geodetic Accuracy of SEASAT-SAR Imagery Products." Final Report, Surveillance Satellite Project January 1980.

Fleming, E.A. "Change Detection by Landsat as a Guide to Planning Aerial Photography for Revision Mapping." 14th Congress ISP Hamburg 13-25.7.80 Commission IV W.G.4.

Fleming, E.A., Guertin, F.B., "Determination of the Geographical Position of Isolated Islands Using the Digital Image Correction System for Landsat MSS Imagery" 14th Congress ISP Hamburg 13-25.7.80, Commission IV W.G.4.

Appendix II List of Participants.

CHAIRMAN: Dr. J.M. Zarzycki
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INS applications

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EARSEL Working Group on Space Cartography

E. Fleming, Topographical Survey

ESA - Space Lab Metric Experiment

Dr. J.M. Zarzycki
Canadian project coordinator.

5.3 REPORT OF THE WORKING GROUP ON DATA HANDLING AND SATELLITE TECHNOLOGY

INTRODUCTION

The working group had an active year: providing advice and support on the major new satellite activities, LANDSAT-D and RADARSAT; assessing computer tape production at Prince Albert; and preparing a listing of Canadian industrial companies with remote sensing expertise.

REPORT OF SATELLITE TECHNOLOGY SUB-GROUP

Chairman - J. Taylor

Between May to September, 1980, the group met frequently to provide advice on the Canadian position for a shared radar satellite program with NASA. The position recommended was for a Canadian leadership position in a radar satellite program primarily oriented to sea-ice applications. An agreement which preserved this position, was signed by NASA and EMR in November 1980.

The group also prepared a brief on the industrial and governmental needs and capabilities for a radar satellite program to be given to the Cabinet Committee for Social and Economic Development. Due to time limitations, a revised and shortened version of this brief was given to Cabinet ministers in December, 1980.

REPORT OF THE CCT SUB-GROUP

Chairman - F. Potts

The group postponed consideration of a format for cassette tapes because the 34 Mbyte tape unit from DEI Ltd. was withdrawn. DIPIX Ltd., who will use these cassettes in their LCT-11 image analysis system, are now using the 67 Mbyte unit from 3-M Ltd. They are using the format developed for disk on the DOE ARIES system.

They have started to assess the CCT production at CCRS and have visited the Ottawa and Prince Albert facilities. An interim report on this work is appended.

A listing of Canadian companies engaged in remote sensing systems and services is also appended.

REPORT OF IMAGE ANALYSIS SUB-GROUP

Chairman - D.G. Goodenough

The Image Analysis System Sub-Working Group (IASSWG) has met three times since its inception as a sub-group of the Data Handling and Satellite Technology Working Group.

(1) December 12, 1979 at CCRS in Ottawa;

(2) March 13, 1980 at McGill University in Montreal;

(3) August 27 and 28, 1980 at the University of British Columbia and MDA in Vancouver.

A list of participants from industry, government and universities is given in the Appendix. The following items were adopted as suitable areas for discussion by the IASSWG:

(1) CCRS initiatives in the research and development (R&D) of image analysis systems;

(2) standards for data linkages, processed data, user/system interaction, evaluation of algorithms;

(3) concerns related to geocoded data base structures;

(4) concerns related to the provision of image analysis services.

IMAGE ANALYSIS PLANS AT CCRS

Considerable time was spent at each meeting discussing CCRS image analysis plans for LANDSAT-D Thematic Mapper data, as well as for a more sophisticated information extraction system called TOPAS (Terra Observation Pattern Analysis System). The development of a LANDSAT-D Image Analysis System (LDIAS) is a funded program designed to give CCRS the capability of making full use of the better spectral, spatial, and radiometric resolution expected from the thematic mapper. TOPAS is a proposed program for the development of an information extraction system

with Canadian industry which will integrate satellite and aircraft remote sensing data with other geographic data base information. Both of these R&D image analysis systems are also expected to lead to further benefits to Canada through the development of world class industrial capability in image analysis systems and the worldwide marketing of products. Thus, discussions with representatives from industry in the context of this working group have been particularly helpful to CCRS in its efforts to come up with proposals having blends of industrial involvement through government contracts.

It was recommended that CCRS should provide the following thematic mapper image products:

(1) fully corrected;

(2) raw data CCTs (1600 bpi, 6250 bpi) with tables for radiometric correction;

(3) subscene CCTs on map grids.

With the exception of large agencies, users would not be provided with HDDTs. Serious consideration should be given to tape cassettes and an eye should be kept on developments in the area of optical storage devices.

FORMAT STANDARDS

The group was asked to study two format documents:

(1) "Standard Format for the Transfer of Geocoded Polygon Data", CCRS Research Report 79-3, which describes a standard format for the transfer, via CCT, of geocoded information in spatial data polygon files;

(2) "UNIDSK File Format Specification", CIAS Project Memo 79-65, which describes a universal disk file structure conceived and designed at CCRS. It was felt that UNIDSK may be a good place to start fulfilling the need for a standard image disk file format. One suggested way to strive for compatibility is to define a virtual machine with logical primitives and operators which could be implemented on a variety of systems. However, after further consideration by CCRS and the University of British Columbia, it was concluded that the implementation of such a set of largely machine independent specifications would only lead to procedures too inefficient to be practical.

COST RECOVERY AT CCRS

CCRS plans for cost recovery for image analysis services were presented for preliminary discussion and comment, although the mechanisms for handling project proposals have yet to be finalized. Nevertheless, it was recommended that CCRS must ensure consistency and fairness in its implementation and application of the cost recovery rules.

LIST OF PARTICIPANTS IN THE IMAGE ANALYSIS SYSTEM SUB-WORKING GROUP

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CANADIAN CCT PRODUCTION - INTERIM REPORT

SCOPE

This report was occasioned by a request to the CCT Sub-Working Group of CACRS. The terms of reference were "to advise on means of improving CCT production in Canada". This document is an interim report summarizing the situation as perceived after a visit to the Prince Albert Satellite Station (PASS).

INTRODUCTION

CCT Production in Canada is supposed to be performed out of three coordinated centres. These are PASS, SCSS and CCRS in Ottawa. To adequately assess the situation, it was planned to make an initial visit to CCRS, then to visit PASS and SCSS and finally to return to CCRS to discuss some of the impressions gained from the PASS and SCSS visits. As of this time, only the initial visit to CCRS and the visit to PASS have been completed. Consequently, some of the observations reported should be treated as provisional since no effort has been made to discuss them with some of the CCRS staff involved. It should be noted here that the author expects to find the major problems in CCT production to exist at SCSS rather than at PASS.

PASS

The overriding impression at PASS is that of a smoothly running system with very few, if any, problems not within the control of the station staff. This is in spite of a system, MIPS, being used to perform a task for which it was not originally designed. Equipment in operation there includes antenna, downlinks, HDDTs, computer systems and an elaborate photographic laboratory. The credit for this state of affairs must be given to the staff, both those under contract with SED and government staff.

PASS is in a fairly isolated location, and as a result would expect that some difficulty would be experienced in retaining highly trained staff. This appears not to be the case. In fact, the station director emphasized that, as a matter of deliberate policy, he attempts to involve all staff in interesting technical work outside that required to simply keep the station operating. This policy is obviously successful insofar as staff turnover is concerned and perhaps more important, has permitted PASS to overcome some potential system problems quite effectively without having to resort to outside help. As a result, personnel at PASS have acquired a very significant amount of expertise in the design and operation of Satellite Ground Receiving Stations. This expertise should be intimately involved in any future equipment procurement for PASS, in particular for LANDSAT-D systems. By so doing it is hoped that many of the "teething" problems involved with MIPS might be avoided.

PASS is presently upgrading the MIPS system to improve its utilization. It is claimed that once these modifications have been completed PASS will be able to produce about 1,000 CCTs per year. This number could be increased by working extra shifts if required without any necessity to modify the equipment. Since MIPS is also used for the operation of both single band and multiband images, and since these activities necessarily impact CCT production, obviously a priority policy must be used to intelligently allocate resources. For example, at present a significant amount of MIPS time is used to produce CCTs to be transferred to Ottawa for colour image production on the CIR. Perhaps some of this colour-on-demand might be produced directly on the LBIR at PASS. If this were possible, the loading on MIPS would be somewhat reduced, thus making it more available for CCT production.

On the question of turnaround, again it appears that a priority policy is required. Technically it should be possible to give end users very rapid turnaround but at the expense of system loading.

If end users were prepared to pay, then PASS would probably be able to meet a rapid turnaround requirement through working extra shifts. Otherwise, any rapid turnaround work will impact the production of standard products.

An area worthy of further investigation is that of the end user interface. At present some CCT orders are processed through CCRS in Ottawa from where they are

sent to PASS. This procedure appears to work well. Where difficulties seem to occur is in the area of user assistance after receipt of the final product. At present, any difficulties are raised directly with CCRS from where, if necessary, they are referred to PASS. Perhaps a "hot-line" could be initiated to PASS so that end users could have the opportunity of discussing their problems directly with PASS personnel. This would have two desirable results. First, end users would have their problems, (real or apparent) corrected more rapidly than at present and secondly PASS could become better acquainted with user acceptance of their products.

In summary, a number of recommendations have been made, all of an organizational nature. The absence of any specific technical recommendations is a reflection of the technical competence apparent at PASS. Further possible recommendations have been set aside for the present until after a visit to SCSS has taken place and final discussions with CCRS have been held.

CANADIAN INDUSTRY: REMOTE SENSING SYSTEMS AND SERVICES

A number of industrial organizations are currently active within Canada in applying various techniques to remote sensing problems. Much of this activity has lead to significant export sales which should be a point of some pride both for the companies involved and for CCRS. It is expected that CCRS, together with other Federal and Provincial government authorities will continue to support industrial activity through the contracting out policy, through staff secondment and through the use of various government technology transfer programs.

Remote sensing covers a very broad sphere of activity. Instead of attempting to include all companies active in this area, this report concentrated on those companies which might expect to interact closely with CCRS in the course of their normal business activities. This arbitrary and somewhat subjective classification was thought to be the best compromise between serving the interests of readers of this document and attempting to present an exhaustive review covering all Canadian industrial remote sensing activity.

The method used to compile this report was first to draw up a list of companies known to be active in remote sensing. Companies were selected through informal consultation with CCRS and by reference to attendance lists at previous Canadian Symposia on Remote Sensing. This initial list, together with a letter requesting a short contribution describing their remote sensing activity was circulated to all companies. About 25% of the companies solicited did respond. A small number were also able to bring to my attention other companies whom they thought should have been included in the list. These companies were also approached.

The list, presented below in alphabetic order, consists of the initial list of companies augmented as described above. Originally, it was intended that contributions from responding companies would be simple collated and included with this report. In view of the fact that such a small proportion of solicited companies did actually respond in the limited time available, each entry in the list is simple accompanied by a few key-words describing their remote sensing activity. Perhaps in future years a more complete study might be funded resulting in a comprehensive directory of industrial activity in remote sensing. Any Canadian company offering remote sensing services, who wishes to be included in an updated listing should contact CCRS.

Barringer Research Ltd.,
304 Carlingview Drive,
Rexdale Ontario
M9W 5G2 - remote sensing instruments, manufacturer

Collins & Moon,
435 Stone Rd. West,
Suite 215,
Guelph, Ontario
N1G 2X6 - mapping software, consultants

Control Data Corp.,
130 Albert Street,
Suite 1105,
Ottawa, Ontario
K1P 5G4 - image analysis software, computer system mfgr.

Deloitte, Haskins & Sells Assoc.,
Suite 630,
99 Bank Street,
Ottawa, Ontario,
K1P 6B9 - software, agricultural consultants

Dendron Resource Surveys Ltd.,
880 Lady Ellen Place,
Ottawa, Ontario
K1Z 5L9 - forestry surveys, consultants

DIPIX Systems Limited,
1785 Woodward Drive,
Ottawa, Ontario
K2C OP9 - image analysis equipment manufacturer and services

Geostudio Consultants,
525 St. Laurent Blvd.,
Suite 24,
Ottawa, Ontario
K2H 8K7 - remote sensing software, consultant

Gregory Geoscience Ltd.,
1750 Courtland Crescent,
Ottawa, Ontario
K2C 2B5 - remote sensing, mineral exploration, environmental analysis consultant

Imapro Inc.
W. Royalty Industrial Park,
Carlottetown, P.E.I.
C1E 1BO - colour image recorders, manufacturer

Intera Environmental Consultants Ltd.,
2841 Riverside Drive,
Suite 204,
Ottawa, Ontario
K1V 8N4 - remote sensing, software, ICE, SAR consultants

MacDonald, Dettwiler & Associates,
10280 Shellbridge Way,
Richmond, B.C.
V6X 2Z9 - LANDSAT, ground stations, weather satellite station, SAR systems & software, image analysis systems manufacturer

James F. Maclaren Ltd.,
Consulting Engineers,
Planners & Scientists,
1240 Portage Ave.
Winnipeg, Manitoba
R3G OT6 - consulting engineers, planners and scientists

J.D. Mollard Assoc.,
815 McCallum - Hill Bldg.,
Regina, Saskatchewan
S4P 2G6 - engineering geology, consultants

Moniteq Laboratories,
630 Rivermead Road,
Concorde, Ontario
L4K 1B6 - monitoring environmental quality

NORDCO,
P.O. Box 160,
Pouch Cove, Newfoundland
AOA 3LO - remote sensing, consultants

NORPAK Ltd.,
Pakenham, Ontario
KOA 2XO - image display sub-system, manufacturer

OVAAC-8 International Inc.,
4800 Dufferin St.,
Downsview, Ontario
M3H 5S9 - image analysis system - manufacturer

Paul Fuenning & Assoc. Ltd.,
7027 Kenossee Place, S.W.
Calgary, Alberta
T2V 2L6 - geological consultants

Philip A. Lapp Ltd.,
14A Hazelton Ave.
Toronto, Ontario
M5R 2E2 - remote sensing, agriculture, consultants

Reimchen Surficial Geology Ltd.,
4381 Gallant Ave.,
North Vancouver, British Columbia
V7G 1L1 - surficial geology - consultants

Remotec Applications Inc.,
P.O. Box 5547,
St. John's, Newfoundland
A1C 5W4 - remote sensing applications, ocean, ice, satellite data, airborne, services

SED Systems Ltd.,
710 - 350 Sparks Street,
Ottawa, Ontario
K1R 7S8 - ground station operations and systems, remote sensing sensors, manufacturer

Canadian Astronautics Limited
1024 Morrison Drive
Ottawa, Ontario
K2H 8K7 - conceptual design studies for a Canadain remote sensing satellite system
- software development

SPAR Aerospace Limited
1800 Ormont Drive
Weston, Ontario
M9L 2W7 -infra-red systems, satellite systems, radar

5.6 REPORT OF THE WORKING GROUP ON ENGINEERING APPLICATIONS

WORKING GROUP ACTIVITIES

The Working Group devoted most of the year in preparing, with the assistance of the C.C.R.S., the proceedings of the First National Workshop on Engineering Applications of Remote Sensing and began the task of assembling materials for the preparation of a user's manual. Request was also received from the American Society of Photogrammetry to contribute Canadian case histories in engineering applications to a new edition of the Manual of Remote Sensing. The compilation of case histories is now in progress.

RECOMMENDATIONS

Based upon the discussions we had during the workshop held in Ottawa last year, the following are some of the recommendations made by the Engineering Applications Working Group:

In recognition of the fact that most engineering applications require relatively large scales, that the routine production of enlarged, digitally enhanced LANDSAT imagery to, for example, 1:50,000 or larger, be investigated.

As engineering applications of satellite imagery generally require greater spatial resolution than that presently available, that CCRS give continued high priority to arranging for the availability of the highest resolution satellite imagery of Canada to be remotely sensed in the future by orbital platforms operated by other countries.

Workshops particularly oriented towards engineering applications be arranged and co-ordinated by CCRS on a regular basis, in conjunction with the working group.

That an audio-visual presentation on the engineering applications of remote sensing, accompanied by reproductions of the appropriate imagery, be prepared by CCRS for distribution to the user groups such as government agencies, private industry, and universities and colleges.

Appendix 1

Members of the Working Group on Engineering Applications

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5.8 REPORT OF THE GEOGRAPHY WORKING GROUP

Activities

Following the annual CACRS meeting held in April 1980, the terms of office of all members of the Geography Working Group expired. Dr. Philip Howarth, who had been chairman of the Working Group for several years, also resigned his position at that time.

At the April 1980 CACRS meeting, a major topic of discussion had been future organization and direction for CACRS. There was to be possible reorganization and a new structure for the committee. For this reason, Dr. L.W. Morley, who was in the process of resigning as Director General of CCRS, decided to leave the reappointments to his successor.

In February 1981, Mr. E.A. Godby, the new Director General of CCRS, invited Ms. M.D. Thompson to take over the chairmanship of the Working Group.

Forecast

In keeping with the task-oriented prespective for CACRS Working Groups, the Geography Working Group will undertake the preparation of a Canadian presentation on change detection with Landsat for the COSPAR (Committee on Space Research) Symposium XXIV (to be held in Ottawa in June 1982). This task is currently in the initial planning stages.

5.10 REPORT OF THE WORKING GROUP ON ICE

Airborne Remote Sensing

The CCRS Convair 580, with SAR, scatterometer, radiometer, PRT-5 and RC-10 mapping camera on board, flew two ice missions during 1980, both in a similar area of the Beaufort Sea. Comparative imagery was obtained of sea ice under melt conditions in late June/early July and under early freeze-up conditions in mid-October.

Aerial photography was used for research into Liard and MacKenzie River ice conditions, hydrologic and glacier studies, by Snow and Ice Division, NHRI.

Spaceborne Remote Sensing

Work has been initiated on a bilaterial NASA/Canada synthetic aperture radar (SAR) satellite mission requirements study. Energy Mines and Resources is the lead agency on behalf of the Canadian Government for the RADARSAT programme. The goals of a bilaterial SAR satellite program would be to provide timely information on ice and ice-covered oceans, to provide research data for analyses of ice and open oceans and to evaluate the contributions of a SAR satellite system for assessing renewable and non-renewable land resources.

To support the study, an experimental program is planned including airborne SAR missions, using the CCRS SAR-580. The satellite SAR is expected to be a C-band radar; the CCRS SAR is being modified to include C-band, see Technical Developments.

Technical Developments

A contract has been let to Canadian Astronautics Ltd., Ottawa, to provide a C-band (5.3 GHz) channel to the CCRS X/L band SAR. The additional instrumentation will allow the acquisition of either dual polarized X- and C-band imagery or dual polarized X- and L-band imagery. Modifications to the antenna mount and radome will simplify the task of altering the radar depression angle and of removing and changing the antenna. Work on the C-band channel should be completed in April and it is hoped to acquire initial C- band imagery of sea ice and icebergs during the Danish ESA/JRC experiment off Greenland.

Negotiations are underway on the work statement and funding details on a contract for the development of an X-band, wide swath synthetic aperture radar designed for ice reconnaissance. The development of the radar will take place in Canadian industry and the funding will be split between DSS, EMR, CCRS and the petro-industry. The first production radar will be used operationally in support of Arctic oil company operations.

Under the sponsorship of Transportation Development Center (TDC), an experimental prototype remote sea-ice thickness sensor was developed and tested both in the laboratory at MPB Technologies (MPBT), Inc. Ste-Anne-de-Bellevue, Quebec and in the Beaufort Sea, in April 1980. The field experiments were successful for brackish, first-year and multi-year ice thickness.

The TDC/MPBT sea-ice thickness sensor consists of a synthetic pulse radar (SPR) and an impulse radar (IMR) sharing the same antenna. This package enables one to measure sea-ice thickness from 0.5 m to a few metres.

An over-the-horizon radar is under development by CRC and C-CORE (for DFO and DND). During 1980 software was developed and checked out with a small data-set from the ocean near St. John's, Newfoundland. It is hoped that sea state and presence or absence of ice and icebergs in the Labrador Sea will be detected, using a transmitted beam from New York to Labrador and received at CRC, Ottawa. This system uses HF frequencies and relies on reflection from the ionosphere to achieve over the horizon operation.

In November 1980 Dome/Canmar and Intera mounted a conventional X-band marine radar (Decca 25 KW) 70 m above the ice, on top of the drill tower of the Explorer II drill ship. The experiment to determine ice discrimination was run in Winter Harbor, McKinley Bay.

In spring 1980 Intera developed a digital UHF recording and downlinking facility for airborne SAR data; this was utilized in the Icemap II project for Dome/Canmar in October, when SAR imagery was transmitted in real-time to provide full-quality imagery on the drill ship.

Applications

The CCRS airborne SAR was used by Intera in a real-time, operational mode during October, 1980, to support Dome-Canmar in their Beaufort Sea drilling operations.

The AES Ice Patrol flew approximately 2500 hours of ice reconnaissance during 1980, of which 1350 hours were flown with the SLAR-equipped aircraft, in operational support of marine activities in ice-covered waters.

F. G. Bercha Ltd., Calgary, has acquired an airborne SLAR during 1980, which has now been certified for Canadian use and will be operating on a Bercha aircraft out of Calgary. The SLAR is essentially the same as that on the AES ice patrol aircraft.

Aerial photography is used on a routine basis to monitor ice conditions during frontier exploration. Oil companies and remote sensing service companies now use Landsat, NOAA and SLAR data routinely both in near-real time and historically.

Some investigations of SEASAT SAR imagery look very encouraging while ice applications of the SEASAT altimeter and scatterometer data also are under investigation.

User Liaison

A Final Workshop for participants in the Sursat Ice Experiments was held in June at A.E.S., Downsview. Proceedings will be available soon, see Appendix II.

Training

The Ice Branch of A.E.S. at Downsview, gave a five week course to trainee ice observers and one week courses in English and French to officers of the Canadian Coast Guard.

Conclusions and Forecast

The Working Group on Ice, in accordance with the CACRS recommendations that working groups should have meaningful goals, met in December to update its mandate and membership. The list in Appendix III comprises membership in the group from January 1981, for terms of 1-3 years. The acting chairman is Laurence Gray of CCRS.

The 1980 year marked the end of a successful Sursat experiment for the ice community, with a final meeting held in June to discuss results, conclusions, future study requirements and plans.

As a consequence of the successful co-operation established during the Sursat Programme, it is anticipated that extensive international co-operation will continue during the RADARSAT ice research to take place at various locations in the Arctic during 1981 and 1982.

Recommendations

The Working Group on Ice recommends that:

1. a systemmatic evaluation of the three frequency channels of the SAR be undertaken.

   While acknowledging that CCRS now provides in the SAR-580 one of the most advanced facilities in the world for research and development into microwave remote sensing, ground and airborne testing is recommended to study the limitations due to system noise, saturation, non-linearities and stability of the various parts of the radar. Such a study is a prerequisite to establishing a relative calibration and, possibly, a limited absolute calibration for an output image product. Also such a study should help with the problem of establishing what aspects of a final image reflect terrain backscatter levels and contrasts and what aspects reflect radar system limitations and characteristics.

2. land ice (glaciers and freshwater ice, both on lakes and rivers) should be considered in any studies for Radarsat. The expected improved resolution will increase potential usefulness of radar for such targets and sorties planned for the airborne SAR (X, C) should include overflights of land ice test areas.

Appendices

Appendix I - Current Projects

For glacier studies see Canadian Geophysical Bulletin 1980, and for glacier, sea ice and ice physics studies see Ice, 1981, the newsbulletin of the International Glaciological Society.

Appendix II - Current Bibliography

Bibliographies of Glaciology in Canada are available from Simon Ommanney, Snow and Ice Division, NHRI.

Rossiter, J. R. and D. P. Bazeley, ed., May 1980, Proceedings of the International Workshop on the Remote Sensing of Sea Ice Thickness, St. John's, September 25-26, 1979, 505 pp.

Ramseier, R. O. and D.F. Lapp, ed., Feb. 1981, Proceedings of the Final Sursat Workshop, Downsview, June 1980, Atmospheric Environment Service.

Markham, W. E., Feb. 1981, Ice Atlas - Canadian Arctic Waterways, Environment Canada, AES. (in English and French).

Appendix III - List of Group Members

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Member from the Fisheries Council of Canada, Director D. Edwards.

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Mr. D. J. Lapp (Secretary)
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MacDonald, Dettwiler & Associates
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5.11 REPORT OF THE WORKING GROUP ON OCEANOGRAPHY

Because the interests of the oceanographic community have in general been covered in specialized SEASAT and SURSAT programs, this working group did not meet as frequently in 1979 and 1980 as it did in previous years. With the need for new coordination and information exchange in the light of planned future Canadian and foreign satellite programmes, the group has now been restructured. A meeting was held on April 10 at CCRS (Sheffield Road) which was attended by 14 scientists from federal government departments (including 4 from CCRS), 12 from private industry and two from universities. Representation from industry and government research was good, but more representation from ocean data user groups (METOC and AES) would have been useful.

SATELLITE REMOTE SENSING DATA

E. Shaw of CCRS informed the group of the recently approved budget increase to CCRS covering installation of Landsat D receivers, upgrading of image analysis equipment, a contribution to the European ERS-1 satellite and phase A of the joint Canada/US Radarsat program. A. Collins also reported on the Japanese MOS program, and J. Gower and H. Zwick led a discussion of water colour observations. Data collection and platform location was also identified as a topic of high interest to the group.

Radarsat

The program involves a high resolution imaging synthetic aperture radar (tentatively 30 m resolution at C band with 1990 launch) on a polar orbiting satellite with much of the radar itself contributed by Canada. Canadian ice interests for gas and oil developments are the driving force, but Canadian teams are to be formed also in the fields of "oceans", "renewable land resources" and "non-renewable land resources". Similar teams should be organized on the US side, although with cancellation of NOSS, Radarsat is looked on as a candidate carrier for a wider selection of sensors.

Dr. Mason (BIO) requested names of potential "ocean" team members, and Emery (UBC), Ploeg (NRC), Dawe (Remotec), Jain (Moniteq), Keeley (DFO), Peteherych or Kerman (AES) Gower (DFO) and Denner (Memorial Univ.) expressed interest. Mason, Dawe, the AES representative and Denner were named as potential attendees at a meeting in Washington, D.C. in the weeks of April 20 or 27 to discuss the program with the U.S. 'ocean' team. A report on potential Canadian "ocean" participation in Radarsat was requested by Dr. Shaw to be completed before the end of May. Dr. Mason commented on the problem this tight schedule imposed.

Dr. Lapp of P. Lapp Associates has been contracted to survey the user requirements for Radarsat data. Details of his tour of Canada can be had through Ottawa Federal Government phones 996 5630 or 995 6730. Concern was expressed at the lack of needed research experience for providing accurate answers to such surveys. A recommendation on increasing research money was drafted (see below).

The SAR-580 with 2 frequency imaging radar (including C band) will be made available for experiments related to Radarsat, in three periods in 1981: West Coast Aug. 5-15, East Coast Aug. 29-31, Beaufort Sea Oct. 1 - Dec. 31. Proposals for experiments should be submitted to Ed Shaw (CCRS).

ERS-1

Canada has associate membership in ESA, and can now participate in the remote sensing Preparatory Study to its termination in 1982/83 with a full vote in ERS-1 planning. Canadian contacts are:
Remote Sensing Advisory Group (users) E. Langham
Earth Observation W.G. (sensors) K. Raney
Program board for remote sensing R. Baker

ERS-1 is planned to be a predominantly ocean observation satellite carrying, 1. Active Microwave Instrumentation. A C-band package which can be used in any of 3 modes: as an imaging SAR (30 x 30 m resolution 75 km swath), a wave scatterometer (directional wave spectra computed from 5 km SAR scenes every 100 kms) or a wind scatterometer (similar to the SEASAT instrument but at C band and giving only 400 km swath).

2. A Radar Altimeter similar to the SEASAT instrument.

3. An Ocean Colour Monitor similar to the instrument proposed for NOSS, but with a "u" in "colour".

The SAR 580 will be going to Europe in the summer of 1981 to collect C-band SAR data in support of the ERS-1 programme. CCRS has suggested Canadian participation in experiments, if European principal investigators consent is given.

Canadian requirements for NOSS ocean satellite data were being coordinated by AES. ERS-1 seems the obvious source of data after cancellation of NOSS, but no decisions have yet been taken. The Canadian side of the Radarsat program aims to launch a C-band imaging radar. ERS-1, designed partly with Canadian input and Canadian requirements in mind, will now carry such a SAR. Such multiple options are welcome, but plans are now confused.

The Japanese MOS Programme

This programme includes 3 satellites that cover approximately the capabilities of Landsat, the NOAA weather satellites and the ERS-1 type satellite.

Canada is planning a joint programme with the Japanese with the SAR-580 going to Japan for a few months period. Little contact has yet been made on this work, which is carried out solely within Japan.

WORLD CLIMATE RESEARCH PROGRAM REQUIREMENTS

J. Gower (IOS Pat Bay) attended a meeting of the JSC-CCCO group of the World Climate Research Programme in Oxford England (January 1981) in which two major ocean experiments, based largely on satellite capabilities, were discussed. These were CAGE measuring heat and water vapour flux through a "CAGE" like volume containing most of the North Atlantic, and WOCE "World Ocean Circulation Experiment" in which satellite altimetry (largely TOPEX) corrected by gravitational data from "GRAVSAT" and extrapolated below the sea surface by ship data would measure water movements. The meeting aimed to coordinate satellite programs to optimise data collection for these experiments and a report will be available. F. Dobson (BIO) is chairman of the CAGE planning committee, C. Wunsch (MIT) is responsible for WOCE. A NASA/JPL report "Satellite Altimetric Measurements of the Ocean" March 1981 describes TOPEX plans.

WATER COLOUR OBSERVATIONS

Coastal Zone Color Scanner

This sensor now in orbit on Nimbus 7, has collected an enormous amount of data since launch in 1978, but little has been made available to users. The data are potentially more valuable to many physical and biological oceanographic studies than the microwave sensors discussed above, although limitation by cloud cover restricts operational use of the data. Apart from its low availability, the data needs considerable processing by the user. Moniteq has developed software for CCRS, and IOS Pat Bay has adapted a Scripps (Visibility Laboratory) software package. First results look quite impressive.

New Sensors

The proposal from IOS Pat Bay to develop a fluorescence line imager has received cabinet approval for a $1M development program. This covers construction of an airborne scanner and image processing equipment and a study for a sensor to operate in a satellite. The scanner will be based on a two dimensional diode array, using a focussed holographic grating to achieve about 300 spectral bands in as many spatial channels. The data will be preprocessed to form about 6 spectral bands with the spectral response under software control, or to give full spectral response in 6 different look directions. Such an instrument should form the next generation of multispectral scanner for a variety of purposes, although its capabilities are particularly suitable for fluorescence mapping over water.

CCRS is developing a "MEIS II" scanner based on a number of one dimensional diode arrays each imaging in one spectral band. This instrument is primarily designed for use over land but could also be adapted to water colour observations.

Analysis of ocean colour data from CCRS' present scanner shows that this instrument lacks the needed signal to noise for coastal or ocean observations, and improved instruments, such as the above, are badly needed.

DATA COLLECTION AND PLATFORM LOCATION

Many useful oceanographic observations are now being made with this technique and several points were made:

1) System Argos provides a useful service, though cost is often cited as too high.
2) AES has planned a local satellite receiving station for the Halifax area which includes positioning and data collection capability.
3) The ongoing SARSAT program (US, France, USSR, Canada, Search and Rescue Satellite) involves location of cheap emergency location transmitters by a package to be flown on NOAA 7 and later satellites. Ground stations are being built by Canadian Astronautics Ltd. A future development may reduce the cost of platforms.

4) CCRS already has a Data Collection Platform working group which lacks an oceanographic representative, J. Garrett (IOS, Pat Bay), J. Elliott (BIO), Glen Catlin (Bristol Aerospace) and Logan Duffield (Hermes) were suggested for this and E. Langham undertook to look into this liaison.

IMAGE ANALYSIS

Bedford Institute is evaluating image processing equipment available in Canada. Small contracts are being given to OVAAC-8, Dipix and MDA to process a package of digital ocean imagery as a demonstration to DFO scientists. This is being organized for late May by H. Edel (DFO, Ottawa) and B. Topliss (BIO). W. Emery (UBC) has suggested the scientists also visit the UBC image processing facility.

SURVEYS OF "OCEANS FROM SPACE"

F. Bunn of PhD associates reported on a study of contributions of satellites to transport, fisheries, oceanography and other ocean users, carried out by the (non-profit) Institute for Research in Public Policy of Montreal. A meeting was held in January 1981 to collect input. Few members of the working group were aware of the study and some concern was expressed as to its completeness and value of its conclusions as a result. The report is due to be submitted to DFO in the near future and will have to be examined as it stands.

J. Gower (IOS, Pat Bay) organized the COSPAR/SCOR/IUCRM conference "Oceanography from Space" held in Venice, Italy, May 1980. This covered the status of optical, infrared and microwave passive sensing, active radar imaging and scatterometry, and radar altimetry. A session on ice applications and papers on satellite data collection were included. Proceedings should be available in the summer of 1981 from Plenum Publishing Corporation, New York.

AIRBORNE SENSORS

Use of airborne sensors as discussed above stresses back up and testing of satellite systems. For large scale ocean sensing, satellites have sufficient advantage for this to be a reasonable attitude, but in many studies R. O'Neil felt airborne sensing is valuable per se.

CCRS can provide a range of sensor packages on aircraft, charged on a "per line mile" basis. Thermal scanning and aerial photography services are commercially available and fall outside CCRS responsibility. Shortcomings of the CCRS scanner for water colour measurement was noted above.

Other sensors include a laser fluoresensor, a lidar bathymeter, a precision photographic "aerial hydrography" installation, a scattermometer and the SAR-580 referred to above.

RECOMMENDATIONS

1. Whereas there is a serious deficiency in significant research being carried out in Canada on the applications of remote sensing to the study of oceanographic and near shore phenomena, and whereas Canada has developed a significant capability in the development of a high technology remote sensing industry including satellite hardware, sensor technology, data collection and image analysis systems, the working group recommends that an amount roughly equivalent to 5% of CCRS' technology budget should be devoted to a research subvention fund to sponsor appropriate applications research studies in Canadian universities and industrial organizations. We recommend CCRS approach NSERC about making such a fund available.

2. It was recommended that CCRS should designate an oceanographic liaison scientist on its Applications Division who would attend oceans working group meetings and work on oceanographic uses of RADARSAT and other data for oceanography.

3. Since data collection and platform location are an important part of "oceanography from space", it was recommended that increased liaison was required between the ocean and the data collection platform (DCP) working group. Garrett and Elliott (DFO), Catlin (Bristol Aerospace) and Duffield (Hermes) were suggested as possible members.

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5.12 REPORT OF THE WATER RESOURCES WORKING GROUP

Introduction

Two meetings of the group were held in 1980. The first was held in Quebec City in conjunction with the Workshop on Data Collection Platform Networks (sponsored by this Working Group and the Canadian Remote Sensing Society); the annual business meeting was held at the Atmospheric Environment Service, Downsview. Much of the Working Group's effort for 1980 centred around the DCP Workshop, first its organization and secondly the discussion and implementation of recommendations from it.

This report, unlike previous years, will be subdivided by water resource activity, with discussion focusing on any type of remote sensing within the activity. The Working Group considers data retransmission via satellite and weather radar as applied to water resources to be within its area of concern.

The current terms of reference of the group, as reviewed and revised at the business meeting are given in Appendix I.

Remote Sensing of Water Resource Variables

a) Precipitation

Considerable development work is being conducted to provide areal precipitation estimates useful for water resource applications. In Alberta, the Alberta Research Council is designing the specifications for a system whereby the existing radar facilities at Penhold can provide real-time rainfall data to the River Forecast Centre in Edmonton.

The Atmospheric Environment Service, through outside contractors, is testing a program (RAINSAT) to produce short range (2-4 hour) forecasts of precipitation areas which will initially identify areas of occurrence or non-occurrence. This system uses radar data to develop statistical signatures of rain areas in the satellite data base. A rain map is produced using radar data, where available, and otherwise just GOES satellite data. Predictions of areal precipitation will be provided by automatic extrapolation using pattern correlation. At least one year's testing and verification of the system in a portion of Eastern Canada only will be required. Goodwood Data Systems are developing a STREAMFLOW version of this system for the Ontario Ministry of Natural Resources.

The "Stormy Weather Group" at McGill University continued with its research on precipitation estimation using radar and the integration of satellite and radar data. In co-operation with INRS-Eau, a study in the Yamaska river basin is combining radar and ground based rainfall measurements to provide improved rainfall data to the CEQUEAU model in order to increase the accuracy of the model's run-off prediction.

B.C. Hydro is engaged in efforts to obtain an operational system to estimate precipitation and runoff from enhanced GOES-IR imagery. This system is being developed by Dr. D. Ingraham of U.B.C., using cloud-top temperatures as an index of storm activity.

b) Snowcover

Snowcover mapping from aircraft (snowline flights) is being conducted by B.C. Hydro twice a year during the freshet for 20 drainage basins. The data are being used to calibrate simulated snowcover in an operational runoff simulation model (FLOCAST). Snowcover data from satellite imagery (GOES) are being provided by NOAA-NESS in Washington, D.C. for the Columbia River drainage above MICA dam. During 1980 seven such reports were prepared.

In Ontario, the Ontario Centre for Remote Sensing conducted two conventional aerial photography flights during snowmelt along the upper reaches of the Grand River. One gamma ray spectrometer flight was completed. Efforts related to satellite snow cover mapping in support of flood forecasting are currently on a hold status as abnormal snow conditions in 1979-80 necessitated reduced activity.

At INRS-Eau in Quebec, efforts continued on the visual analysis of NOAA-4 and NOAA-5 imagery to study the retreat of the snowline in spring. The information on the spatial distribution is compared to that furnished by the CEQUEAU model.

The Hydrometeorology Division of Atmospheric Environment Service continues to provide snow cover areal extent analyses for the Saint John River Flood Forecast Centre. Digital data from all four channels of TIROS N are used in a supervised clustering or classification technique to identify whether individual 1 km x 1 km areas are snow covered. The clustering technique uses a mini computer and colour graphics display to specify regions of the feature space corresponding to various targets, e.g. snow in coniferous forest, snow in deciduous forest, and snow in open fields. Recorded satellite data are analyzed to produce maps of the areal extent of snow cover

in the Saint John Basin within a day of a clear weather overflight.

c) Water Quality

The National Water Research Institute, Burlington, Ontario in conjunction with CCRS and Moniteq Limited are currently finalizing research related to a five component optical model for chlorophyll and suspended minerals in Lake Ontario. Model calibration involves the use of passive in-situ and low altitude airborne spectro-optical measurements tuned to the optical bands of the Nimbus G CZCS. The final stages of the atmospheric correction model are being tested. The Ontario Centre for Remote Sensing in conjunction with Moniteq Limited are adapting computer algorithms used previously with linescanner data to digitized multi-narrow band aerial photography. The objective of this work is to provide quantitative digital colour maps of chlorophyll and suspended solids in lakes from digitized aerial photography.

Also, the Ontario Centre for Remote Sensing, under contract with OME, has flown multispectral aerial photography of Sturgeon Bay to be used to complement field observations in the preparation of maps of the aerial distribution of aquatic macrophytes.

d) Surface Water Temperature

From 1966 to 1980 the Hydrometeorology Division of AES monitored temperatures of the Great Lakes (excluding Lakes Michigan and St. Clair) using airborne radiation thermometry. Until 1978 surveys were conducted approximately monthly on each of the lakes during the ice-free season. From 1978 onward, as the capability to retrieve water temperatures from NOAA polar orbiting environmental satellite infrared data was perfected, the ART program was gradually reduced, terminating in 1980.

Retrieval of Great Lakes temperatures from satellite digital infrared data began in 1977. Analyses were obtained first from the NOAA-5 and later from TIROS-N and NOAA-6 satellites. Accuracy of temperatures derived from SRT data is still in the evaluation stage. Comparisons with "ground truth" measurements to date indicate that the RMS error is about $1^{o}C$. SRT temperatures are averages of, at best, 1 km square surfaces at the satellite sub-point, and represent progressively larger areas outward to the edge of scan. At present most analyses are derived using data from the 9.5 - 11.5 u channel and an atmospheric correction routine that requires real-time radiosonde data as input.

The Hydrometeorology Division is attempting analyses of Great Lakes temperatures once every two weeks. In practice, this sampling frequency is seldom attained, due to cloud cover. To date, analyses of surface water temperature from SRT have been performed for the Great Lakes, Lake Winnipeg, Bay of Fundy and other Maritime coastal areas, and very recently for smaller lakes in Ontario and on the St. Lawrence Seaway.

The Water Resources Branch and the Ontario Ministry of the Environment are continuing to focus on the application of low altitude airborne infrared mapping of thermal plume discharges to the Great Lakes, notably, off the Pickering Nuclear Generating Station on Lake Ontario and the Bruce Nuclear Power Development Site on Lake Huron. Both non-imaging (ART-airborne radiation thermometery) and imaging (IR linescanner) sensors have been used for data acquisition under contract to OCRS and the private sector. The assessment of thermal plume data continues as well as the development of digital image analysis techniques.

e) Soil Moisture, Groundwater

At the University of Sherbrooke research on the remote sensing of soil moisture continues. Unfortunately, HCMM imagery promised a long time ago was only just received. First results from the imagery indicate that the spatial resolution is not good enough to obtain sufficiently conclusive results. It would seem to be better for the moment to limit oneself to airborne data of a finer resolution.

The Ontario Centre for Remote Sensing (OCRS) in conjunction with M.M. Dillon and Gartner Lee Associates under contract from the Waste Management Branch of the Ontario Ministry of the Environment are conducting a two year study using remote sensing techniques for the mapping and detection of leachate from landfill sites. Airborne infrared linescanning has proved to be the sensor of choice over conventional aerial photography in the Canadian climate.

The OCRS on behalf of the Fisheries Branch of the Ministry of Natural Resources is currently finalizing a study on the use of airborne infrared linescanning to detect springs suitable for a hatchery water supply. The IR imagery from five townships in the Bowmanville-Trenton area formed the basis from which extensive field verification of springs was

conducted this summer.

The Saskatchewan Research Council's venture into full cost recovery, an operational program, after seven years of successful research for its potash environmental monitoring program,failed. The remote sensing contractor hired by CCRS failed to take the imagery within the time frame requested. One flight line even missed the mine. None centred on the headframe of the mine -- a criteria achieved in 80% of the previous years of flight lines.

f) Erosion

Landsat imagery is being used at CCRS to detect possible erosion sites in Eastern Canada. It is expected that this technique will be useful in many applications outside Canada.

g) Flooding

A recent project by Intera Environmental Consultants involved high resolution radar (SAR) applied to river flooding. It was learned that SAR can map flooded areas more accurately than conventional aerial photography at scales typically used, and that images could be collected regardless of weather conditions.

Satellite Data Retransmission

The most effective satellite "remote sensing" application in the water resource sector, affecting most water resource agencies in the country, is the implementation of data retransmission from data collection platforms (DCP) throughout the country.

The first network of DCP's was installed in Quebec, and now consists of 53 stations. This network is operated by the Quebec Department of Natural Resources and is well organized in all phases of operation, such as user-coordination, siting, installation, maintenance, data retrieval and distribution of real-time data, and data archiving.

In 1980 Alberta Environment installed four GOES DCP's (Handar) and there are plans to install an additional 33 over the next five years. These installations are part of the real-time data network which was designed by the Alberta River Forecast Centre with flood forecasting and water management as the main considerations.

In British Columbia, B.C. Hydro installed 14 GOES DCP's (LaBarge), and it is in the process of installing an additional seven. Plans call for the conversion of all conventional hydrometeorological telemetry stations to GOES DCPs.

The Conservation Authorities and Water Management Branch of the Ontario Ministry of Natural Resources is currently installing a network of nine LaBarge DCP's in Northern Ontario for use for flood warning and flow forecasting. With the end of the retransmission capability of Landsat being near, two sites are being converted to the GOES mode.

The Saskatchewan Research Council is now operating 3 DCP's (2 on GOES-E and 1 on GOES-W). Research is being conducted by SRC on methods to interface standard sensors to DCP's. Most sensor equipment sold today does not have calibration electronics built into them, and as a consequence, service technicians cannot adequately field test the total package.

At the national level, both the Atmospheric Environment Service (10 DCP's) and the Water Survey of Canada are expanding their networks of DCP's. The latter group currently operates 60 in co-operation with the provinces and territories, but this number is expected to increase to 350 within 5 years. About 10% use TIROS-N, the rest use GOES.

User Liaison and Training

A most successful workshop on Data Collection Platform networks was held in Quebec City September 29-30, 1980. The workshop was organized by members of the Water Resources Working Group, and hosted by Environment Quebec. All major manufacturers of DCP hardware, and agencies engaged in satellite telemetry were represented. Interested parties from all parts of Canada and the USA were in attendance. A total of 15 papers (Appendix II) were presented. The facilities of Environment Quebec for the operation of the Quebec DCP network were demonstrated. A lively panel discussion on government policies in the field of satellite data transmission concluded the workshop. The panel members included representatives from NOAA, ARGOS, AES, WSC and Environment Quebec, and a number of members from the floor participated in the discussion. In general, the workshop participants expressed the need for clear, nationwide government policies in the field of satellite data transmission, with particular attention to sensors, training and data archiving. Proceedings of the Workshop will be published by the Canadian Remote Sensing Society in early 1981.

A Workshop on satellite observations of snow-cover, river ice and lake ice was organized by the Alberta Remote Sensing Centre in Edmonton, September 16 to 18, 1980, in Edmonton. Lectures in these fields were provided by the representatives from NOAA/ NESS in Washington, D.C.

Conclusion and Forecast

The members of the CACRS Water Resources Working Group feel, that the development, promotion and application of remote sensing techniques in the field of water resources have been most successfully conducted by this group, and that this work should therefore be continued by representatives active in this field. Successful remote sensing workshops have been held on snowcover mapping, on soil moisture determination, and most recently on data collection platform networks. Through annual meetings with provincial or regional colleagues engaged in water resource activities it has been possible for the Working Group to determine specific needs for technology transfer. These needs have been answered by organizing and sponsoring the necessary workshops or training sessions.

In the field of water resources, satellite data have proven their value for large scale studies where detail and timeliness are not of overriding importance. However, the water resource manager still needs all weather capabilities with greater definition and faster delivery of processed data to the user. Data collection platforms offer one mechanism for obtaining point data rapidly, and satellite retransmission of data is now recognized as an important management tool. Techniques for the use of DCP's in obtaining real-time data for water management are now becoming established. However, nation-wide coordination of the efficient utilization of this important tool is still required. Until there is a more appropriate mechanism to carry out this function, the WRWG will attempt to fulfill this need. It is planning a follow-up workshop on DCP's in early 1982 to address common problems outlined at Quebec City.

Although DCP's have the group's immediate attention, interest in other remote sensing methods is strong. Snowcover mapping by remote sensing methods is being used by NOAA/ NESS, AES-HQ, and B.C. Hydro, but requires considerable subjective input. The development of more objective techniques which can be implemented more widely in an operational mode are necessary.

Gamma ray surveys have been successfully applied to the remote sensing of snow-water equivalents on flat lands. To obtain real-time data for operational purposes, data analysis methods must be improved. Further progress in the development of remote sensing techniques to detect snowpack water equivalents, snow depth, state of the ground, and soil moisture is expected to be in the field of active and passive microwave sensing. Participation in RADARSAT experiments is planned by various members of the WRWG.

Considerable progress has been made in the mapping of precipitation areas by the use of radar and satellite imagery. The successful technology transfer in this field is most important for effective water management and especially flood control.

Advances in image analysis techniques have been successful in a variety of water resources applications, such as the detection of potential erosion sites, water quality studies, detection of peat bogs, and wetland mapping. A number of consulting firms are offering their services in the application of these techniques. The WRWG realizes that considerable expertise in the application of remote sensing to water resource problems now exists in the private sector. It is in the process of compiling a list of consultants carrying out remote sensing activities in water resources.
It is planned to continue regional meetings as necessary. Also, it is hoped that the Working Group will serve as a focus for reviewing, co-ordinating and of course participating in remote sensing research activities in the water resource field. In the past members were generally informed of projects after they were conducted. If they have a chance to review potential projects before they occur a more effective use of manpower, resources and scientific expertise should be realized. Co-operative programs should be more effective.

Recommendations

It is recommended, that with respect to the airborne program, CCRS review the successful completion rate (in percent) of airborne remote sensing assignments to its contractor, and review line-mileage and ferry charges for customers located some distance away from Ottawa.

It is further recommended, that CCRS not implement cost-recovery for imagery, until it is in the position to meet user demand within

an operational time frame. It has been reported that orders for large scale Landsat imagery of Saskatchewan from CCRS have been delayed by up to six weeks and that indexing (cloud cover) was sometimes in error.

Imagery from the weather satellites is being used in many remote sensing applications in operational water management. However, there is still confusion among users from where such imagery is to be obtained. Does CCRS provide or intend to provide NOAA data from Prince Albert? Can users obtain imagery from Atmospheric Environment Service? It is recommended that CCRS take the necessary steps to clarify this confusing situation.

Appendix I - Revised Terms of Reference

1. Promote the dissemination of information regarding remote sensing techniques applicable to water resources:

- by informing federal and provincial agencies of recent developments in remote sensing technology and applications;

- by encouraging or initiating special courses and organizing seminars in remote sensing as applied to water resources problems;

- by encouraging cooperation between agencies and disciplines involved in remote sensing related to water resources;

- by reporting on research or operational remote sensing programs;

- by identifying and specifying the types of data most useful for water resources activities;

- by suggesting and encouraging new research programs and operational procedures where this seems appropriate in the national interest;

- by assessing the benefits of remote sensing techniques in relation to cost.

2. Advise Canada Centre for Remote Sensing (CCRS), through CACRS, on matters relating to Water Resources, and compile an annual report including:

- a review of current Canadian activities;

- an evaluation of progress and recommendations for future activity.

Appendix II - Papers Presented at Workshop on Data Collection Platform Networks, September 29-30, 1980, Quebec City

1. Operational Space Telecommunication Systems for Environmental Data: Chairman - Dr. J. Kruus, Network Planning and Standards Division, Atmospheric Environment Service, Downsview

GOES Data Collection System - Mr. Douglas H. MacCallum, National Environmental Satellite Service, Washington, D.C.

SNOTEL Data Collection System - Mr. Don Woodward, U.S. Soil Conservation Service, Broomall, Pennsylvania

ARGOS Data Collection System - Mr. Jean-Luc Bessis, Service Argos, Toulouse, France

2. Description of Available Equipment: Chairman - Mr. Jeff Whiting, Saskatchewan Research Council, Saskatoon

LaBarge - Mr. Maurice Parisé, GENEQ Inc., Montreal, Quebec

Handar - Mr. Harry Christie, Handar, Sunnyvale, California

Bristol - Mr. W.R. Whitehead, Bristol Aerospace Ltd., Winnipeg, Manitoba

Electronique Marcel Dassault - M.M. Peberay, E.M.D., Saint-Cloud, France

Compagnie pour l'électronique, l'informatique et les systèmes, Mr. D. Bernadet, CEIS, Toulouse, France

Meteor Burst System - Mr. Andy Verostko, Western Union Telegraph Co., McLean, Virginia

Office de la recherche scientifique et technique outre-mer, Mr. J. Callède (ORSTOM, Paris, France)

3. Description of National, Provincial and Regional Activities: Chairman - Dr. B.E. Goodison, Hydrometeorology Division, Atmospheric Environment Service, Downsview

Province of Quebec - Mr. C. Pesant, Environment Quebec, Quebec

Water Survey of Canada - Mr. Ian Reid, Water Survey of Canada, Environment Canada, Ottawa, and Mr. R.J. Myslik, Water Survey of Canada, Guelph

British Columbia Hydro - Mr. U. Sporns, B.C. Hydro, Vancouver

Atmospheric Environment Service - Mr. A. Donnelly, AES, Environment Canada, Downsview

Province of Alberta - Mr. David Graham, Alberta Environment, Edmonton

Dome-Canmar - Mr. Bryan Mercer, Dome-Canmar Environmental Research Corporation, Calgary

4. Panel Discussion: What are the applicable official policies of government agencies? Chairman: Dr. Jean-Pierre Fortin, Institut national de la recherche scientifique, Québec (Panel members include representatives from NOAA, ARGOS, AES, WSC, Quebec. Included was discussion from the floor).

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6.1 REPORT OF THE INTERPROVINCIAL/ TERRITORIAL ADVISORY SUB-COMMITTEE TO CACRS

Introduction

The work of IPTASC, an advisory committee to CACRS, was carried out through meetings, communication among members, communication between the Chairman and the Director General of CCRS and at CACRS meetings. This report is based mostly on the committee meetings.

Each of the provinces and territories is represented by a member. See Appendix I - List of Members.

During the current year the committee held two meetings. The first meeting, 22-23 January, 1981, was held at, and hosted by, the Ontario Centre for Remote Sensing, Toronto, Ontario. The second meeting, 13 April, 1981, was held at the Canada Centre for Remote Sensing, Ottawa, Ontario.

Meetings

The agenda for the first day of the Toronto meeting included: the theme and organization for the 1981 CACRS meeting, proposed by the 1981 Chairman, Mr. Jean Thie, who was in attendance; discussion with Mr. E. A. Godby, Director General, CCRS, on the role of IPTASC within a reorganized CACRS; amendments to the IPTASC terms of reference and a tour of the Ontario Centre for Remote Sensing.

Mr. Jean Thie described his proposed CACRS theme and agenda, which were province oriented, and explained that the proposal originated in a concern that the provinces had a relatively small impact on the national program. The members of the committee supported the concept, proposed agenda and structure for the meeting and extended an offer of assistance. The committee unanimously supported the proposed theme, "Remote Sensing from a Provincial Viewpoint", as in the words of one member (V. Zsilinszky), "it provided an opportunity to discuss in concrete terms what had so far only been vaguely spoken of, and that it could result in guidelines for the development of remote sensing in Canada over the next 5-10 years." The committee recommended that technology transfer to the users in the provinces/territories should be a major concern at the CACRS meeting. The IPTASC agreed to provide the 1981 CACRS Chairman with the names of suggested speakers.

Mr. Lee Godby, Director General, CCRS, in attendance, briefed the meeting on a suggested IPTASC involvement in the planning and operation of the national remote sensing program. In view of his proposal the terms of reference for the committee were reviewed. The committee endorsed Mr. Godby's recommendations that a comprehensive paper on the history, role and operation of remote sensing in Canada be prepared for wide distribution. Many suggestions and recommendations were extended as to the proposed report's format and distribution, all of which were aimed at strengthening the national program, particularly in the provinces.

The proposed federal technology transfer program was studied. It was agreed that formal provincial membership in the planning and operational phases of a national program for technology transfer would be of benefit and should be part of the mechanism. The committee emphasized the need for immediate action to implement technology transfer to provincial users.

Dr. Simsek Pala conducted a briefing and informative tour of the Ontario Centre for Remote Sensing.

The second day of the Toronto meeting - attended by IPTASC members only, dealt with CACRS meetings in general and the up-coming meeting in particular, federal-provincial relations in remote sensing technology transfer, IPTASC terms of reference and the formulation of recommendations to CACRS.

The second meeting of the year was held at CCRS, Ottawa. It was concerned with reports from members as to remote sensing activities in each province/territory, the annual report to CACRS, changes in IPTASC terms of reference, advice and recommendations to CACRS and to the Director General, CCRS.

Mr. Victor Zsilinszky, Ontario Centre for Remote Sensing, became Chairman for a two year period replacing Cal Bricker, Alberta Remote Sensing Center, who's term of office had expired. Mr. Frank Hegyi, British Columbia Forest Service, was elected Vice-Chairman.

Technology Transfer Meeting

The Chairman of IPTASC in 1980 attended the CCRS sponsored Ottawa "Workshop on the Transfer of Federal Technology to the Provinces". He suggested it be carried out from CCRS through and in cooperation with provincial remote sensing centers, agencies or representatives; and that the technology transferred be of practical value at the user level.

Recommendations

The Interprovincial/ Territorial Advisory Sub-Committee to CACRS recommends that:

(1) CCRS give high priority to arranging for Canadian participation in the SPOT program;

(2) CCRS submit a feasibility study to CACRS Executive Committee regarding the inclusion of an optical sensor in the RADARSAT;

(3) a more equitable ferry charge be applied to the lease arrangement of CCRS aircraft. Further that the OCRS charge-back formula be investigated as such a mechanism for feasibility and cost recovery;

(4) IPTASC be kept informed on any action taken toward technology transfer with present approved funding and a method be established whereby this group can have input into future planning;

(5) CCRS operationalize the "MOSAICS" project as soon as possible.

Appendix I - List of Committee Members

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6.2 REPORT OF THE ALBERTA REPRESENTATIVE

Airborne Remote Sensing

The Alberta Remote Sensing Center, Alberta Environment, throughout the year coordinated requests for airborne flights between requestors and the Canada Centre for Remote Sensing. Some requests were withdrawn after discussion regarding the capability of private industry to carry out the flights. Other requests were submitted to Airborne Operations, Canada Centre for Remote Sensing. The Alberta Center maintained liaison with Airborne Operations and requestors throughout the acquisition and supply of the imagery.

Spaceborne Remote Sensing

The Center provided, through its Landsat facilities, Landsat selection and order service to more requestors than in past years. The facility includes: Landsat scenes in microfiche received daily from the Prince Albert Satellite Station; selection by in-house terminal to CCRS's On-Line Retrieval System; Alberta Prime Scene listing and index map and large imagery library. Advice and assistance was extended to users and potential users on the practical uses of Landsat data.

Alberta Remote Sensing Center

The Alberta Remote Sensing Center assisted provincial users in the acquisition, application, and analysis of remotely sensed data for the survey and management of Alberta's natural resources. The Center's staff offered advice and assistance in the operation of its specialized equipment. A technical library and document retrieval system was available. The Center's facilities were available free of charge to Albertans. There was again this year an increase in the number of Alberta and out-of-province users.

Training

In cooperation with the Faculty of Extension, University of Alberta, the Center conducted the "Ninth Alberta Remote Sensing Course". The need for such courses is evident; this course was some 50% oversubscribed. Those attending were from government, education, private industry and the public from across Canada.

The "First Workshop on Satellite Observations of Snow Cover, River Ice and Lake Ice" was conducted in Edmonton by three scientists from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington. The workshop was jointly sponsored by the Alberta Remote Sensing Center and the Alberta River Forecast Center, Alberta Environment.

The Second "Canada Centre for Remote Sensing Image Analysis System (CIAS) Applications Workshop", sponsored by the Canada and Alberta Centers was held in Calgary.

The Faculty of Agriculture and Forestry, University of Alberta, has acquired a digital image analysis system. Located in and operated by the Department of Soil Science, the system is being utilized by Dr. P.H. Crown in his senior under graduate course in Remote Sensing and by graduate students who are using digital Landsat and airborne MSS data in land classification and resource inventory studies. A new graduate level Remote Sensing course is being scheduled for the 1982 academic year by Dr. Crown. The use of the image analysis system will form a substantial component in this course.

The Faculty of Education, University of Alberta, is involved in remote sensing research in the field of education. Dr. J.M. Kirman's Project Omega deals with child and adult levels, and graduate studies in remote sensing education. Undergraduate education courses have also been enriched with remote sensing data. Techniques for teacher in-service training in remote sensing have been developed and successfully used. While current activity deals with Landsat imagery, all areas of remote sensing educational concerns are of interest.

The Center provided speakers and tours of the Center for educational institutions, universities, colleges, technical schools, high schools and elementary schools. Short courses and briefings were presented to government departments and other agencies throughout the province.

Special Projects

Alberta Energy & Natural Resources' Resource Evaluation and Planning Division, in cooperation with Alberta Forest Service, utilized Landsat imagery for the delineation of the Alpine Zone as part of the Alberta Biogeoclimatic Classification Program. Using manual interpretation of Landsat C1, 1:250,000 scale hard copy images, with reference to large scale aerial photographs, Russ Hendry produced 12 map sheets at a scale of 1:250,000 covering the Rocky Mountains of Alberta. The Landsat scenes specifically

produced by CCRS for this project proved superior to the regular product for the interpretation of the Alpine Tundra.

Mike Boyd, Alberta Department of Recreation and Parks, has been involved in the use of DICS processed Landsat spectral intensity values since 1979. Habitat conditions have been successfully mapped within existing and proposed provincial park areas. This ongoing work involves the incorporation of Landsat information with other land related data (soils, slope, aspect etc.) through a geographic information system (POLYGRID) developed for Alberta Recreation and Parks and operated on the government IBM 370.

The Center financially supported through its Remote Sensing Demonstration Project Program a number of projects carried out in Alberta by universities and private industry.

One project was the Alberta Rangeland Study. A joint project of the Government of Alberta and Canada involving the Canada Centre for Remote Sensing, Department of Energy, Mines & Resources, Alberta Remote Sensing Center, Alberta Environment and Lands Division, Alberta Energy & Natural Resources.

Appendix I - Alberta Advisory Committee on Remote Sensing

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6.3 REPORT OF THE BRITISH COLUMBIA GOVERNMENT REPRESENTATIVE

Airborne Remote Sensing

The acquisition of air photography, covering a considerable portion of British Columbia was coordinated by Surveys and Mapping Branch of the Ministry of Environment, in cooperation with a multi-agency Mapping Steering Committee. Some details of the air photo coverage are as follows: parts of the Queen Charlottes, northern and south-central B.C. were covered at 1:50 000 scale; portion of east coast Vancouver Island was photographed at 1:5000 scale; and a limited amount of colour air photography was also acquired on Vancouver Island. In addition, the Ministry of Forests implemented operationally the use of large scale 70 mm photography, as an integral part of the Provincial multi-phase forest and range inventory system. Some airborne MSS data was also acquired, through the cooperation of CCRS, by the Ministry of Forests and the University of British Columbia.

Spaceborne Remote Sensing

Spaceborne remote sensing activities in British Columbia increased during 1980, although they were conducted mainly on experimental and research basis. Agencies involved in these activities include the University of British Columbia, Ministry of Forests, B.C. Hydro and Power Co., B.C. Research Council, Environment Canada, Canadian Forestry Service, MacDonald, Dettwiler & Associates Ltd., and some other relevant industry representatives.

The Ministry of Forests, in cooperation with CCRS, MDA and the Pacific Forest Research Centre (CFS), carried out a feasibility study of using remote sensing and satellite image analysis technology to monitor the changes and depletion of the forest and range resources in the Province. As a result, the entire Province will be monitored in 1981 with the aid of satellite image analysis.

Conclusion and Forecast

Satellite image analysis applications are expected to increase in 1981. A Remote Sensing Committee is currently being organized for the purpose of information exchange, coordinating relevant activities in B.C. and for providing representative advice to CACRS through the B.C. representative.

As the new B.C. representative to CACRS, at this time I would like to acknowledge the contribution of my predecessor, Miss C. Mary Redmond, to remote sensing and CACRS. Finally, with the aid of the Remote Sensing Committee, the B.C. report for next year will be more detailed and thorough. (Submitted by Frank Hegyi, Inventory Branch, Ministry of Forests, 1319 Government Street, Victoria, B.C. V8W 3E7, Tel.: 604-387-6722).

6.4 REPORT OF THE MANITOBA REPRESENTATIVE

AIRBORNE REMOTE SENSING

During 1980, a working group called the Interdepartmental Committee on Aerial Photography (I.C.A.P.) was put into action to serve the photography acquisition needs of the Provincial Government and Crown Corporations. The objective of I.C.A.P. is to maximize contract benefits for aerial photography by having single tenders issued that may include several project areas which are in the same geographical proximity. Under this arrangement, block areas of commitment are not duplicated and cost sharing agreements between different departments allow larger block areas to be flown that would not have been possible from a single budget. The committee also acts as a central clearing house for tendering, imagery checking and support for a Provincial Air Photo Library for print storage and distribution of information on coverage.

This year approximately 26,990 line kilometers of aerial photography were flown in Manitoba. The divisions of use for this photography are as follows:

Federal Government Mapping purposes	13.9%
Provincial Government Community Base Mapping	2.4%
Provincial Government Forest Inventory Mapping	50.0%
Provincial Government General Resource Purposes	33.7%

The Manitoba Remote Sensing Centre's 70 mm camera service (S.A.P.) received requests from 18 clients and successfully completed 3,715 line kilometers of aerial photography. The main users of this photography are Municipal Assessment Branch, Agricultural Crown Lands Branch, Water Resources Branch, Forestry Branch and Parks Branch.

Manitoba Hydro, in conjunction with the Brandon Chamber of Commerce, had an aerial thermographic mission flown for the City of Brandon.

The Air Photo Library and Map Distribution Office is also part of the Manitoba Remote Sensing Centre. The Air Photo Library now contains a stock of some 900,000 aerial photographs. Thanks to special budgetary allotments, approximately 150,000 photographs were brought in during 1980. These photos fill all the gaps in coverage caused by lack of funds during pre and post-war years. There is a steady increase in the use of these older photos as people realize their benefits for performing chronological studies related to bio-physical changes, etc.

SPACEBORNE REMOTE SENSING

The Manitoba Remote Sensing Centre maintains a subscription to Isisfiche on all LANDSAT imagery available for Canada. This information is available to all who wish to use it. There has been an increase in the use of LANDSAT data by various government departments, Crown corporations and private industry. Students from the University of Winnipeg taking advanced remote sensing course are also using this data for a variety of study purposes.

APPLICATIONS

The Remote Sensing Centre increased its staff by two during 1980. The addition of a technician and a resource planner, specializing in bio-physical related work, enhance the expertise and allow additional project work to be carried out by the Centre.

On the request of the Provincial Municipal Planning Branch, an ecological (biophysical) land classification was completed for the Local Government District of Mystery Lake. In the process, an integrated approach to land survey was used. Areas of land are classified according to their ecological unity and includes the description, the comparison and the synthesis of data about the biological and physical characteristics of the land.

Relief, slope, soil texture, geomorphic mode of deposition of soils, surface expression, drainage and presence of permafrost are all indicated on a map symbol complex.

A similar study was completed for the Grass River Provincial Park upon the request of Parks Branch, Department of Natural Resources.

The Manitoba Centre has also undertaken a project to map barren land caribou habitat using LANDSAT data for the Wildlife Branch, Department of Natural Resources.

Vegetation cover maps are required in order to develop a management plan for the caribou winter range. The project area, in the sub-arctic region of Northern Manitoba covers an area of 81,000 km^2.

LANDSAT M.S.S. data provides the

most recent coverage of the area with a resolution sufficient for the scale of mapping (1:250,000). LANDSAT also provides repetitive coverage of the area, therefore updating maps every 5 years would be possible.

A computer classification involving clustering using migrating means, principal component enhancements and visual interpretation are three data analysis techniques being evaluated to determine the most effective and efficient means of mapping caribou habitat. The project will be completed by the spring of 1981.

Color infrared photography is being used in the Province on several projects to satisfy the following objectives:

- an interpretation study was completed to determine the effects of sulphur emission on vegetation in the Thompson area.
- a vegetation cover map was completed for Netley-Libau Marsh.
- The Wildlife Branch, Department of Natural Resources performed a muskrat hut count on three marsh areas to obtain census figures.
- the La Sale River is being monitored to determine locations of point source discharges of saline water.
- sequential photo missions were flown for Dauphin Lake to monitor and map receding shorelines.
- Ducks Unlimited is using color I.R. photomosaics as a base for vegetation and topographic mapping of Delta Marsh.

A private consultant using LANDSAT and airborne imagery to determine the suitability of numerous lakes for the production of wild rice, is under way.

The Remote Sensing Centre performed a brush cover classification project for the Wildlife Branch. The final map will be used by Wildlife Branch for the development of future wildlife management units.

The Agricultural Crown Lands Branch is using custom flown 70 mm aerial photography to monitor hay cutting lease areas.

The Manitoba Department of Agriculture had color infrared photography flown by C.C.R.S. of several test areas in Southern Manitoba. The future study of this photography will be in conjunction with the large area crop inventory experiment and will include a study of yield forecasting. The department has also completed a 1:1,000,000 physiographic map of Manitoba by using airborne imagery for those areas where previous data did not exist.

A consultant's report was completed by James F. MacLaren Ltd. to determine remote sensing renewable resource monitoring needs in Manitoba.

Thirty-three detailed questionnaires were completed by Federal, Provincial, University and private agencies. One hundred and thirty-two separate resource studies were identified where remote sensing techniques could be applied.

As a follow-up to the report, a number of user agencies have been contacted to initiate several pilot studies. The range of resource interests covers a very broad spectrum.

A chrono-sequential study is now under way to monitor the effects of reconstruction of a major drain in the Manning Canal Watershed, Southeast of Winnipeg. To date, regional survey plans and aerial photos dating from 1946 to 1979 have been examined. Color infrared photography will be flown in 1981 and 1984 to determine beneficial effects of drainage improvements.

TECHNICAL DEVELOPMENTS AND NEW EQUIPMENT

A model 750 AGA thermal scanner, owned by the Forestry Branch, was pressed into full service this year. A technician from the Remote Sensing Centre operated the equipment. Fires in Manitoba this year consumed approximately 603,000 hectares of timber. The thermal unit was kept busy on 25 fires to aid in mop-up operations.

USER LIAISON

The Manitoba Remote Sensing Centre continued to maintain interpretation equipment and provide information services to anyone wishing to use the facilities. There has been a steady increase in the use of our equipment with some pieces being booked almost constantly.

The Centre is now offering a kit for sale which will allow in-shop aerial photography retrieval and photo ordering services. The kit consists of 35 mm microfilm aperture cards of all aerial photography flight maps dating back to 1923. A computer listing is also supplied which indicates all the necessary data required for conducting a photo search. The 1,700 card deck includes flight maps for all Class "A" 9" x 9" photography, 70 mm photography flown by the Centre and high level photo-

graphy flown by C.C.R.S. With the aperture deck and computer listing, rapid photo searches and photo ordering services are available from a remote location. To date, 10 of these systems have been purchased by government and private organizations.

TRAINING

The University of Winnipeg's Geography Department offers credit courses in introductory and advanced remote sensing. The University is investigating the establishment of a diploma program in remote sensing.

The Manitoba Centre has conducted many seminars in the past year for government agencies and educational organizations. These seminars or short courses are tailored to individual needs.

The Centre has also made available 19 short courses in remote sensing which are in slide and audio format. These kits, produced by Purdue University, allow students to learn the basic fundementals of remote sensing at their own speed.

CONCLUSION & FORECAST

There is a steady growth in the use of remote sensing techniques in Manitoba. Continued education and the spreading of information on the basic techniques of remote sensing is vital. The science of remote sensing is advancing rapidly. It is important that the user community be made aware of the basic fundamentals and new developments in order that they may be able to investigate the potential uses of remote sensing in their projects.

6.5. Report of the New Brunswick Provincial Representative

Committee Activities

During the year the New Brunswick Committee was re-activated.

Regular monthly meetings were held.

CCRS Liaison representation established and regularly attending meetings.

Committee members represent Federal, and Provincial Governments, private and academic sectors.

Sub Committees appointed
(a) Program (b) Centre of Office
(c) Standards (d) Membership

Committee Liaison Officer employed for short term.

Information exchange forum provided.

Focal point for Remote Sensing in New Brunswick established.

Developing Liaison activities with MRMS.

Airborne Remote Sensing

Flight by CCRS in support of Erosion Mapping Project.

Experiment in specie identification for forest inventory using colour prints covered 100,000 hectares.

Local company providing airborne 70mm support to Provincial users.

Local company discussing contracting with MRMS to experiment with applying RC8 and Vinton systems to airborne needs.

Department of Agriculture continues to support a 35mm oblique system.

Dendron have been working with Fraser Inc. on a Technical Transfer project.

Map updating using 35mm obliques by Department of Agriculture.

Quick response by video recording of flood monitoring and pollution events.

Snow cover mapping by Department of Environment.

Highway Planning has introduced a 70mm quick look approach.

At least one pulp and paper plant is using 70mm information plus photo interpretation to determine volumes of outside piled material.

Technical Developments

Analysis yet to be completed of images of the Sussex, N.B. area. This is a project started in cooperation with Dr. Peter Kourtz of the Petawawa National Forestry Institute.

Application was made by the University of New Brunswick for an Image Analysis System.

The University of New Brunswick has acquired Linear Measuring Set System.

Local Company is doing hest loss survey of school buildings for Department of Education.

Gestalt orthophoto maps prepared from CCRS high level photography of the 1973 flood on the Saint John River.

Application

Graduate Student at University of New Brunswick working on Ph.D. thesis for crop identification in New Brunswick.

A number of papèrs have been given by persons at the University of New Brunswick on Remote Sensing. More are being prepared.

Papers were given at the Sixth Symposium on Remote Sensing.

Seminars given in Department of Agriculture on Remote Sensing for Erosion work and Stats Canada - CCRS project.

Snow cover area mapping. Support of Saint John River Flood Forecast.

Benefit Analysis

Agriculture showing time and dollar saving to update mapped information.

Snow cover area mapping.

Gestalt orthophoto map series cost less than $10,000 as a very inexpensive 1:10,000 base map of a record event.

Liaison

The Committee is establishing linkage with CCRS and assisting agencies and individual users to better develop understanding and utilization of Remote Sensing technology.

The New Brunswick Remote Sensing Committee has been re-organized and is now actively promoting the technology in New Brunswick. The requirement for a local "Centre" to focus efforts has been identified and steps are underway to bring this about in 1981.

Various users in the Province are acquiring equipment and cooperation among the user community is increasing.

A contact list of some 125 interested individuals has been developed.

Training

Persons attended the Sixth Symposium in Halifax and Remote Sensing Workshop and conference in Kansas.

Conclusion and Forecast

Now that the New Brunswick Remote Sensing Committee is actively prusuing the development of Remote Sensing technology an improvement in its usefulness and utilization is anticipated.

Recommendation

That CCRS through the New Brunswick Remote Sensing Committee make available as much equipment and material as possible in order to support and sustain the development of the capability in New Brunswick. That CCRS ensure that the New Brunswick Committee and the technical liaison officer are fully informed of all activitied from CCRS to the New Brunswick Committee which may impact the New Brunswick situation. That the New Brunswick Committee is informed of all activities or overtures relevant to the realm of Remote Sensing in the Province of New Brunswick.

6.6 REPORT OF THE PROVINCE OF NEWFOUNDLAND AND LABRADOR, 1980

AIRBORNE REMOTE SENSING

During 1980 the Newfoundland Department of Forest Resources and Lands continued its ongoing forest inventory program obtaining colour and colour infrared photography. This program provides up-to-date imagery for all government departments to use in resource management.

C-CORE has continued to advance the development of its airborne impulse radar system. This has included flight trials over first and multi-year ice.

REMOTEC carried out a program to obtain stereo photographs of ice targets in a program to develop improved dimensional models for ice hazard detection programs.

SPACE BORNE REMOTE SENSING

NORDCO continued to operate and manage the Shoe Cove Satellite Station under contract from CCRS.

Companies involved in weather forecasting for the offshore industry continue to use Shoe Cove Station data.

REMOTEC continues to utilize space data products in all aspects of ocean and ice monitoring.

TECHNICAL DEVELOPMENTS

REMOTEC is continuing with its development of ice hazard detection systems for both ships and aircraft platforms.

REMOTEC has purchased a NORPAK Image Analyzer interfaced to an HP1000 computer and is now utilizing this system in day to day analysis and application projects.

REMOTEC has just completed a laboratory program for the test and development of sensing systems for use in the detection of oil under ice.

NORDCO through a funded project developed a Visual Imagery System for the Shoe Cove Station. The system allows for real time monitoring of the data stream. It has been used for relaying MSS data from Shoe Cove to Ottawa.

C-CORE has commenced a long term project to investigate the use of surface based over the horizon radar with a view of being able to locate and characterize sea ice from land stations or surface vessels.

The Province of Newfoundland is assisting NORDCO in a market survey of Newfoundland and the Maritimes. The output of this program will be to encourage a pilot project approach to remote sensing. The results of this market search will be available in early 1981.

REMOTEC continues its involvement in programs to measure atmospheric aerosols with the aim to improve the use of infrared sensors over ocean paths.

TRAINING AND ADVANCEMENTS

Art Collins of CCRS gave a presentation to various government agencies on the capabilities of Shoe Cove and the data products available.

The Province is continuing with its plans directed towards the establishment of a remote sensing group within the Provincial Government.

SUMMARY

With the offshore activity

remote sensing in all its aspects is becoming increasingly important in Newfoundland. This is especially true for private industry and for Crown owned companies. Increased remote sensing activity is forecast for 1981.

RECOMMENDATIONS

There is a need for a quality demonstration project in Atlantic Canada. Recent activities by various remote sensing groups interacting with potential clients have shown that the interest is there but there is a certain degree of cautiousness caused by previous failures or conflicting statements. Newfoundland thus recommends that consideration be given to a pilot project geared for users in Atlantic Canada. This project should be of a magnitude that technology transfer can be facilitated to those interested local remote sensing concerns and in a manner that will satisfy the needs of the many potential small users in this area.

6.8 REPORT OF THE PROVINCE OF NOVA SCOTIA

Recommendations

Whereas there are numerous and ever-increasing hardware/software systems in the Canadian remote sensing community; and that these systems often redundantly develop software capability; and that there is no convenient and efficient means for the transfer of remote sensing software among these systems; and since it is to be benefit of technology transfer interests to minimize the wasted manpower involved in software duplication:

It is recommended that -

> In future development of image analysis software by federal government agencies (such as that for the upcoming Image 200), that a primary and integral design feature be the transportability of the software to other computer systems. It is further suggested that at the planning and development stages of a new software package, where the architecture of the software has been designed, but where changes may still be implemented, that the developer of such package report on the transportability features of the software to IPTASC.

The development of Geographic Information Systems that allow the full integration of raster and polygon data sets offer the resource manager the promise of an operational management tool:

It is recommended that -

> CCRS pursue an active development policy with respect to such GIS technology and that this technology be developed in such a way as to maximize its transferability and minimize the cost of conversion to the Canadian remote sensing user community.

Recently a number of private companies have appeared in the market place offering remote sensing image acquisition services. During the 70's the bulk of this imagery was acquired through the airborne operations section of CCRS. Under this former arrangement CCRS provided technical advice on mission specifications, as well as cameras, lens, filters and films suitable to achieve the user requirements. In addition, the rigorous quality control standards required by CCRS assured the user of a top quality image product.

As operational image acquisition must now be placed with the private sector and as many users do not have the technical expertise for detailed mission planning and quality control and inspection:

It is recommended that -

> (a) CCRS formalize a procedure by which users may obtain technical assistance and detailed mission specifications suitable for tender generation.
>
> and
>
> (b) CCRS provide quality control and inspection of imagery obtained to ensure that it meets tender specifications.

6.9 REPORT FROM THE PROVINCE OF ONTARIO

The following report is based on replies to a questionnaire distributed by the Ontario Centre for Remote Sensing.

No. of agencies contacted:	70
No. of replies	
Government:	4
Universities:	7
Industry:	12
Total	23

Airborne Remote Sensing

Professor S. H. Collins of the University of Guelph employed 60 black and white 9" x 9" airphotos, both standard provincial photography and products of the National Air Photo Library.

Professor S. G. Hilts of the University of Guelph reports the use of approximately 150 aerial photographs, for the most part black and white FRI photos, but also high-altitude colour and infrared colour photos.

Dr. J. R. Pitblado of Laurentian University used a small number of black and white, colour and colour infrared aerial photographs in research, and approximately 40 photos, including all three types, for teaching purposes. A few thermal and radar images were also used for instruction.

Dr. P. J. Howarth of the University of Guelph employed approximately 350 panchromatic stereotriplets for teaching, and an additional 30 black and white, colour and colour infrared photos for an advanced-level class. Dr. Howarth reports that 1400 black and white aerial photographs were used for three projects, and 144 colour infrared photos were also required; however, the university did not purchase all of this coverage. Both thermal and radar imagery were used in instruction and labs.

Dr. B. Boucek of Sir Sandford Fleming College reports the use of approximately 1,000 standard provincial aerial photographs for teaching purposes, as well as 500 from the National Airphoto Library, and over 1,000 from other sources. With regard to thermography, Dr. Boucek reports that a demonstration of the AGA Thermovision was presented, and additional information about the application of thermography obtained from the OCRS and from private companies. In cooperation with the OCRS, small-format aerial photography was obtained, and other coverage was also acquired of the Town of Lindsay, the location of the College.

Professor J. Vlcek of the University of Toronto used 500 black and white airphotos, 25 colour and 25 colour infrared, for teaching and research.

Professor D. K. Erb of the University of Waterloo employed 1,500 to 2,000 aerial photographs, including black and white, colour and colour infrared, for illustration in teaching. No thermal or radar imagery was used, but Dr. Erb plans to include both imageries in 1981 courses.

Dr. A. Kesik of the University of Waterloo used approximately 2,000 black and white panchromatic aerial photographs, 50 colour photographs, and SLAR imagery, for teaching purposes.

The Technical Support Unit of Water Resources Branch, Ministry of the Environment, reports the use of 40 large-scale aerial photographs for drainage pattern studies and environmental impact assessment.

The Great Lakes Surveys Unit of the Water Resources Branch, Ministry of the Environment, employed approximately 100 9" x 9" archival colour and false-colour photographs from various sources for water quality surveillance and planning support. Approximately the same number of 35 mm "Skywatch" archival diapositive colour obliques were used as well. The Great Lakes Surveys Unit had several thermography flights performed by Intertech Remote Sensing, and six flights conducted by the OCRS to obtain non-imaging thermal radiometer data.

The Surveys and Mapping Department of Ontario Hydro employed black and white panchromatic coverage of a total distance of 1,950 km, Aerocolour coverage of 50 km, and unspecified aerial photographic coverage of 2,000 km.

The Ontario Centre for Remote Sensing conducted an extensive and varied schedule of multi-camera airborne sensing. The Centre acquired a new aircraft during 1980, a Navajo Chieftain, and outfitted it with two

sensor hatches, one for microcomputer-controlled multi-camera aerial photography and the other for a Daedalus thermal infrared linescanner, acquired in 1979. The Centre obtained aerial photographic coverage for use in conjunction with aerial thermography of over ten Ontario regions and cities obtained by Intertech Remote Sensing Ltd. Research was conducted into the use of gamma ray spectrometry for the assessment of water content of snow, as input to flood forecasting. The OCRS employed large quantities of aerial photography of all types, from provincial and national sources, in research programs and training seminars.

Acres Consulting Services reports the use of approximately 100 1:15,840-scale aerial photographs and the same number at a scale of 1:10,000, in hydrological and geological studies.

Beak Consultants Ltd. employed 250 black and white airphotos, at two different scales, for land use and vegetation mapping.

Bird and Hale Ltd. used over 1,000 standard provincial aerial photographs in engineering and environmental assessment projects.

Dendron Resource Surveys Ltd. used approximately 15,000 aerial photographs, 9" x 9" panchromatic, 9" x 9" colour and 70 mm colour. The company also requested the acquisition of large-scale airphoto coverage from private industry and coverage using the inertial navigation systems sensor package from CCRS.

Ecologistics Ltd. employed 500 1:10,000-scale black and white photographs in vegetation and soils mapping.

Hunter and Associates used 2,000 black and white and 200 colour aerial photographs, and commissioned colour photography in the Western Arctic, although the contractor did not complete the work.

Kenting Earth Sciences used 2,000 standard provincial airphotos, and obtained its own black and white and colour airborne coverage of areas in Eastern Canada.

Questor Surveys Ltd. reports the use of approximately 10,000 black and white aerial photographs from provincial and federal sources.

Scintrex Ltd. employed approximately 1,000 aerial photographs, at scales from 1:12,500 to 1:50,000.

W. Strok and Associates Ltd. used a small quantity of airphotos and mosaics in drainage analysis, land use updates and road site studies.

Union Minière Exploration and Mining Corp. Ltd. (UMEX) employed a few colour 1:18,000-scale aerial photographs for the interpretation of structural geology.

Spaceborne Remote Sensing

Professor S. H. Collins of the University of Guelph reports conducting experimental work on Landsat CCT's and involvement in developing data-processing programs for CCRS.

Dr. J. R. Pitblado of Laurentian University employed approximately 50 black and white and colour Landsat images, one black and white enlargement and four CCT's in teaching and in the mapping and monitoring of vegetation recovery near a smelting complex.

Professor P. J. Howarth of McMaster University used Landsat imagery, digital classifications and enhancements in lectures and labs, and also weather satellite imagery. Four research projects required the use of 14 DICS tapes, approximately 40 MSS and RBV colour transparencies, 10 EBIR outputs and electronic and line-printer outputs. Seasat radar data was used in two projects.

Dr. B. Boucek of Sir Sandford Fleming College employed black and white Landsat images and colour composites in instruction and demonstration.

Professor J. Vlcek of the University of Toronto employed Landsat imagery for teaching purposes.

Professor D. K. Erb of the University of Waterloo used Landsat black and white images and colour composites, mainly in transparency format, to illustrate course material. He plans to use approximately 200 black and white images of Southern Ontario for a second-year course and labs beginning in the winter of 1981.

Dr. A. Kesik of the University of Waterloo reports the use of 50 Landsat and Skylab images, and two Landsat CCT's, in graduate research.

The Ontario Centre for Remote Sensing employed approximately 1,000 Landsat images and approximately 50 CCT's in its research, training and application projects.

Acres Consulting Services employed 10 Landsat MSS colour-composite prints in hydrological and geological investigations.

Beak Consultants Ltd. reports some limited use of Landsat colour-composite prints.

Bird and Hale Ltd. used a Landsat mosaic in project presentation, and employed additional imagery in regional geology mapping.

Dendron Resource Surveys Ltd. made limited use of satellite data in testing the feasibility of its application for forestry purposes.

Ecologistics Ltd. employed three 1:250,000-scale black and white Landsat enlargements in the identification of wetlands across two watersheds in Southern Ontario.

Geostudio Consultants Ltd. used digital Landsat data (DICS tapes) in a project to develop a methodology for the monitoring of temporal changes in agricultural land use and small waterbody occurrence in Western Canada.

Hunter and Associates reports that Landsat imagery was a minor component of all projects conducted in 1980.

Union Minière Explorations and Mining Corp. Ltd. (UMEX) applied small quantities of black and white Landsat MSS and RBV imagery, at scales of 1:500,000 and 1:250,000 respectively, to structural geology mapping outside Ontario.

Technical Developments

Professor S. H. Collins of the University of Guelph developed three programs for CCRS concerning line-to-raster and raster-to-line data conversions, and the creation of digital elevation models in raster form.

Dr. J. R. Pitblado of Laurentian University reports research in biomass estimations using ratio techniques.

Dr. B. Boucek of Sir Sanford Fleming College began to develop the use of microcomputers for remote sensing demonstration and instruction.

Professor J. Vlcek of the University of Toronto reports the development of a new method for the measurement of thermal emissivity.

The Great Lakes Surveys Unit continued work on digital thermal infrared linescanner data and on the development of instrumentation and techniques for water quality data acquisition.

The Ontario Centre for Remote Sensing put an Applicon Colour Plotting System into full operation, in conjunction with its digital image analysis system. Work began on the development of programs to combine satellite data with digitized map data for the production of thematic maps. The Centre initiated the development of software for quantitative mapping of chlorophyll content in waterbodies using digitized aerial photography. An investigation began into the use of airborne gamma ray spectrometry to provide snow-water equivalency data for flood forecasting. Operational tests were performed on the use of airborne video recording for agricultural crop inventory.

Dendron Resource Surveys Ltd. continued development of a photogrammetric and software package for mapping and inventory based on large-scale aerial photography.

Geostudio Consultants Ltd. undertook a project to develop a computer-based system for accessing Landsat digital data on the basis of farmland parcel descriptions from the Dominion Land Survey system.

Applications and Benefits

Professor S. H. Collins of the University of Guelph reports that students performed projects applying remote sensing data to soils, land use, fisheries and wildlife, landscape architecture, hydrology and forestry. Commercial projects were also undertaken on the evaluation of farm land and woodlots.

Professor S. G. Hilts of the University of Guelph applied remote sensing to the continued development of a masterplan for a provincial nature reserve park, to research on land use change in Mississauga over a 23-year period, and to the teaching of fieldwork in resources management. He finds remote sensing to be the single most valuable tool for field study in resource and environmental management.

Dr. J. R. Pitblado of Laurentian University used remote sensing, with emphasis on digital analysis, for the mapping and monitoring of vegetation recovery in the vicinity of smelting complexes.

Dr. P. J. Howarth of McMaster

University reports that remote sensing was applied to the following projects:

- development of a methodology for change detection
- change detection in the Peace-Athabaska Delta (Landsat digital data)
- vegetation studies in Northern Ontario (Landsat image enhancement)
- geological mapping in the Grenville Province of Ontario (Landsat MSS/RBV; Seasat radar)
- land use/land cover mapping in the Hamilton-Wentworth region (Landsat MSS/RBV; airborne SAR)

Dr. D. K. Erb of the University of Waterloo continued an aerial photography-based study on the geomorphology of Jamaica. Dr. Erb comments that remote sensing, especially aerial photographic interpretation, is an indispensable tool in geomorphological analysis and environmental impact assessment.

Dr. A. Kesik of the University of Waterloo applied conventional and high-altitude aerial photography, as well as Landsat imagery, to the study of landforms and compilation of geomorphological maps for an area outside Ontario. Dr. Kesik comments that the application of remote sensing to small-scale thematic mapping increases the productivity of map compilation, and that synoptic images, such as Landsat mosaics, provide an excellent basemap for the study of extensive areas.

The Technical Support Unit of Water Resources Branch, Ministry of the Environment, applied aerial photographic interpretation to drainage pattern and environmental impact assessment.

The Great Lakes Surveys Unit of Water Resources Branch, Ministry of the Environment, applied archival aerial photography to general water quality surveillance and trace contaminants surveys, as support for field work planning. Aerial thermography was applied to the study of thermal plumes from the Pickering nuclear generating station on Lake Ontario, and revealed plume features which had not been previously encountered or expected.

The Ontario Centre for Remote Sensing conducted an extensive program of research and development projects in 1980. Some highlights are as follows:

- map preparation for the wetland classification of the Hudson Bay-James Bay Lowlands
- continuation of land use/land cover mapping for the province, by the digital analysis of Landsat data
- continuation of agricultural land use update mapping for the province, by the digital analysis of Landsat data
- continuation of the typing of forest resources north of latitude 52° N by the digital analysis of Landsat data
- completion of an operational aerial photographic methodology for the assessment of forest regeneration success; preparation of an instruction manual on use of the technique
- continuation of an investigation into the operational use of Landsat data for the mapping of snow-cover extent, as input to flood forecasting
- research into the use of airborne gamma ray spectrometry for the acquisition of snow-water equivalency data, as input to flood forecasting
- continuation of research into the applicability of airborne and spaceborne SAR data, including an investigation of SAR for wetland identification
- research into the mapping of wild rice on aerial photography and Landsat imagery
- preparation of a state-of-the-art report on the application of thermography to forestry
- coordination of data acquisition for fourteen towns and cities; direction of thermography presentations to homeowners at twelve residential energy conservation clinics of the Ministry of Energy
- continuation of the forest disease and infestation detection programs
- continuation of multi-date aerial photographic coverage of permanent sample plots, for the systematic study of phenological and temporal changes
- experiments in selective forest typing from Landsat data
- experiments on simulated Landsat D and SPOT data

- an experiment on vegetation analysis in industrially-polluted areas using the digital analysis of Landsat data.

Acres Consulting Services applied aerial photography and satellite imagery to hydrological analyses (e.g., the definition of water boundaries, the determination of water levels, the identification of swamps and floodplains, and a comparison of wet and dry-season conditions), as well as to geological investigations. The company found Landsat data particularly useful for studies in third-world countries, where little or no mapping was available.

Beak Consultants Ltd. applied aerial photography and a very limited amount of satellite imagery to land use, vegetation and wildlife habitat mapping for proposed thermal generating station sites in Saskatchewan, and to vegetation mapping in central Quebec.

Bird and Hale Ltd. used aerial photography and some satellite data for such projects as route location, park site selection, environmental assessment studies, materials searches, subdivision approvals, and other investigations related to hydrology and geology.

Dendron Resource Surveys Ltd. applied large-scale aerial photography to the development of an aerial forest inventory methodology and Landsat imagery to research on forestry problems. Research was conducted into forest inventory compilation systems and specifications for resource mapping imagery.

Ecologistics Ltd. applied aerial photographic interpretation to fill line mapping, soil mapping, vegetation cover type mapping, and wetland evaluations. Landsat enlargements were used to identify possible wetlands across two watersheds in Southern Ontario.

Geostudio Consultants Ltd. undertook a study sponsored by the federal Department of Agriculture to develop a methodology for using Landsat data to monitor multitemporal changes in agricultural land use and small waterbody occurrence in Western Canada.

Union Minière Explorations and Mining Corp. Ltd. (UMEX) applied aerial photography and a limited amount of satellite imagery to structural geology studies for mineral exploration, related to projects outside Canada. Remote sensing was found to be a valuable complement to ground geophysical surveys and geological mapping.

Training

Professor S. H. Collins of the University of Guelph conducted courses in terrain measurement, including elements of surveying and photogrammetry, and photointerpretation.

Professor S. G. Hilts of the University of Guelph provided training in the use of airphotos as a fieldwork base to fourth-year students.

Professor J. R. Pitblado of Laurentian University gave two undergraduate courses in remote sensing.

Professor P. J. Howarth of McMaster University reports that a third-year remote sensing course was provided to 53 students, a fourth-year course to 33 students, and that there was a graduate remote sensing class of 5 students.

Dr. B. Boucek reports that Sir Sandford Fleming College offered a photointerpretation course in forest technician and fish and wildlife technician programs; a supplementary aerial photography course in a forest technologist program; remote sensing courses in geology technologist, fish and wildlife technologist, forest recreation technologist and thematic cartography technology programs; and basic courses in photogrammetry and photointerpretation in most programs offered by the College.

Professor J. Vlcek of the University of Toronto conducted remote sensing training.

Dr. D. K. Erb of the University of Waterloo conducted third-year courses in airphoto interpretation for geography and the study of geomorphological processes, and supervised honours essays employing airphoto interpretation and remote sensing. In 1981, he will teach two half-year courses in introductory airphoto analysis and remote sensing to a total of 200 students, and will offer a fourth-year course in applied airphoto interpretation.

Professor A. Kesik of the University of Waterloo taught an introductory course in airphoto interpretation and remote sensing to approximately 100 students per term from geography, earth science, engineering and environmental studies departments.

The Ontario Centre for Remote Sensing began in 1980 to implement its comprehensive program of remote sensing technology transfer directed to government, private industry and

universities in Ontario. Seminars in applied remote sensing for government and private industry staff are a major component of this program. Three general seminars for government and industry professionals and two seminars for government managers were conducted in 1980. A specialized seminar was conducted for forest fire control staff. The Centre offered three photo interpretation courses concentrating on boreal forest conditions for staff from government and private companies, and one photo interpretation course concentrating on Great Lakes-St. Lawrence forest conditions, for staff from government organizations. In addition, the Centre conducted demonstrations on applied remote sensing for groups of undergraduates from several universities, offered guest lectures, and assisted the preparation of undergraduate and graduate theses. In cooperation with university professors, the Centre began planning the production of remote sensing teaching aids. Work was also begun on research projects undertaken in cooperation with two university professors.

The Centre's Head of Research and Training conducted a series of seminars and lectures in applied remote sensing at the University of Freiburg, West Germany, under the auspices of the Canada-Germany Scientific and Technical Exchange Program.

A meeting was held in the fall of 1980 with representatives of industry from across the province, to present in detail the technology transfer program directed to the private sector. The Centre's offer of training, consultation and cooperation in research and application was very well received. Numerous companies specified their training requirements. Cooperative research projects with two companies were initiated.

Acres Consulting Services reports that one of its staff participated in a five-day applied remote sensing seminar conducted by OCRS, and that a second staff member attended an OCRS course in photo interpretation for the boreal forest region. Beak Consultants Ltd. also had one staff member at an OCRS boreal-forest photointerpretation course. Ecologistics reports that one staff member participated in the OCRS technology transfer program, with regard to the application of remote sensing to land use investigations.

Dendron Resource Surveys Ltd. participated in symposia and conducted training courses for clients.

Mr. G. T. Hunter, President of Hunter and Associates, presented lectures at the University of Waterloo.

Conclusions and Forecast

Professor P. J. Howarth of McMaster University observed that there was a lack of coordination and interaction in remote sensing at the provincial level, but that the OCRS technology transfer program and an increase in the activities of the Ontario Association of Remote Sensing would help to overcome this.

Dr. B. Boucek of Sir Sandford Fleming College commented that good cooperation existed with the OCRS, and that liaison between the College and the Centre would be even more productive in the future.

Dr. D. K. Erb of the University of Waterloo stated that, while the use of remote sensing was quite widespread in the province, the greater availability of funds for basic research in remote sensing was required.

Dr. A. Kesik of the University of Waterloo found contact between industry and universities improved, and remarked that the cooperation between universities and the OCRS was very helpful, as was the role of the Ontario Association of Remote Sensing.

Mr. R. C. Ostry, Head of the Technical Support Unit, Water Resources Branch, Ministry of the Environment, expressed the view that remote sensing in Ontario was in a state of stagnation, for lack of resources and lack of management support.

It is the view of the OCRS that an active technology transfer program in Ontario is the most effective means of extending the operational application of remote sensing. A high level of interest in the program has been shown in 1980 by government organizations, private companies and universities and colleges.

Mr. James Rowsell of Beak Consultants Ltd. believes that remote sensing is advancing very well in Ontario.

Mr. D. R. Cressmen, President of Ecologistics Ltd., also commented that good progress was being made in the interpretation of Landsat data, but that more operational use of Landsat analysis was required for agricultural land use studies toward watershed planning.

Mr. G. T. Hunter of Hunter and Associates stated that more funding should be available for research and equipment acquisition in the private sector, so that the cost

and benefits of remote sensing could be made evident.

Both Professor S. G. Hilts of the University of Guelph and Mr. P. G. Lazenby of Questor Surveys Ltd. commented that there was a lack of readily-available information - such as an annual update - on remote sensing activities and new developments province-wide.

Recommendations

Professor S. G. Hilts of the University of Guelph recommends that integrated information on the availability of remote sensing data be provided, incorporating provincial and national collections.

Dr. J. R. Pitblado of Laurentian University recommends the production of a directory of remote sensing-related facilities available in government, private industry and universities, of research undertaken and of jobs available in all three sectors.

Dr. B. Boucek of Sir Sandford Fleming College also called for better access to new data, methods and instruments, a more active exchange of information with the federal program, and better coordination of education and training.

Dr. D. K. Erb of the University of Waterloo recommended that more remote sensing research be commissioned of universities. He remarked that, in some cases, minimal initial funding would be required, and supplementary funding could be considered as results were produced.

Professor A. Kesik of the University of Waterloo recommended that action be taken on the reorganization of CACRS.

Mr. R. C. Ostry, Head of the Technical Support Unit, Water Resources Branch, Ministry of the Environment, recommended that demonstration projects and cost-benefit assessments be conducted.

The Ontario Centre for Remote Sensing makes the following recommendations:

(a) that a mechanism be established whereby provincial representatives to CACRS may make input to the planning of the federal technology transfer program;

(b) that CCRS establish a plan for the reorganization of CACRS and submit it for comment to the provincial representatives;

(c) that the federal program begin preparations as soon as possible for technological expansion to receive and process Landsat D data;

(d) that CCRS take action on the recommendation made to CACRS in 1979 for production of a brochure on operational remote sensing techniques.

The OCRS also commends CCRS for the recent improvement in the quality of Landsat imagery production.

Both Acres Consulting Services and Bird and Hale Ltd. recommended that the necessary action be taken to reduce the time required to receive an imagery order.

Dendron Resource Surveys Ltd. recommended that decisive action be taken to involve industry in those remote sensing developments that are ready for application, and that a strong program be implemented to transfer new remote sensing technology to the end user.

1980 Publications/Prepared Papers

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6.10 REPORT OF THE PRINCE EDWARD ISLAND REMOTE SENSING COMMITTEE

The Prince Edward Island Remote Sensing Committee has not been active during the past several years. Consequently, no remote sensing projects were initiated in 1981. Given the current status quo, it is somewhat improbable that a remote sensing program will be activated in the forseeable future.

Although no remote sensing centre for the Atlantic region currently exists, it is not felt that the organization of such a facility (regardless of its location) would have a wholly significant influence on the development of a remote sensing program on P.E.I. The existance of a centre could be established with technical and financial support from C.C.R.S. However, in the absense of a commitment from the Government of P.E.I., use of the facility by the province would be minimal. This commitment is not likely to occur until such time as remote sensing techniques can be proven to be more effective in answering resource base questions (i.e. agriculture and forest inventory) than conventional methods. Satellite data, although less precise than airborne R.S. data, seemed to offer good potential. However, a combination of communication problems associated with distance between C.C.R.S. and P.E.I., the unique nature of our problem, and our lack of remote sensing expertise eventually eroded the program to its current level.

In spite of the existing low level of R.S. activity on P.E.I. it is still believed that the technique holds promise. However, as previously stated, the level of activity will not increase until (1) a firm commitment is made by both government and C.C.R.S. (2) C.C.R.S. fully appreciates and understands the nature of our problems, (3) our expertise are upgraded significantly and (4) a realistic approach is designed and adopted.

6.11 RAPPORT DU QUEBEC

Système de traitement numérique

Le point marquant de la télédétection au Québec en 1980 a été l'implantation d'un système de traitement numérique, propriété conjointe du ministère de l'Energie et des Ressources, de l'Université Laval et du Centre de recherches forestières des Laurentides. Les trois organismes se partagent le temps d'utilisation du système.

Connu sous l'appellation de SCANIQ, ou Système conjoint d'analyse numérique d'images de Québec, il est physiquement installé au Centre québécois de coordination de la télédétection.

Sa configuration actuelle comprend deux sous-systèmes, dédiés successivement au traitement conversationnel et au traitement par lots. Le logiciel dont il est muni place SCANIQ dans la famille ARIES et le rend directement compatible avec plusieurs autres systèmes au Canada, entre autres celui du Ontario Centre for Remote Sensing et celui de l'Institut national de recherche forestière de Petawawa.

Le diagramme de la configuration actuelle de SCANIQ est illustré à la fin de ce texte.

Télédétection aérienne

Mis à part les programmes de photographie aérienne conventionnelle, très peu de vols de télédétection ont été réalisés au Québec au cours de l'année, si ce n'est ceux appartenant au programme de simulation des données de SPOT et de Landsat D, dans le cadre de la préparation du Colloque sur les applications de la prochaine génération de satellites d'observation de la terre (voir section 6.11.5).

Télédétection spatiale

Au point de vue des applications des données de satellites, des pas importants ont été franchis au cours de l'année vers la phase opérationnelle, principalement dans le domaine de la végétation nordique et de la forêt.

Après une longue phase de recherche et de développement de méthodologies, certaines possibilités d'application opérationnelle et d'envergure se dessinent maintenant très nettement et, avec la création de l'infrastructure nécessaire (voir section 6.11.4), ces méthodologies seraient aptes à être reprises pour une phase de production.

Les travaux réalisés au Centre de recherches forestières des Laurentides (C.R.F.L.), conjointement avec l'Hydro-Québec, ont démontré la faisabilité de la cartographie à petite échelle (1:500 000, 1:250 000 et même 1:125 000) de la végétation nordique.

Le C.R.F.L. a également établi, conjointement avec le ministère de l'Energie et des Ressources, la méthodologie pouvant mener à la production d'une carte synthèse (au 1:125 000) de la forêt québécoise directement à partir des données de satellites et des données de terrain (obtenues par survol du territoire en avion léger). Ont également été entreprises des études visant à adapter la même méthodologie à un pré-inventaire forestier. Il s'agit de faire une cartographie générale d'inventaire (au 1:125 000) et de déterminer comment elle peut orienter les travaux de l'inventaire plus détaillé au 1:20 000.

On sait que la Société de conservation de l'Outaouais utilise de façon opérationnelle des pseudo-cartes de combustible forestier obtenues grâce à une méthodologie développée à l'Institut national de recherche forestière de Petawawa. Cette méthodologie continue à être améliorée et un pas important a été franchi par l'introduction des images corrigées DICS, dans le cadre d'un projet visant à répéter l'expérience de l'Outaouais dans une autre Société de conservation, soit celle du Saguenay — Lac-St-Jean.

C'était là une première tentative de transfert de technologie, menée par le ministère de l'Energie et des Ressources, avec la précieuse collaboration de l'Institut national de recherche forestière de Petawawa. Le projet a été reporté à l'été 1981, puisque les produits n'ont pas été livrés à temps à la Société. Le problème est intervenu au niveau de l'alimentation en images DICS.

Transfert de technologie

L'arrivée de SCANIQ à Québec et l'avancement des travaux dans le développement des méthodologies crée dans la province un environnement et une conjoncture très favorables à un transfert de technologie des centres de recherche aux organismes gestionnaires des ressources.

Sauf la tentative mentionnée à la section précédente, il n'y a pas eu d'opération en ce sens au cours de l'année. Cependant, le Centre québécois de coordination de la télédétection a commencé à définir le type de

transfert pouvant répondre aux besoins du Québec et a amorcé un projet en ce sens.

Voici les grandes lignes de ce type de transfert. On doit transférer au gestionnaire des ressources non pas la machine, mais le produit. Ce produit, orienté spécifiquement vers telle ou telle application, pourrait être offert par l'industrie privée, possédant les systèmes de traitement et un personnel de télédétectistes informaticiens. On doit réintégrer l'interprétation humaine dans le processus d'exploitation des données des satellites. L'interprétation serait faite par un autre groupe de télédétectistes, les téléthématiciens, rattachés à l'organisme de gestion des ressources ou à l'entreprise privée. Le programme canadien doit assurer l'existence de données d'entrée.

A la lumière des méthodologies prêtes à passer au stade de production au Québec, on peut identifier le "produit orienté," dans un premier temps, à une image accentuée en couleur pour une fin spécifique. La demande existant, un premier programme de transfert de technologie consisterait à encourager l'"offre", pour ainsi créer le marché. Ce programme doit aussi encourager la formation de services d'interprétation de ces documents.

Au Québec, presque tous les éléments sont là pour amorcer un tel programme: personnel, équipements, méthodologies, expertise, organismes donneurs, organismes receveurs, organismes disposés à offrir les services, données d'entrée, thèmes d'application, etc. Il s'agirait d'articuler le tout, d'amorcer le mouvement et de le maintenir avec ... les argents suffisants.

Un programme complet consisterait à assister cette machine jusqu'à ce qu'elle devienne autonome, ou rentable. Le marché serait alors créé.

Colloque sur l'utilisation de la prochaine génération de satellites d'observation de la terre

Le Colloque, devant avoir lieu les 25 et 26 novembre 1980 à Montréal, a été reporté aux 24 et 25 mars 1981.

Six expériences, basées sur des simulations de SPOT ou de Landsat D, ont été entreprises au Québec en vue de ce Colloque. Il s'agit: d'une étude sur la végétation nordique, dans la région de la baie de James; d'une étude sur l'environnement propice à l'éclosion des insectes piqueurs, dans la région de Sorel; d'une étude sur l'utilisation des sols, près de Granby; d'un examen des possibilités du capteur panchromatique de SPOT (pixel de 10 m) pour la confection et la revision de la carte topographique; d'un essai de cartographie des coupes forestières avec le même capteur; et enfin d'une étude de l'environnement et de la forêt, par simulation du Thematic Mapper, dans la région de la Côte-Nord.

Rappelons que ce colloque est parrainé conjointement par le ministère de l'Energie et des Ressources du Québec et le Centre canadien de télédétection.

Activités diverses

L'Association québécoise de télédétection a tenu son troisième congrès à Québec les 27 et 28 novembre 1980. Quelque vingt communications ont été présentées et les comptes rendus seront publiés ultérieurement.

Presque toutes les universités québécoises font maintenant appel à la télédétection, soit dans le cadre de travaux de recherche, de l'enseignement ou comme simple outil pour d'autres disciplines. Des travaux ont été portés à la connaissance du C.Q.C.T. à l'Université Laval, à Sherbrooke, à Mc Gill, à l'Université de Montréal, à l'Université du Québec à Montréal, à Chicoutimi et à Trois-Rivières, ainsi qu'à l'Institut national de recherche scientifique à Québec.

L'Université Laval a offert son service SANIOT (Service d'analyse numérique des images obtenues par télédétection), grâce à l'utilisation du système SCANIQ.

Le Centre québécois de coordination de la télédétection continue la publication du bulletin "La télédétection au Québec" (3 numéros en 1980) et la distribution de SYDOSAT (3 parutions). Son service de recherche en documentation continue également à répondre à une large clientèle. La collection d'images Landsat sur support 70 mm en diapositives (quatre bandes spectrales) s'est enrichie de 110 nouvelles scènes cette année.

Avec l'arrivée de SCANIQ, le ministère de l'Energie et des Ressources, l'Université Laval et le Centre de recherches forestières des Laurentides ont mis en commun leurs collections d'images sur bandes magnétiques. C'est le début d'une banque de données que sont invités à partager tous les usagers du Québec.

Conclusion

L'arrivée de SCANIQ a introduit au Québec un climat d'échange de

connaissances entre des organismes intéressés aussi bien à la recherche, à l'enseignement, à la formation de personnel, au développement de méthodologies, à la confection de produits spécifiques et à l'exploitation de ces produits. Cette symbiose entre l'Université Laval, le M.E.R. et le C.R.F.L. amorce une circulation très libre des connaissances et des méthodologies.

On retrouve donc au Québec, à la fin de l'année 1980, une conjoncture très favorable à la création d'un "marché des produits orientés" issus de la télédétection.

C'est dans ce sens que devrait être orienté tout programme ou projet de transfert de technologie. Cela présuppose cependant qu'en aval on puisse avoir un service fiable et opérationnel d'alimentation en données d'entrée et c'est ce que devra nous assurer, avant toute autre chose, le programme canadien. Principalement pendant ces années d'incertitude précédant le lancement de Landsat D.

En particulier, le programme canadien devra également assurer un service vraiment opérationnel d'images corrigées géométriquement (DICS), celles-là étant appelées à devenir le produit normal d'entrée. Espérons que l'expérience malencontreuse relative au projet du Saguenay — Lac-St-Jean (section 6.11.3) n'est pas significative.

Addenda

Cette section est ajoutée au rapport du Québec après la tenue du Colloque sur l'utilisation de la prochaine génération de satellites d'observation de la terre.

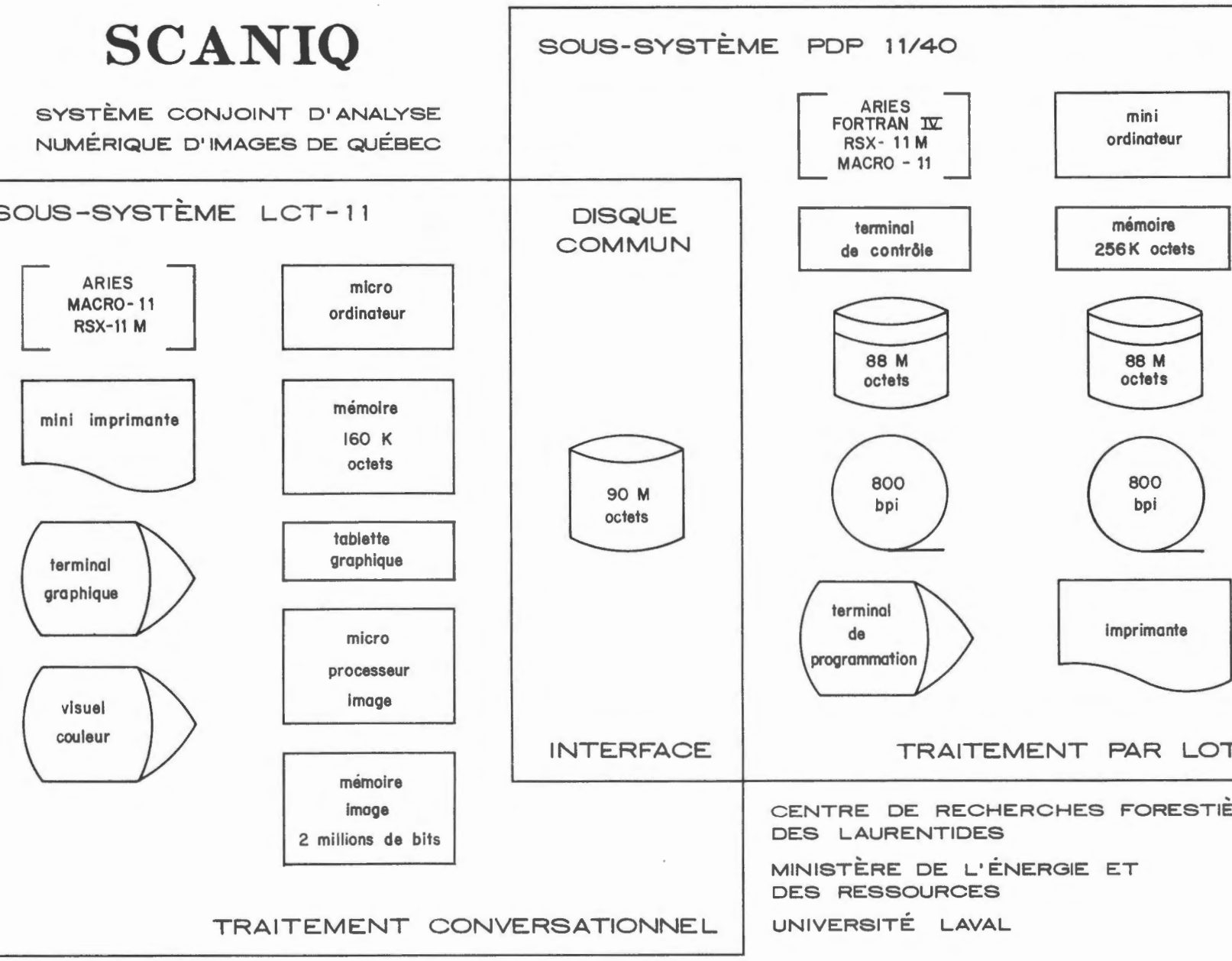
Un "manuel de synthèse", résumant les principales communications et les principales conclusions du colloque sera publié sous peu.

Toutefois, il serait pertinent de diriger immédiatement vers le Centre canadien de télédétection, via le présent rapport au Comité consultatif canadien sur la télédétection, une recommandation émanant du colloque:

"Que le Centre canadien de télédétection établisse et fasse connaître le plus rapidement possible sa politique vis-à-vis l'acquisition et la diffusion des données du satellite français SPOT".

SCANIQ

SYSTÈME CONJOINT D'ANALYSE
NUMÉRIQUE D'IMAGES DE QUÉBEC



CENTRE DE RECHERCHES FORESTIÈ
DES LAURENTIDES

MINISTÈRE DE L'ÉNERGIE ET
DES RESSOURCES

UNIVERSITÉ LAVAL

7.0 REPORTS OF THE CACRS WORKSHOPS, 1980

7.1 Report of the British Columbia Workshop

The use of "remote sensing" (meaning satellite, and 'new' sensor aerial) data is now increasing rapidly. (Note that a provincial aerial photography facility - 9" mapping cameras, stereo boom and specialized experiments - has existed for many years using two aircraft with some higher altitude capability).

Only a co-ordinating committee exists in the province - no centre. The co-ordination role of this committee could be improved and expanded. The roles that would be performed by a centre are being performed by provincial and federal government departments, universities and private industry.

Highlights of the program in the province include:-

Provincial forestry department's image analysis work and computer mapping facility.
Federal forestry department's image analysis system.
MacDonald, Dettwiler and Associates Ltd.'s commercial image analysis and correction facility.
U.B.C.'s image analysis, research and training capabilities.
I.O.S. Pat Bay's data and image analysis and spectrometric capabilities.

It was pointed out that this type of de-centralized evolution:-

Does not infringe on existing mandates.
Represents an advanced level of technology transfer.
Can still maintain a high level of expertise in new systems, given a competitive industrial approach.

This is not to imply that provincial centres are not a useful stage in the development of remote sensing use. The situation in B.C. may not be comparable in other provinces.

Problems were noted with data availability from CCRS for Landsat. I.O.S. gets NOAA data from AES Edmonton and also finds some problems with continuity.

7.2 Report of the Prairie Region Workshop

For the Prairie Region consisting of Manitoba, Saskatchewan, and Alberta, it was agreed by the workshop members that a central organization for each province to deal with remote sensing technology was the best approach.

The role of the central organization would be:-

Co-ordination of programs and activities.
Operating a center which would maintain equipment, provide training and offer consulting services and advice on remote sensing methods and techniques.
Developing methods of transferring remote sensing technology to other government agencies and private industry.
Assisting universities in establishing remote sensing courses and encouraging research and development.

Two of the provinces, Manitoba and Alberta, already have this type of organization. Saskatchewan has a goal to establish a center by revitalizing the Provincial Remote Sensing Committee. They will provide planning and recommend a department where a center should be set up.

The two existing centers have different methods of operation and obtain funding in different ways but the goals are the same. Over the next five years the goal will be to keep current on new developments, obtain the necessary equipment to process data and to transfer the technology to those who can most benefit by it.

Resource Information Requirements

Agriculture

Crop reporting (soil moisture, crop condition, yield production, rangeland condition.

Location of Mineral Deposits (extent, accessibility, environmental impact on developing).

Forestry (inventory, area change, regeneration, protection).

Land Information (ownership, capability, use, cover, transportation, change).

Environmental Monitoring (mining, industry, hydro developments).

Remote Sensing Roles

Agriculture

Crop report system and monitoring rangeland.

Minerals

Monitoring, transportation, route selection.

Forestry

Inventory area change.

Land Information

Monitoring change.

Environmental Monitoring

Mining, water related activity.

Recommendation

That a crop reporting information system be implemented using remote sensing techniques by 1984/85.

7.3 Report of the Ontario Workshop

Provincial Roles

The present situation, with regard to available resources, is all satisfactory or very satisfactory; with regard to provincial needs, R&D, technology transfer, and training are unsatisfactory, others are satisfactory.

In five years, there should be

High priority on R&D, technology transfer, advice, and training.

Medium priority on services.

Low priority on co-ordination.

The lead role should be taken by OCRS in all six of these categories. Better results can be achieved by reducing red tape and staffing limitations.

Resource Industries

Contribution to Economy:

Forestry > Minerals > Industrial
Agriculture > Inland Waters > Fisheries

Priorities for Extended or New Applications:

Forestry > Minerals > Agriculture = Industrial > Inland Waters > Fisheries

Specific Applications Plan for 81/82 to 83/84

Forestry

Forest inventory of unmapped areas
Annual update of entire forested areas
Forest fire fuel mapping update

Minerals, Industrial

Only small projects foreseen except for heat loss.

Agriculture

Crop inventory (annual or semi annual)
R&D on TIR scanning

OCRS Requirements For Better Planning

The Ontario program depends on:-

- archival inventory of Landsat data
- current aircraft and satellite data acquisition capabilities
- future programs

OCRS Needs to Know:-

- which new types of data will be available, their characteristics and schedule (LsD, SPOT, RADARSAT, etc.)
- hardware and software characteristics appropriate for the new data
- the plans of the Federal Government, especially beyond 1983/84.

Ontario and Canadian remote sensing programs are inter-related.

7.4 Rapport de l'atelier sur le Québec

Le situation présente au Québec est la suivante:

1. Le fonction de coordination est assurée de façon assez satisfaisante, avec quelques lacunes, entre autres au niveau de la rapidité de l'information.

2. Les activités de recherche et de développement sont assez bien développées dans deux universités (Laval et Sherbrooke) mais embryonnaires ailleurs.

Elles concernent surtout les applications, ainsi que le développement de logiciel.

3. Le transfert de technologie est quasiment inexistant, mais il est prêt à devenir opérationnel dans le domaine de la foresterie.

4. La fonction d'information et de conseil est assez bien remplie par le C.Q.C.T., avec quelques erreurs. De plus, l'A.Q.T. diffuse - assez mal il est vrai - une certaine quantité d'information et de publications à ses membres: les comptes rendus des deux premiers congrès de l'A.Q.T. ont été distribués à 400 exemplaires dans une vingtaine de pays, et la revue "Télédétection au Québec" du C.Q.C.T. tire à 600 ou 700 exemplaires.

5. La formation est pour l'instant cautonuée dans les programmes universitaires de Laval (Photogrammétrie) et Sherbrooke (Géographie). L'Université McGill offre un certificat en Télédétection qui rencontre un succés mitigé à cause de sa structure trop traditionnelle. L'A.Q.T. a déja donné quelques cours intensifs, mais pas sur une base systématique.

6. Ces facilités existantes au M.E.R. (conjointes avec l'U. Laval et le C.R.F.L.) sont bonnes, mais deviendraient vite insuffisantes si les développements opérationnels apparaissaient. D'autre part, l'éloignementpar rapport aux autres centres (Sherbrooke, Montréal) en rend l'usage prohibitif au niveau des frais de déplacement.

Situation actuelle dans les domaines d'application

1. La Foresterie, qui compte pour 20 à 30% du PNB, est prête à recevoir la technologie: il reste à mettre en place des mécanismes de transfert.

2. L'agriculture, pour l'instant, ne fait aucun usage de la télédétection (sauf de photographies aériennes conventionnelles).

3. Les eaux intérieures (incluant l'Hydro Québec) ne se servent de la télédétection que pour des études d'impact sur l'environnement (S.D.B.J.), mais le processus pourrait être intégré davantage.

4. Les pêcheries et l'océanographie n'en font aucun usage.

5. La Géologie et les Mines se servent surtout de photographies aériennes à basse altitude, et ont une attitude plutôt négative (sauf exceptions) par rapport aux images satellite.

6. Dans les secteurs urbains, industriels et du tourisme, l'utilisation est presque nulle.

Potentiel de développement et rôle futur

Dans tous les domaines cités ci-dessus, le potentiel de développement est important, mais dans l'ensemble, on se heurte aux obstacles suivants:

1. Scepticisme sur la précision (surtout du point de vue spatial), qui demande à voir des preuves concrètes.

2. Manque de formation des utilisateurs potentiels.

3. Grand cloisonnement et "champs réservés" à l'intérieur de la fonction publique provinciale.

4. Un trop petit nombre de compagnies ou bureaux de consultants prêts à accepter des contrats opérationnels (manque d'équipement).

5. Une absence totale de "marketing" de la télédétection.

Les solutions proposées pour de futur sont:

1. L'assistance aux utilisateurs sous forme de recettes simples et éprouvées (classification forestière) (C.Q.C.T.).

2. Développement de la recherche dans les universités, en particulier pour la préparation de Landsat D et SPOT, par une action concertée F.C.A.G./MER.

3. Assistance aux compagnies québécoises susceptibles d'offrir des services de consultation et/ou d'application (C.Q.C.T., gouv. fédéral).

4. Formation des adultes et des professionnels sous forme de stages courts/certificats (A.Q.T., Universités).

5. Animation du domaine privé par une préparation conjointe de projects de démonstration (C.Q.C.T., A.Q.T., Université) en particulier pour l'utilisation des sols (O.P.D.Q.) et le zonage agricole.

6. Pressions au niveau politique provincial, en insistant sur le petit nombre de contrats de R&D accordés au Québec par rapport aux autres provinces (A.Q.T.).

7.5 Report of the Atlantic Region Workshop

The Atlantic Region Workshop presented the following recommendations:

1. That the three Maritime Provinces and their Remote Sensing Committees recommend to the Council of Maritime Premiers the establishment of a Maritime Remote Sensing Co-ordinating Committee comprised initially of the Provincial Remote Sensing Committee executives and appropriate Council representatives and that a program for remote sensing applications demonstration and appropriate technology development be initiated and enhanced with the Region.

2. That the Provincial Remote Sensing Committees and the Provinces ensure through an appropriate organizational structure and program that the Maritime Remote Sensing Co-ordinating Committee's activities and programs serve the needs and interests of each Maritime Province and their resource managers.

3. That the Province of Newfoundland be invited to send observers if not participants to the Maritime Remote Sensing Co-Ordinating Committee's meetings and that the possibility of an "Atlantic" Committee be left open at this time.

4. That CCRS and the Maritime Provinces jointly provide human and technical resources to the Maritime Committee for the purpose of initiating a Maritime Region program for remote sensing technology transfer and applications development. (The Atlantic Workshop suggested that in the early phases, CCRS should set up a Maritime (Atlantic) Region office jointly with the Maritime Remote Sensing Co-ordinating Committee.)

5. That in support of the Maritime Committee's activities and programs, CCRS continually endeavour to provide co-ordination of information about the remote sensing activities of all federal agencies in the Maritimes and that when possible CCRS assist the Maritime Committee in gaining access to other federal government remote sensing resources and programs within the Maritimes.

8.0 UPDATE TO THE REPORT OF THE ACTION TAKEN BY CCRS AS A RESULT OF THE 1979 CACRS RECOMMENDATIONS

In the 1979 CACRS Report, all the recommendations made were compiled in Section 3 and comments by CCRS followed each recommendation. Most of the comments made at that time are still valid, but the following additional comments are published now, based on new facts and actions. The numbers cross-reference to the 1979 CACRS Report.

3.1.2 A presentation on a remote sensing satellite program was made to MSED cabinet ministers in November 1980. Plans for the program were developed in consultation with industry and are contained in the 1980 ICS 5-year plan.

3.1.3 CCRS has developed formal relationships with ESA and NASA that could lead to options for a shared remote sensing program. However, our plan for this program maintains emphasis on Canadian leadership and overall program management.

3.1.4 All aspects of this recommendation have been accepted and included in the ICS 5-year Space Plan.

3.1.5 The Shoe Cove station will continue to receive Canadian remote sensing satellite data, particularly with the lower orbiting altitude of Landsat-D. We will use the CCRS newsletter and other remote sensing publications to provide information on approved programs for this station.

3.4.1 CCRS is participating in the feasibility study of the Fluorescence Line Imager (FLI) sponsored by the Department of Fisheries and Oceans (Patricia Bay).

The spectroscopic capabilities of the aircraft C-GRSD are being upgraded to include the MPPH and OMA in addition to the MSS which has been flown as an operational sensor in this aircraft for the past two years. This facility will contribute quantitative data for sensor design and algorithm development.

3.4.2 The aerial hydrography package was used by the Canadian Hydrographic Service in the summer of 1980 to survey a 100 km section of the Bruce Peninsula (Lake Huron).

The combination of stereo photogrammetry and the profiling lidar bathymeter is considered to be sufficiently well developed that the private sector is laying detailed plans to establish a ground processing facility to reduce the data. The facility should be operational in 18 months time. Shortly thereafter industry plans to acquire a hardened operational airborne system. The facility will both serve Canadian needs and exploit the international market.

There are no immediate plans to build a scanning lidar bathymeter.

3.4.3 The ice community, through AES and the Ice Working Group, are represented in the RADARSAT project. If approved, an innovative research radar will be developed within this project.

3.5.1 As soon as CCRS assumed responsibility for the marketing and distribution of Landsat data products in June 1980, order entry clerks began sending opinion survey questionnaires with all shipments of microfiche, black and white prints, CIBACHROME prints, CCTs and 70mm reproductions. Approximately 2000 of these were mailed requesting feedback on whether or not the products shipped

were damaged in transit, missing, defective or incorrect. General comments were also solicited. The response to this survey was very poor and totally unreliable for statistical analysis. As a result, CCRS is continuing to respond to user complaints on an "as required" basis, while the Data Processing Division of CCRS has developed an internal system for monitoring product delivery times. For example, a survey of 77 orders of colour products resulted in an observed average delivery time of 2.5 weeks.

Feedback from users pertaining to CCRS services is being continuously monitored in a number of ways. CIAS users are required to record their impressions of each analysis session in a written report to CCRS. The nature of some of these investigations, however, makes it impossible to present the results publicly (geological exploration studies by private companies, for example). Finally, a report on user feedback resulting from CCRS airborne services was published in 1980, summarizing seven years of operations. However, the manpower required to produce this document would make it impractical to generate on an annual basis.

3.5.2 Since June 1980 CCRS has taken on the full responsibility for LANDSAT data production, through the use of sub-contractors at the Prince Albert and Shoe Cove stations and government personnel at Ottawa. The responsibilities include maintaining and improving the functions of ordering, production, quality control, distribution, invoicing and user interface and assistance on all Landsat products.

The new set of quality control procedures for all Landsat products are unique for each site and the products produced at that site. Better quality control of CCTs is being pursued by increasing the stations' capabilities in hard-ware, software and CCT screening, which came on-line in the summer of 1981 at PASS. Each station is to be self reliant in CCT production and quality control, thereby improving delivery time of CCTs and CCT products to users.

Delivery times for each product line have been developed and imposed on each production site. These delivery times are monitored by the Landsat Product and Control organization within CCRS weekly. Procedures have also been developed and placed into effect so that users are notified at the time the order is placed of any expected delay of their products, and also notified of any delays or problems with their order while in progress.

3.7.2 Information on the services offered by the national program for remote sensing in Canada is currently distributed in the form of a prospectus entitled "The Canada Centre for Remote Sensing". This 13-page document has been supplemented by a second publication describing in greater detail the products of the airborne program as well as the products and characteristics of the two principal image analysis systems offered by CCRS (the CIAS and TRIAD). A separate announcement describing the analogue Photo-graphic Analysis System (PAS) was distributed via the CCRS newsletter.

3.7.3 CCRS recognizes the critical need for its users to prepare budgets for the acquisition of remote sensing data. The problem is compounded since all of these users have different fiscal years for budgetary planning. Historically, price increases for CCRS products have become effective on June 1 each year. In 1980, for example, an approximate 10 percent general price increase was announced in April giving two months notice to users. Due to unforeseen circumstances, such as increasing interest rates, increased material costs (such as photographic film) or changes in government policy (such as the imposition of cost recovery), the production costs (and hence, prices) of CCRS products are subject to constant increases. For planning purposes, these increases could conservatively be assumed to follow the historical pattern of annual ten percent increases. However, because of the lead time needed to negotiate the terms and conditions and prices of these prices within the Federal Government infrastructure (DSS, etc.) the actual announcement of these prices should not be expected sooner than April 1 each year.

3.8.2 The U.S. have rejected the Canadian proposal for a real-time downlink. They are offering real-time access to Canada via domestic communication satellite links from White Sands, N.Mexico.

3.8.6(a) The Applications Development Section of CCRS has completed an extensive document in support of a continuing program of CIAS digital image analysis workshops. The document consists of text and images covering: project planning, biophysical and physical considerations, image corrections, computer-aided analysis techniques (enhancement, classification, indirect measurement), output products, supplementary data and remote sensing digital data sources. This document may be accessed through the Technical Information service of CCRS in Ottawa.

3.8.6(b) CCRS initiated three actions in 1980 to improve CCT production, quality and timeliness. First, a contract was placed to augment and reconfigure the hardware and software of the PASS station system to improve the throughput by a factor of three over last year. This modification became operational in the summer of 1981. Second, CCRS is acquiring colour display systems for each station and will develop software for improved quality control screening and monitoring of CCT products at the production site. This upgrade is in progress and is targeted for completion in late 1981. In addition to the above a CCT sub-working group has been asked to assess CCT production and quality control.

3.8.7 Any user in eastern Canada may request that Shoe Cove receive and record data as far west as track 28 but on a limited time period or for the duration of a project.

3.8.9 CCRS placed the digital Image Correction System, DICS, into operation in 1980. This system generates geometrically corrected Landsat subscenes and outputs them at 1:500,000 scale in colour. DICS products are now a standard product line. Users may order a DICS image from any Landsat frame and then have the resultant image enlarged to any scale up to 1:50,000 by photographic enlargement.

3.10.2 It is not practical with current processing speeds to convert all SEASAT SAR data to images. For high priority scenes CCRS is producing raw CCT data for processing by MDA

at a cost of over $1000/scene. Limited processing of SEASAT data will be performed in concert with future airborne radar experiments.

3.10.6 The SURSAT office was closed in 1980 and the image records and inventory transferred to CCRS. CCRS plans to publish in the Newsletter a list of digitally processed scenes presently available from either NAPL or MDA, Vancouver. CCRS does not have a method for presenting the coverage of unprocessed SEASAT data except by use of the orbit track maps employed by the SURSAT office. CCRS has a copy of these track or orbit maps for all data recorded at Shoe Cove and some obtained from JPL in the U.S. The orbit coverage maps are not in a form suitable for distribution to users.

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10.0 TABLE OF ACRONYMS USED IN THIS REPORT

AES	Atmospheric Environment Service, DOE
ARIES	Interactive remote sensing interpretation system, DOE
ART	Airborne Radiation Thermometry
BIO	Bedford Institute of Oceanogrpahy, DFO
CACRS	The Canadian Advisory Committee on Remote Sensing
CCRS	Canada Centre for Remote Sensing
CCT	Computer-compatible tape
CDA	Canada Department of Agriculture
CFS	Canadian Forestry Service, DOE
CHS	Canadian Hydrographic Service, DFO
CIAS	CCRS Image Analysis System
CIR	Colour Image Recorder (a CCRS instrument)
CNES	Centre national d'études spatiales (France)
COSPAR	Committee on Space Research (International)
DCP	Data collection platform
DFO	Department of Fisheries and Oceans
DICS	Digital Image Correction System (a CCRS system)
DND	Department of National Defence
DOE	Department of the Environment
DREO	Defence Research Establishment Organization, DND
DSS	Department of Supply and Services
EARSEL	European Association of Remote Sensing Laboratories
EMR	Department of Energy, Mines and Resources
ERIM	Environmental Research Institute of Michigan
ESA	European Space Agency
FLI	Fluorescence Line Imager (a DFO instrument)
GOES	Geostationary Operational Environmental Satellites, a series of US meteorological satellites
HCMM	Heat Capacity Mapping Mission (a US satellite)
HDDT	High density digital tape
IACRS	Inter-agency Committee on Remote Sensing, an executive-level committee representing many federal departments
ICS	Interdepartmental Committee on Space
INS	Inertial navigation system
IPTASC	Interprovincial-Territorial Advisory Subcommittee of CACRS
IR	Infra-red
ISIS	Integrated Satellite Imaging Systems Ltd. (No longer in operation)
JPL	Jet Propulsion Laboratory (USA)
LANDSAT	US remote sensing satellite series (formerly ERTS)
LBIR	Laser beam image recorder (a CCRS instrument)
LDIAS	LANDSAT-D Image Analysis System, CCRS
MDA	Macdonald, Dettwiler and Associates Ltd., Vancouver
MIPS	Multi-Image Processing System (a CCRS system installed at Prince Albert)
MRMS	Maritime Resource Management Service
MSED	Ministry of State for Economic Development
MSS	Multispectral Scanner
NAPL(RC)	National Air Photo Library (Reproduction Centre), EMR
NASA	National Aeronautics and Space Institute, USA

NHRI	National Hydrographic Research Institute, DOE
NOSS	National Oceanic Satellite System (a joint program of NASA and NOAA)
NSERC	Natural Sciences and Engineering Research Council
OCRS	Ontario Centre for Remote Sensing
PAS	Photographic Analysis System
PASS	Prince Albert Satellite Station
RADARSAT	Canadian radar satellite program
RBV	Return Beam Vidicon, a camera system on LANDSAT
RMS	Remote Manipulation System, NRC
SAR	Synthetic aperture radar
SCANIQ	Système conjoint d'analyse numérique d'images de Québec
SCSS	Shoe Cove Satellite Station
SEASAT	Ocean-parameter-observing satellite (USA) 1978
SLAR	Side-looking airborne radar
SPOT	Satellite pour l'observation de la terre (a satellite proposed for launch in 1985 by CNES, France)
SURSAT	Surveillance Satellite Program (Canada)
TDC	Transportation Development Centre
TM	Thematic mapper, a sensor to be carried on LANDSAT-D
TOPAS	Terra Observation Pattern Analysis System (next-generation CCRS analysis system)
TTO	Technology Transfer Office, CCRS
UTM	Universal Transverse Mercator System

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