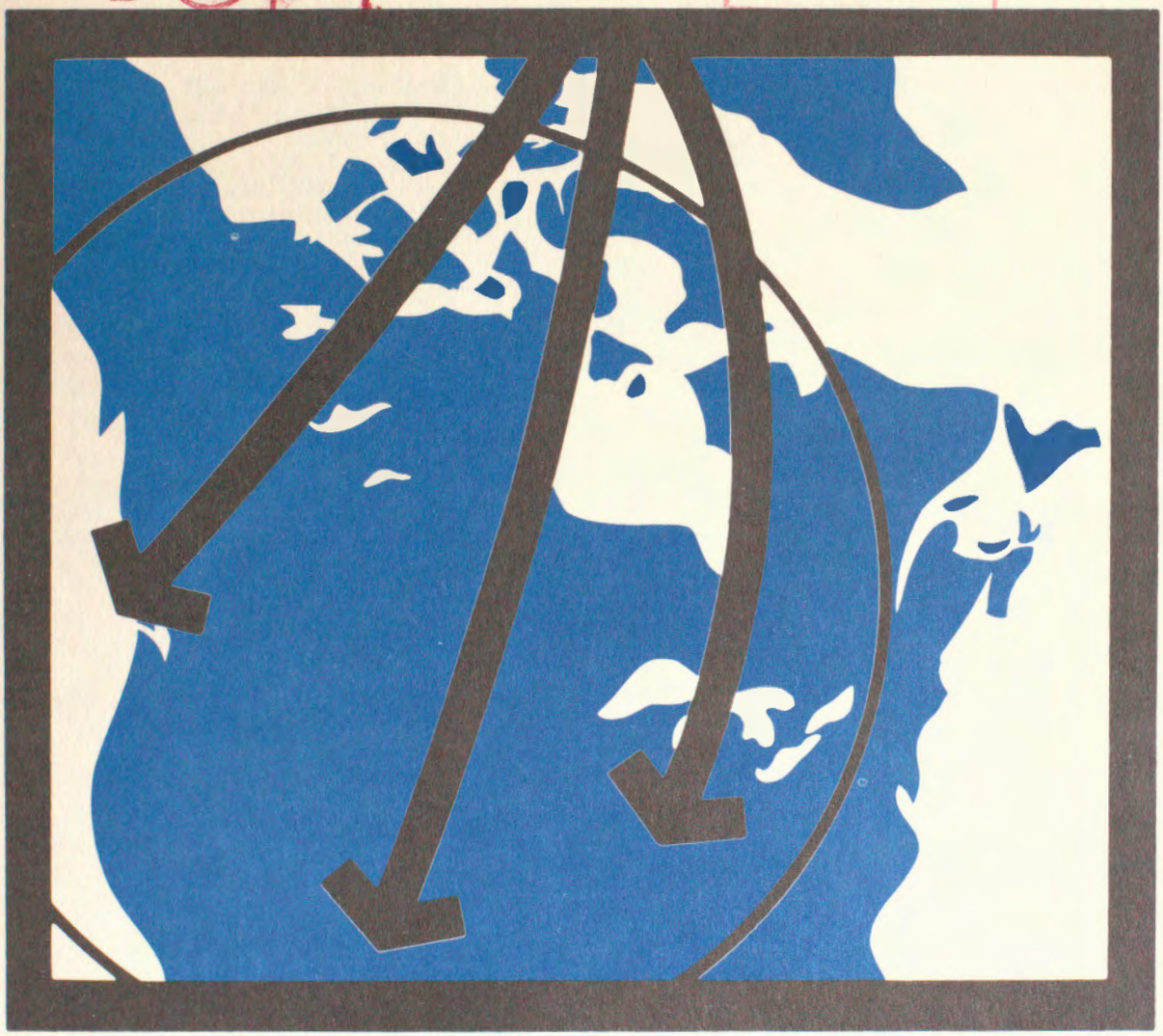
THE CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING



1977 REPORT

Dr. J. D. Keys
Chairman
Interagency Committee on Remote Sensing
Department of Energy, Mines and Resources
Ottawa, Ontario

Dear Dr. Keys:

This year's CACRS meeting was marked by an awareness of increased remote sensing activity in the provinces. This is encouraging since it is the provinces and the territories that have the operational mandate for resource and environmental management. You may recall that the original plan for the National Program on Remote Sensing called for 50:50 cost sharing of provincial centres between the individual provinces and the federal government. This was cancelled because of the deteriorating federal/provincial fiscal relations in 1972, a fact which severely hampered the development of remote sensing in Canada.

Perhaps the time has come in which senior provincial resource and environmental managers should be consulted again with a view to achieving further federal/provincial cooperation in resource and environmental management information systems including remote sensing.

We should be thinking in terms of eventually establishing provincial forestry and agricultural monitoring centres which will have access to near real-time satellite and airborne remote sensing data as well as meteorological satellite data for their management areas.

Yours sincerely,

L. W. Morley

L. W. Morley
Chairman, Canadian Advisory
Committee on Remote Sensing

13 June 1978

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FOREWORD

BARRIERS TO REALIZING REMOTE SENSING BENEFITS

L.W. Morley

The advent of earth observation satellites: meteorological satellites, environmental monitoring satellites, resource satellites, data relay satellites, and in case I have left any out - remote sensing satellites, together with the new airborne remote sensing systems is ushering in a new era of ocean and land management. For the first time in man's history, he has (at least potentially) the means for continuously monitoring land, sea and air in a timely and synoptic fashion. True, a lot of this is still on paper! much more research needs to be done, but organizational, not technical problems, are now looming as the major barriers to the skilful management of our resources and control of our environment using both the old and the new techniques. We remote sensors in our naiveté have been guilty of assuming that somewhere out there in our society are the environmental control officers, the end-users, the resource managers and the decision makers who were trying honestly to do a good job but just did not have adequate information and as soon as they got it, their efficiency would increase enormously. After several years of trying to search out these people, we have come to the conclusion that they do not exist, at least not in the whole - only in part in any one person.

Our earth observation and management system resembles a fool who has enormous visual and sensory powers and a brain that can convert the data into information but who is then incapable of making logical decisions for action, based on this information. By this statement, I do not mean to impune our partial resource and environment managers. Our barriers are organizational. We are suffering from an overload of data and information of a potentially powerful nature which our organizational structures are not set up to cope with.

When we are dealing with data whose value does not decay rapidly with time (i.e. mapping) there is time for these data to be translated into information and to weave its way through our outmoded bureaucratic structure before it arrives, sometimes by luck, on the desk of a person who is in a position and has the means to do something about it (i.e. manage). On the other hand, we are not achieving benefits from data whose value does decay rapidly with time (monitoring), because by the time it is analyzed and begins threading its way to some happenstance manager, it's about as useful as last week's newspaper.

In analyzing the value of Landsat data, over the past six years for Canada, proven benefits from slow-decay data are substantial, but proven benefits from analysis of fast-decay data are almost non-existent. The exception that proves the rule is Landsat and NOAA data on sea-ice which will be discussed later. In the extensive potential cost/benefit analyses that were done for ERTS before launch, in both Canada and the U.S., the potential benefits from monitoring far exceeded those from mapping activities. Six years later, after the fact, the reverse proved to be true. In fact the benefits from monitoring in Canada were nearly zero. We must explain why.

Both for weather and sea ice, near real-time data gathering, analysis and dissemination operational systems exist. There are few, if any, real-time complete operational systems for hydrology and flood monitoring, forest monitoring and crop monitoring. The reason that they do not exist is that until satellite and airborne remote sensing, and satellite data relay systems came along, it was not possible to gather data synoptically and quickly enough to make it worthwhile setting up such centres. The fact that such systems do not exist for hydrology, forest and crop monitoring, means that real benefits cannot be realized in these fast data-decay areas.

Let us take the example of forestry. Forest inventory is slow-decay data. A forest inventory map is produced and it is useful to the manager for at least a few years. The remote sensing benefit is determined by calculating how much was saved by using remote sensing methods as opposed to conventional methods. Few seem to ask the question what is the benefit of a forest inventory map, whether produced by remote sensing or conventional methods. It is certainly

useful to the timber company manager if he is looking for suitable trees to cut, but is not much use to the government forest manager who is trying to manage the forest for maximum sustainable yield. The information he needs is "change information". What is the change from last year, from last month or last week? His important decisions should be based on change detection. He has to monitor the forests to determine how much was cut from last year, how much new skill has been produced by the spruce budworm, how is the forest regeneration progressing;is the cutting so intensive that it is causing erosion; is the forest dry or wet and what is the fire danger, etc.? This is the kind of change information on which his decisions for action are based.

It was mentioned that the only monitoring activity in Canada that was achieving benefits from Landsat and NOAA imagery is the ice reconnaissance program. Perhaps it is this program that best demonstrates the thesis presented here. This program is properly organized in that Landsat and NOAA Quicklook data are faxed into ICE CENTRAL where the data are combined with aircraft reconnaissance data to make timely ice maps which are then fixed directly to the decision makers - in this case the ship captains. The point I wish to make here is that there is an organization in place capable of receiving quick-decay data, analysing it and getting the useful information out to the end-user.

In water resource management, adequate organizations do not exist to deal with real-time data in an operational way. It is not enough to know the quantity and quality of the water supply. We must know the change in order to regulate and to know the change, we must monitor.

Thus for much of resource and environmental management, change mapping or monitoring is what is required. Before airborne and satellite monitoring existed, it took so long to map, that it was never possible to map quickly enough to monitor.

The objective of land management is to manage in such a way as to maintain the productivity of an area. Here is where we observe the organizational barrier. In a given area, it is a mistake to have one agency responsible for forest inventory, another for forest fire control, another for hydrology, another for forest meteorology. It is better to divide the area into manageable regions and to investigate the monitoring of all environmental and resource data within the region. The actual management responsibility could be split up, but the cost of assembling all the relevant timely data and information should have a common information centre.

A paper on the importance of monitoring was published "The New Scientist" on 2nd February 1978, entitled "Ecological Monitoring in East Africa" by Croze, et al. In this paper they cite many examples of how monitoring, as opposed to one-time mapping or infrequent mapping, is crucial to effective management. "Monitoring provides important feedback between environmental management and its effects". "Too often policy-makers were handed a geology or vegetation map or the number of livestock ... by an ecologist who then believed his responsibility had ended."

I could conclude by suggesting that monitoring benefits which are far greater and more important than one-time or infrequent mapping benefits will never be achieved until the organization is set up for monitoring. Interdisciplinary Environmental Monitoring Centres need to be set up in regions of manageable size where all the satellite, airborne and ground data relating to that area are routinely analyzed in such a way as to reveal changes - daily, weekly, seasonal and yearly changes in the vegetation, the water, the rainfall and the temperature, etc., in the hydrosphere, the biosphere, the lithosphere and the atmosphere. All this is now possible for the first time in history and we must organize for it in order to achieve benefits.

1.0 THE CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING

1.1 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 to review programs and make recommendations.

1.2 Terms of Reference

The purpose of the Canadian Advisory Committee on Remote Sensing is advising and assisting the Government of Canada, through the Minister of Energy, Mines and Resources, in meeting the objectives of the national program on remote sensing of the surface environment by assessing national needs, promoting research and development, by diffusing remote-sensing technology into Canada, and by assisting in the coordination and evaluation of programs to assure a high level of national benefits relative to the cost of remote sensing.

Its advisory duties shall include:

- coordination of existing and proposed new programs and recommending priorities
- advising on remote-sensing platforms:
  - satellite systems
  - aircraft systems
  - balloon systems
- sensor development
- data processing
- cataloguing, reproduction and marketing of data
- regional involvement
- research grants and contracts

It will assist:

- by generating requests for airborne remote-sensing surveys
- by carrying out on-going evaluation of existing projects
- by organizing conferences, seminars and training courses for the diffusion of remote-sensing technology into Canada.

The Committee will establish such working groups as it may deem necessary to carry out this work.

2.0 SUMMARY MINUTES: CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING, ARNPRIOR, ONTARIO, APRIL 10-13,1978

2.1 Dr. L.W. Morley welcomed participants to the annual CACRS meeting, and briefly mentioned some of the changes that were taking place, particularly in the airborne and satellite programs.

The meeting broke into small groups to prepare the consolidated reports for presentation to the plenary session the following morning.

2.2 CONSOLIDATED REPORTS

Short consolidated reports were presented to the plenary session on behalf of the provinces by Mr. Burtt Smith, the Ocean Management groups by Dr. Jim Gower, the Water group by Dr. Ira Brown, the Land groups by Mr. Roy Slaney, the Vegetation groups by M. Guy Rochon, the Technology groups by Dr. Phil Lapp, and the Specialty Groups by Mr. Graeme Morrissey. The detailed reports had all been circulated in advance.

2.3 SPECIAL REPORTS AND PRESENTATIONS

Mr. E.A. Godby, Associate Director-General, CCRS, gave a presentation to the plenary session on the current activities of CCRS. This was followed by a status report on the SURSAT program by Dr. Roy VanKoughnett, Project Manager, and a report on the plans and progress towards LANDSAT-D reception and analysis by Dr. Murrary Strome, Chief, Applications Division, CCRS (see section 4 for summaries of these reports)

After lunch, two papers were presented for consideration by the meeting in workshop groups. These were: "Regional Environmental Information Coordination Centres" by L.W. Morley, Director-General, CCRS; and "Discussion paper for improvement in CACRS organization and operations", by E.A. Godby and J.C. Henein.

2.4 WORKSHOP GROUPS

Following these presentations, the conference broke into three workshop groups consisting of (a) provincial representatives, (b) chairmen of working groups, and (c) representatives of specialty groups. The members of these groups spent a total of ten hours discussing ways of improving the national program. Each group came out with a list of recommendations which are given as 3A to 3R below.

2.5 DISCUSSION OF RECOMMENDATIONS

On the final evening and morning of the meeting, the members reconvened in plenary session to discuss the conclusions reached and recommendations made by the individual workshop groups (see section 3). Time was also allowed for discussion of the general recommendations by the working groups, provinces, and specialty groups. (see section 3)

2.6 CONCLUSION

Dr. Morley closed the meeting at noon on Thursday, April 13,remarking on the amount that had been accomplished in three days, and looking forward to a successful year ahead.

He also thanked Mr. Cal D Bricker, Administrator, Alberta Remote Sensing Center, for his excellent work as General Chairman of the meeting. (Next year's meeting will be chaired by M. Guy Rochon, Chairman, Working Group on Forestry, Wildlife and Wildlands.)

3.0 RECOMMENDATIONS

Each working group, province, and specialty group was invited to include recommendations in its annual report to CACRS. These recommendations are summarized below from 3.1.1 to 3.11.2. In each case, CCRS has added comments or action statements.

As well as this, the meeting itself came up with a total of eighteen further recommendations as a result of the workshops described in 2.4. These recommendations, with comments by CCRS, are summarized under 3A to 3R.

3.1. Major resource and funding requests

3.1.1. In the light of commercial and educational developments in the province, Government support for major research and development projects directed to meeting user requirements in the fishery, offshore petroleum and shipping industries should continue and increase. Efforts in this direction to date have shown the potential of a viable remote sensing community in Newfoundland.

- Newfoundland

- CCRS supports this recommendation and believes that the activities undertaken at the Shoe Cove Satellite Station and through the SURSAT program and its potential follow-on will help to meet it.

3.2. Future program planning and development

3.2.1. The LANDSAT-D program represents a significant advance in remote sensing technology and is likely to form the technological basis of future operational systems. Thus it is essential that Canada participate to the fullest extent possible in the U.S. NASA Landsat-D program. The Working Group recommends that Canada obtain the facilities necessary to receive, process, distribute and analyze Landsat-D thematic mapper data of high quality in a timely fashion providing the greatest possible Canadian territorial coverage.

- Data Handling

- CCRS is now developing plans to participate in both the Landsat-D and SPOT programs to the fullest extent possible within existing resources. In addition, CCRS will be requesting additional funds in order to adequately serve the Canadian user interests.

3.2.2. CCRS should exercise the greatest influence possible to ensure that SPOT and Landsat-D have sufficient compatibility to make it economically and technically feasible to receive, process, distribute and analyse the data from both satellites.

- Data Handling

- CCRS is exerting the greatest influence possible to encourage maximum compatibility between SPOT and Landsat-D. Meetings between CCRS and CNES as well as between CNES and NASA are scheduled to discuss these issues.

3.2.3. CCRS should concentrate its budgetary resources on the improvement of the Landsat product, as a priority over involvement in new programs, in order to better serve the remote sensing user community.

- Ontario

- See the response given to workshop recommendation M.

3.2.4. The Canadian remote sensing community actively participate in the LANDSAT-D program. A multispectral scanner be incorporated with the thematic mapper on LANDSAT-D. All satellite data for Canada be recorded even though all thematic mapper data may be processed on a selected scene basis. Satellite data, as computer compatible tapes, be processed to provide imagery that is geometrically corrected, edge enhanced and contrast stretched, on a 1:50,000 NTS map sheet basis.

- Acriculture

- Every effort is being made through CACRS and its Working Groups, to encourage the active participation of the Canadian user community in the Landsat-D program. A Multispectral Scanner System will be flown on the first (only) Landsat-D mission. It is planned that all data obtainable from PASS will be recorded, but only selected scenes processed. CCT data will eventually be available in CCT form as edge enhanced, contrast stretched and geometrically corrected with 25m square pixels to 1:50,000 UTM map sheet projection. The cost of each tape covering one map sheet is expected to be approximately $150-200. We will maintain a goal of recording all LS-D thematic mapper data but may be limited by our financial resources.

3.2.5. That CCRS, Agriculture Canada, and other agencies support developmental research on microwave remote sensing for land applications.

- Agriculture

- CCRS is engaged in extensive microwave remote sensing research for both ocean and land applicatons, particularly through the SURSAT project.

3.3. Promotion of practical applications

3.3.1. A definition of "operational" suitable to CACRS and CCRS be prepared and used by all Working Groups.

- Water Resources

- This will be done and circulated to CACRS for comments.

3.3.2. The national remote sensing program should place emphasis on practical demonstration projects in all disciplines as a means of extending the operational use of remote sensing.

- Ontario

- See response to Workshop recommendation H.

3.3.3. It is recognized that there are increasing attempts to consider the ultimate applications of the data being acquired in the new programs at CCRS. This policy is to be encouraged and it is recommended that efforts be made to continue and, if possible, increase the emphasis given to applications development.

- Geography

- CCRS plans to continue its emphasis on the end applications of its various programs. To illustrate this focus, steering committees have been established to provide guidance to the research activities in the Visible and Infrared as as Microwave regions of the spectrum. This guidance is meant to ensure that the research activities are clearly directed toward solving applications problems.

3.3.4. The Water Resources Working Group recommends that CCRS concentrate more of its effort in the area of visual image interpretation by:

(i) a continuing high level of effort in the quality and consistency of image reproduction - a better product will attract more users:

(ii) development of photo interpretative aids and techniques - in-house, by contract, and by unsolicited proposals:

(iii) initiation and/or support of demonstration projects and educational workshops, courses, etc. - the more people aware of and able to make greater use of a product, the better the market.

- Water Resources

- CCRS has long recognized that the simplest analysis method which works is generally the best. Thus, wherever photo interpretation can be used to solve an applications problem, this would be the analysis method of choice. CCRS has recognized the need to improve the quality and consistency of its photographic products, and is striving to meet this need to the extent possible within its resources. (See also 6.1)

  CCRS would appreciate the advice of the CACRS Working Groups on the shortcomings of present photointerpretative aids and techniques. There are a very large number of aids of various types available, and numerous well established techniques.

  CCRS has conducted one workshop on aerial photography, and has participated in workshops, seminars, courses and demonstration projects designed to make people aware of the products available and their applicability to solving user problems. Many excellent courses are offered regularly by a number of Canadian universities and by the Alberta Remote Sensing Centre. The EROS Data Centre conducts several excellent courses on photo interpetation every year. CCRS staff will continue to participate in such activities to the extent possible.

3.3.5. That the problem of marketing and promotion of remote sensing products be faced and that the following be implemented:

Case histories relating to the successful applications of remote sensing be prepared by CCRS and outside contractors for use in a major promotional drive.
A modest marketing and promotional budget be set up and used for the purpose of establishing an impact in certain vertical markets, in conjunction with the producers of remote sensing products.

- Photo Reproduction and Marketing

- CCRS will work together with working groups in attempting to meet this recommendation. It would be appreciated if the working groups would list the case histories they are aware of in their annual reports.

3.4. Sensors and systems

3.4.1. Since the main sea ice data gap is sensing the ice thickness and distribution in winter darkness and ovetcast conditions, great emphasis should be placed upon the development and installation of an impulse radar for aircraft operation.

- Ice

- MOT is pursuing a device for this purpose.

3.4.2. CCRS should expedite analysis of data from test flights of the aerial hydrography system and provide a definite report on the overall feasibility of the project. OAS is unhappy at the apparent lack of progress in this work.

- Oceanography

- CCRS has been maintaining ongoing contact with CHS re status and progress on the Aerial Hydrography system. CCRS was not fully aware of OAS' extent of interest and as a result of this recommendation has provided them with a detailed status review.

3.4.3. High priority should be given to improving capabilities of the Shoe Cove Satellite Station to take advantage of coming ocean-related satellite systems. Capabilities should include on-site data processing and distribution.

- Oceanography

- On-going products and services have higher priority than new systems. Nonetheless we are equipping the Shoe Cove Sation to receive SEASAT-A data. Our original plan to process SAR data on site was cut-back due to funding limitations.

3.5. Technology transfer

3.5.1. CCRS should make software for digital data analysis developed in-house available to the user community at no charge, as a significant part of the transfer of remote sensing technology.

- Ontario

- See response to Workshop recommendation F.

3.5.2. Attention should be directed towards publicizing viable photo interpretive techniques and products by CCRS, and, by means of financial support, through outside contractors.

- Photo Reproduction and Marketing

- This will be done through the publication of selected case studies. CCRS notes that several working groups have volunteered to assemble original material for such case studies. CCRS is prepared to undertake the publication and distribution, including colour plates, of the most informative of these studies, within budgetary constraints. Please direct offers to J.C.Henein, User Assistance Unit, CCRS.

3.5.3 The air survey industry be encouraged to provide operational remote sensing data of the kind currently provided by the Data Acquisition Division of CCRS.

- As a further element in its "Industrial Involvement" effort, CCRS is currently soliciting approvals to make its aircraft and remote sensing systems available to Canadian industry. This should provide the Canadian Remote Sensing service industry (including the air survey industry) with excellent resources with which to respond to the operational needs of remote sensing users.

The Data Acquisition Division of CCRS critically evaluate requests for airborne data to ensure the development of the air survey industry in operational remote sensing.

- Agriculture

- This activity is currently ongoing in the CCRS "Airborne Projects Review Committee". As soon as the aircraft approvals being requested in (a) are received, it will be possible to accelerate the process.

3.6. Quality of products and services

3.6.1. There is much current concern over the quality of satellite image products and services in Canada. A CACRS technical sub-committee should be formed to establish reasonable technical standards for the production of satellite image products. Such standards are required as a basis for an objective approach to the solution of recognized problems.

- Geoscience

and

3.6.2. CCRS should report regularly to CACRS on steps taken to increase the quality of Landsat data. The quality of imagery produced by the EROS Data Centre should be considered as a standard.

- Ontario

- The NAPL research and development group have conducted testing and evaluation of the PASS and SCSS photographic operations and have established film product standards. The UAMU will also act as an ombudsman to ensure that users are provided with quality products.

3.7. Data, products and production

3.7.1. Specifications for a Geographic Gridded Data Base should be formally established for Canada to ensure effective merging of gridded geographic data with remotely sensed data. The specification should include the definition of a standard tape format for gridded geographic data, and also for line (polygon or chain) oriented data.

- Data Handling

- Specifications are being developed, at the international level, for CCT image formats which also may encompass Geographic Gridded Data Bases. In addition, good progress is being made within Canada in the formulation of a standard for information interchange among data base users for cellular and polygon or chain data.

3.7.2. In recognition of the continuing importance of visual interpretation of Landsat imagery; CCRS should be encouraged and assisted to produce a complete set of colour composite cloud-free Landsat images, destriped, geometrically corrected and contrast optimized, covering the whole of Canada.

- Geoscience

- CCRS is planning a joint demonstration project with the Geoscience Working Group to investigate the feasibility of producing a complete set of colour composite, cloud-free, enhanced and corrected Landsat images for all of Canada.

3.7.3. It should be recognized that repetitive coverage from Landsat type satellites will effectively end with the conclusion of the Landsat C program. Future systems will stress selective (and expensive) coverage with higher resolution systems. The value of existing archive data should thus not be neglected.

- Geoscience

- See response to Workshop recommendation Q.

3.7.4. Landsats 2 and "C" provide limited coverage of underdeveloped nations. Tapes produced by Landsat I therefore deserve reprocessing in light of more recent technical advances.

- Geoscience

- EDC provides reprocessed LANDSAT-1 data on retrospective order basis.

3.7.5. CCRS should report regularly to CACRS on the preservation of the LANDSAT archive: as to what measures have been taken to protect the data from damage, deterioration or loss, and as to the identification of frames that have been damaged or destroyed.

- Ontario

- LANDSAT data tapes are stored for 1 year in Ottawa and then placed in deep storage. Such deterioration as may

have occurred is caused mainly by over-usage of individual tapes, not by damage. All tapes are rotated 90° every 3 months to avoid demagnetization. A list will be prepared of those tapes which have suffered damage.

3.7.6. Enhanced digital products should be developed, and the on site capabilities of doing this work should be accelerated at Prince Albert and Shoe Cove.

- Photo Reproduction and Marketing

- This development is underway, but first priority is given to establishing production of basic products at the stations.

3.7.7. Because of the dynamic nature of ocean phenomena, emphsis should be placed on rapid dissemination of ocean data and imagery.

- FAX is available now from both PASS and SCSS.

3.7.8. Plans for receiving and processing of data at Shoe Cove from ocean-related satellites should be circulated regularly to the ocean community.

- This information is provided through the CCRS newsletter and through bulletins from the SURSAT office.

3.7.9. CCRS should provide image analysis support services for SURSAT projects according to a planned and declared set of priorities.

- It is not anticipated that problems will be experienced in timely provision of image analysis support services for SURSAT projects. However, should difficulties arise in this regard, this recommendation will be implemented.

3.7.10. Oceanographic remote sensing experiments of the SURSAT project should be designed where possible to make use of the best ground truth sources available internatinally.

- The SURSAT project office wishes to point out that adequacy of ground truth played an important part in the experiment selection process.

3.7.11. Canadian experience in water colour measurements should be drawn together and intercompared in time for application to the Nimbus-G coastal zone colour scanner data.

and

3.7.12. CCRS should undertake to arrange access for Canadian scientists to Nimbus-G coastal zone colour scanner data, and should assist in analysis and evaluation of this data.

- Ocenaography

- Dr. K. Thomson, CCRS member of the Nimbus-G Experiment Team, will coordinate efforts to compile documentation on Canadian experience in water colour measurements, and will endeavour to ensure that all Nimbus-G Coastal Zone Scanner information, experiment plans and data over Canadian territory will be available to other Canadian scientists.

3.8. Information

3.8.1. (1) Detailed flight maps of RS flights in the province should be forwarded to the provincial coordinators and (2) Minutes of specialty working group meetings should continue to be circulated to provincial coordinators.

- Nova Scotia

- CCRS undertakes to perform these functions.

3.8.2. That CCRS support, through a subsidy program, the establishment of ISISFICHE in the University centres having viable remote sensing programs.

- Photo Reproduction and Marketing

- See response to 9.1. CCRS feels that ISISFICHE is an operational tool which should not be subsidized on an individual basis.

3.8.3. That CCRS maintain IISS up to date.

- Photo Reproduction and Marketing

- This will be done.

3.8.4. That CCRS maintain the Landsat catalogue and to ensure that it is updated,printed, and published quarterly.

- Photo Reproduction and Marketing

- We will maintain the LANDSAT catalogue but due to costs and publication time may have to settle for longer than quarterly updates.

3.9. Training and Education

3.9.1. That CCRS consider the establishment of a grants system, to assist universities conducting remote sensing courses to purchase remote sensing products, similar to that in effect at NAPL.

- Photo Reproduction and Marketing

- CCRS is considering the establishment of such a system comparable to the one used by NAPL.

3.9.2. It is recommended that an ad-hoc committee on the role of education in the national rempote sensing program be established under the chairmanship of Dr. Phil Howarth.

- Faculty of Forestry,UBC

- This recommendation was passed by the CACRS meeting, and Dr. Howarth has been invited to establish such an ad-hoc committee.

3.10. Organization

3.10.1. In order to more fully access existing expertise, Working Group representation should be included in the CCRS Project Review Committee. This would permit Working Groups to express their collective opinions at an early stage, regarding the value of CCRS and other projects submitted to the Project Review Committee.

- Geoscience

- The Project Review Committee is an internal management committee of CCRS. Therefore it is not appropriate to have working group representation on this Committee.

3.10.2. That CACRS acknowledge to the Department of Energy, Mines and Resources the importance of the NAPL processing facility to the remote sensing community. The department should be encouraged to maintain this vital service intact.

- Geoscience

- This has been done. CCRS joins the working group in recognizing the contribution made by NAPL to the remote sensing community.

3.10.3. The Canadian Advisory Committee on Remote Sensing encourage the establishment of provincial/regional remote sensing centres in those areas of the country not presently served by such.

- See response to Workshop recommendation P.

3.10.4. Agriculture Canada include operational applications of remote sensing in the CANADEX Series.

- Agriculture

- This recommendation is referred to the Chairman of the W.G. on Agriculture for action.

3.11. Benefits and cost recovery

3.11.1. That Treasury Board be advised not to judge the success of the Remote Sensing Program on the basis of products, but on benefits realized through various applications.

- Photo Reproduction and Marketing

- This is done quite regularly, and there are signs that the T.B. is willing to accept benefits as a measure of success. However, benefits are difficult to measure. Further, it cannot be denied that user demand is one indicator(although certainly not the only one) of the success of the Remote Sensing Program. It therefore appears that we will have to accept both methods of measurement.

3.11.2. That Treasury Board rescind its present policy of cost recovery based on product sales.

- Photo Reproduction and Marketing

- This is not under CCRS control. The point has often been made to the T.B. that Remote Sensing information is a "public good" and should therefore be free. However, this is only one viewpoint and the Treasury Board seems more inclined towards the philosophy that "the users should pay as they use" in addition to whatever contribution they are already making to the general tax revenue of the government. Increases in Post Office rates are an example.

Recommendations of the Provincial Workshop

3A. It is recommended that an inter-provincial advisory committee be appointed to advise CACRS on the provincial position before commitment is made by CCRS for involvement that would have an impact on the national remote sensing program. Only one provicial representative per province should be a member of this committee.

- Dr. Morley has invited Mr. Victor Zsilinszky, the Ontario representative, to organize an Interprovincial Advisory Subcommittee (IPAS) of CACRS, with membership consisting of the official representative from each province and the two Territories.

3B. It is recommended that a representative be appointed from each of the two federal territories and appointments be confirmed for Newfoundland, Nova Scotia, British Columbia and others, as required.

- CCRS is taking action to confirm the appointment of representatives from Newfoundland, Nova Scotia and British Columbia, and to solicit nominations of representatives from the Yukon Territory and the North West Territories.

3C. For better user representation, one more representative per province be appointed to CACRS membership on the option of each province. One member should not be less than a middle manager. This might be achieved through inviting representatives of regional remote sensing associations and working groups to attend.

- CCRS is in agreement with this recommendation, and will ask IPAS to recommend the method of selection and the rôle of one more representative each, per province and per territory, at the option of the province or territory.

3D. It is recommended that the newly established User Assistance and Marketing Unit be given adequate strength to act as ombudsman for the users and be responsible for keeping the provincial representatives posted regularly regarding all matters related to the national program.

- CCRS intends the User Assistance and Marketing Unit (UAMU) to act as the ombudsman for all users as required, without interfering unnecessarily with the existing communications links between users and various members of the CCRS staff. In particular, CCRS expects that the Head of the UAMU will keep in close contact with the chairman of the IPAS. At the same time, the members of the Applications Division who have been specifically named as contact points for particular provinces will, of course, maintain their close connections with the provinces.

3E. The success of the provincial remote sensing program is a two-way benefit, that is any achievement at the provincial level is a credit to CCRS as well. Since provincial remote sensing programs and investment in hardware depend on technology transfer from CCRS, it is recommended that CCRS draft a policy statement in this regard. The "Provincial Advisory Committee" should be given the opportunity to examine and to negotiate, if modification is required before it becomes an official policy.

3F. Concern has been expressed regarding the compatibility of interprovincial digital image analysing systems. It is recommended therefore that CCRS provide

(a) development of transportable software

(b) adaptation of existing and future software for digital analysis systems for use in provincial and/or regional centres as well as educational institutions. It is also recommended that CCRS provide advice to potential system users on hardware which is compatible with existing software.

(E.F)- CCRS has always considered as high priority the transfer of remote sensing technology to the user community, including those users and agencies at the provincial level. The technology associated with image analysis is being transferred in two ways:

(a) by assisting Canadian companies in their efforts to develop reasonably low cost image analysis systems;

and

(b) by direct transfer of software, under a no-cost licencing agreement, to the users.

CCRS is only beginning to gain the experience needed to accomplish the software transfer in an efficient, effective manner. Much of our software is proprietary to some other agency and hence not transferable. Some of the CCRS software is so closely enmeshed with this proprietary software that it cannot be easily extricated. Based upon past experience, greater care will be taken to develop software which can be easily separated from proprietary packages. New documentation and change control procedures are being formulated which will make it easier for the user to implement CCRS software on other computers.

A policy for CCRS software dissemination of software to Canadian users has been drafted and will be sent to all CACRS members for comment. Essentially, the software will be provided free of charge to bona fide Canadian user agencies or corporations under a licensing agreement whereby the user agrees not to further distribute the software without the permission of CCRS.

CCRS staff have always been willing to provide advice to any user agency on systems, hardware, software and compatibility.

3G. It is recommended that CCRS provide support to provincial and/or regional centres as well as educational institutions in connection with developing conversion of existing digital image analysing hardware and/or software for compatibility with new satellite programs, e.g. Landsat D and SPOT. The purpose of such support is to minimize the cost of conversion to the centres.

- CCRS will provide assistance, on a consulting basis, to users with regard to conversion of existing analysis systems to handle SPOT, Landsat-D and other airborne and satellite remote sensing data. To ease conversion problems in the future, a new CCT format is being developed internationally which could accommodate data from virtually any imaging type sensor, as well as cellular and polygon geographic data base information. Hopefully, this one change in format to take place before the launch of Landsat would be the last major one for many years, perhaps decades.

3H. It is recommended that a greater portion of the CCRS budget and staff be allocated to practical applications development and service to <u>all</u> regions of the nation and that meaningful dialogue on appropriate problems be undertaken with the regions in determining these problems.

- CCRS would welcome specific advice in this area from IPAS.

3I. It is recommended that CCRS make available relevant cost-benefit documents to provincial representatives.

- CCRS will make cost-benefit documents available to the provincial representatives. In particular, the report entitled "LANDSAT Data User Survey" by Mr. F.E. Hayes is being copied for distribution to the provincial representatives. In return, CCRS would appreciate receiving copies of any cost-benefit documents which the members of CACRS are aware of.

3J. In the light of the expanding role of remote sensing in many disciplines and the possible environmental monitoring requirements of the future, it is recommended that CCRS fund a consultant's study to determine and project the manpower requirements for remote sensing specialists of all levels in the near and long term.

- CCRS has requested the Canadian Employment and Immigration Commission to undertake such a study.

3K. The provincial representatives note with appreciation the support of CCRS personnel to various seminars and workshops held during last year. It is recommended that when future sessions are planned

(1) adequate notice be given to provinces

(2) where sufficient interest is generated, these programs be mounted in those various regional locations.

- The Head of the UAMU will keep in touch with the chairman of IPAS in order to ensure sufficient coordination between CCRS and the regions in organizing seminars and workshops.

3 L. It is recommended that the minutes of all working group meetings and an updated list of membership when appropriate be sent to all provincial representatives.

- The UAMU will undertake the responsibility of distributing all those minutes of working group meetings which it receives to provincial representatives, as well as updated membership lists. The chairmen of working groups should ensure that copies of all minutes are sent to Mr. J.C. Henein in a timely manner for distribution.

Recommendations of the Specialty Groups

3 M. The National Program should emphasize operation and upgrading of existing systems ahead of the introduction of newer technology.

- It is CCRS policy to emphasize operation and upgrading of our existing systems ahead of introduction of newer technology. We implement this policy by applying the majority of our resources and personnel to LANDSAT and airborne operations. We are currently completing a major upgrade of our LANDSAT production system with the commissioning of laser beam recorder system at Prince Albert.

3 M.1 New systems should serve the needs of all geographical areas of Canada.

- Our aircraft program is subsidized so that users in all parts of Canada gain equal access to aircraft remote sensing services. Our LANDSAT program currently provides direct coverage of all Canada from our stations. Within budgetary constraints, we will attempt to implement future programs that satisfy all geographic areas of Canada.

3 M.2 The production of CCT's and improvement of image quality be given high priority.

- We are producing the software so that corrected CCT's can be produced at Prince Albert and Shoe Cove Stations. We have used the services of the NAPL research and development group to conduct testing and evaluation of the Prince Albert and Shoe Cove photographic operations and to establish film product standards.

3M.3 The production of UTM corrected CCT's begin as soon as technically possible.

- We have a development system underway to produce UTM corrected CCT's for LANDSAT data and have produced a few scenes using software techniques. We are planning to bring this system into production in early 1979. Its products will be geometrically and radiometrically corrected and conform to a 1:50,000 NTS map sheet.

3M.4 That CCRS provide software development support and leadership to the remote sensing user community.

- We are developing a software policy and introducing tighter internal documentation standards to maximize our software contribution to the remote sensing community.

3M.5 That CCRS continue to search for effective output display methods.

- We will try alternative methods for producing hard copy colour products from our computer compatible tapes.

3N. That CACRS, in addition to its advisory role to CCRS, should coordinate the National Remote Sensing program via information exchange, recommending priorities, etc.

- CCRS anticipates that IPAS will take an active role in providing advice to CCRS as well as in generating regional activity. CCRS welcomes any and all input from the members of CACRS on an ongoing basis but feels that the activity referred to by the word "coordinate" requires a degree of continuity that cannot be provided by so disperesed an organization as CACRS.

3N.1 That CACRS system of discipline-oriented and special-purpose Working Groups should be continued.

- CCRS is in agreement with this recommendation, but short-term working groups should also be established where needed.

3N.2 The specialty centres should be represented at CACRS

- CCRS notes with pleasure the expansion of remote sensing activities in various institutions across the country. At the same time, it seems possible that if every organization, governmental, educational, or industrial, which undertakes a specialized remote sensing program in the future is to be represented at CACRS, the potential numbers

could become unmanageable. CCRS suggests, subject to the agreement of CACRS, that specialty groups should be represented as far as possible through the established discipline-oriented working groups. At the same time, the committee nominated by the members of CACRS each year to plan the next CACRS meeting is free to invite particular individuals to the CACRS meetings, subject to Dr.Morley's consent, if it feels that such individuals can contribute to or benefit from the program.

Recommendations of the Working Groups

3 O. It is recommended that there be increased information exchange at CACRS meetings. The next CACRS meeting should include

(1) Presentations on the state-of-the-art in remote sensing and its future development, both national and international

(2) Discussions of our national needs, and of

(3) What action is required

- This recommendation will be forwarded to the chairman of the committee nominated by the members of CACRS to organize the next CACRS meeting.

3 P. Given that the climate of federal/provincial relations has changed over the past five years, previous attemps of CCRS and CACRS to encourage the establishment of regional activities in remote sensing should be renewed. In part, this might be encouraged by seminars and workshops.

- CCRS feels that the best motivation for the establishment of regional centres and activities is the example of the successful centres that have been established in certain provinces. This activity can be encouraged by seminars and workshops in the regions, such as those that have been conducted recently by both CCRS and various CACRS members.

  The most obvious source of federal funding for regional activities, if such is required, is the Department of Regional Economic Expansion. Successful requests for DREE funds must originate from provincial governments and therefore the initiative in this regard should be spearheaded by IPAS. CCRS will, however, contact DREE and ensure that they are made aware of the need for regional funds for this purpose in anticipation of provincial or regional requests.

3 Q. It is recommended that CCRS give particular attention to insuring continuity of product formats, despite changing technology. It is felt that continuity of products is very important to continuing research, educational and operational programs. The user cannot always be changing analysis equipment and methods to suit rapidly changing technology.

- See the response to recommendation G.

3 R. Working Groups would welcome more frequent opportunities to exercise their advisory function.

- CCRS notes with pleasure the willingness of the working groups to exercise their advisory functions more frequently, and will make full use of the expertise thus made available.

4.0 REPORTS OF THE CANADA CENTRE FOR REMOTE SENSING

4.1 Historical Highlights

1968

May 23: 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. Sixteen representatives from 8 government agencies attended.

1969

July 22: Cabinet Committee on Scientific and Industrial Research recommended that EMR should be the agency responsible for coordination and funding of "Resource Satellites - Canadian Research Program" and should establish an ad hoc interdepartmental committee to steer the program. The Program Planning Office was officially established with Dr. L.W. Morley as director.

1970

Feb. 14: First Montebello meeting to form the working groups of the Program Planning Office.

May 1: 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.

Feb. 11: Treasury Board's memorandum re: "Change in Organization" authorizing the establishment of the Remote Sensing Centre as a new organizational element of EMR. The Centre was subsequently renamed Canada Centre for Remote Sensing, with Dr. Morley appointed as its founding director.

April 1: Canada Centre for Remote Sensing was officially established.

May 14: Agreement with NASA signed.

Nov. 30: Purchase of Falcon Fanjet aircraft.

1972

Jan. 4: Meeting of the Interagency Committee on Remote Sensing (IACRS) at which terms of reference for the Canadian Advisory Committee on Remote Sensing (CACRS) were approved, and at which the first partial "cost recovery" or "shared funding" formula was approved(whereby CCRS may charge federal Government user agencies for airborne remote sensing).

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

July 23: LANDSAT-1 launched.

July 26: First imagery of Canada received.

July 27: First LANDSAT image presented to Honourable Robert Stanbury, Ministry of Communications, at the International Society of Photogrammetry conference held in Ottawa.

1973

January: Establishment of Applications Division of CCRS, and initiation of a concentrated program of applications research and development.

February: Establishment of remote sensing imagery Browse Facility at CCRS.

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

February 19-22: (Fourth Montebello) second CACRS meeting.

April: Manitoba Remote Sensing Centre established in Winnipeg.

Distribution and sale of LANDSAT Quicklook imagery of Canada undertaken by Donald Fisher and Associates[1], Prince Albert, Saskatchewan.

July: Ontario Association for Remote Sensing established.

September 18:Ontario Remote Sensing Centre established in Toronto.

1974

January: Proposals for private enterprise involvement in the CCRS airborne remote sensing programs requested from industry.

February: ISISFICHE subscription became available from Donald Fisher and Associates.

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1. The name of this company was changed to Integrated Satellite Information Services Ltd. in January 1975.

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 6: Alberta Remote Sensing Centre established in Edmonton.

December: Contract to develop a satellite tracking station to be located in St.John's, Nfld., awarded to MacDonald, Dettwiler and Associates, Vancouver.

1975

January 23: Launch of LANDSAT-2.

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

May 7: Contract signed with Innotech Aviation Ltd., and Intera Environmental Consultants Ltd., for the transition of the airborne production system from government to industry.

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

1976

February: ISIS began to produce and distribute black-and-white LANDSAT products from Prince Albert.

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

December: Cabinet approval of joint submission by EMR and other interested government departments regarding participation in the proof-of-concept SEASAT experiment.

1977

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

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

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

December: Cabinet approval of an inter-departmental experimental program based on readout of data from SEASAT-A, supplemented by an underflight program with an advanced SAR installed in the Convair 580, and an extensive ground-truth program.

4.2 APPLICATIONS DEVELOPMENT

4.2.1 Image Analysis System

The Image Analysis System (CCRS) development will be completed by July. Its capability at that time will be greatly improved over that of the original Image 100. Upon completion of this development the design will be frozen and the facility will be available for users. Procedures will be set up for instituting changes and these will be carefully controlled and documented. Conceptual work has now begun on the next generation of analysis systems which will be able to integrate data from new satellites (with high spatial resolution and large data outputs) and aircraft sensors with existing resource data bases. The new system should be available by 1982.

COMPARISON OF IMAGE 100 AND CIAS

	BASIC IMAGE-100	CIAS
Channels	5	64
Classification Features	4	4
Classes	8 (per pass)	256
Classification Time (including I/O) Landsat 4 Channel		
512 x 512	25-51 min.	10-40 min.
	8 classes	32 classes
3240 x 2386	12.5-13 hour	24-60 min.
512 x 512 2D FFT	...	1 min.

4.2.2 Workshops

Aerial thermograph workshops were given by Ron Brown and Joseph Cihlar in:

-Edmonton, February 7 and 8;
-Quebec, April 3;
-Winnipeg, April 6; and
planned for Vancouver April 11 and 12.

The purpose of these workshops is to demonstrate the capabilities and limitations of airborne thermography for heat loss measurements. The average attendance has been 15 to 20.

Tutorial Seminars on the Control of Aerochrome Infrared Film for Remote Sensing Application were given by Jack Fleming, Bruce Fretts and Joseph Cihlar in Ottawa February 15 and 16 and in Calgary February 24.

Attendance was largely from the aerial survey industry with a few attendees from Provincial Agencies.

4.3 SATELLITE PROGRAM

4.3.1 Landsat 3

Landsat 3 was launched on March 5, 1978 and data was received in Canada starting March 7, 1978. NASA have informed CCRS that they will provide complete Canadian coverage of Landsat 3 for MSS channels 4, 5, 6 and 7 but coverage for Band 8 (Thermal I.R.) and RBV for Landsat 3 is by request only. In addition, Landsat 2 MSS data will only be available as requested.

CCRS has requested:

- Full MSS coverage of Canada for Landsats 2 and 3.
- Full RBV coverage from Landsat 3 until further notice.
- Users will be asked to submit requirements for night-time Landsat 3 MSS Band 8 (Thermal I.R.) data.

4.3.2 Landsat D

A Working Group has been set up to help plan for Landsat D and the French SPOT satellite. CCRS can, within its present budget, finance a bare-bones Landsat D program. This would mean reception at Prince Albert only with limited production and analysis capability. A separate report on the Landsat D program is being presented separately in this report.

4.3.3 Image Production Capability

A new image processing system has been installed at Prince Albert and will be operational by July 15. This facility uses a laser beam output recorder. Two formats are possible - four 70 mm images side by side on a 9" film or 1/1,000,000 image using the full 9" format. CCT's will also be produced. All Landsat products will be generated at Prince Albert except mosaics, special enlargements and colour products. Colour production will remain at NAPL until comparable colour capability is developed at Prince Albert.

4.3.4 Shoe Cove Station

The Shoe Cove, Nfld. Station has been operating and receiving Landsat data on an operational basis since July 21, 1977. An agreement is being negotiated to provide Landsat data of Greenland (with Denmark) and Iceland.

The Shoe Cove Station is now being modified to read out the Seasat SAR data. The station will start receiving SAR data and archiving it on an analogue recorder at reduced resolution by July 15 and will be in full operation recording digital data November 1, 1978.

4.4 AIRBORNE PROGRAM

4.4.1 Evaluation of the Airborne Operation

Ernie McLaren left the Centre to take up a position with Nova Scotia Land-Survey Institute. Joseph Cihlar was seconded to the Airborne Operations on a six-months basis to help interface with users and also to evaluate the projects undertaken in past years on this program to guide future activities. This evaluation took the form of an interview type survey. The majority of principal investigators from the 1975-77 period was contacted by telephone or personally (visits to investigators in 10 Canadian cities were made); in addition, a number of projects from the previous period were included. Each project was documented in terms of purpose, analytical procedures, results, benefits and written reports or papers. The projects were also rated as to the discipline (13 categories), application type (research, pilot, operational) and area (by province). During the interviews, attempt was made to identify applications that have reached operational status.

The evaluation is carried out by discipline and according to the following criteria:

(i) "Average project" statistics: size, number of flight missions, primary sensor.

(ii) Operational applications vs research applications and the status of each.

(iii) Use of the remotely derived information.

(iv) Benefits (actual or potential, and agency-specific or general).

(v) Recommendations.

The survey and project documentation are completed. The evaluation phase is in progress. It is expected that a report will be completed by the end of April

1978. CCRS plans to make the results available to the remote sensing community.

4.4.2 Involvement of Industry in the Airborne Program of CCRS

CCRS is proceeding with the plan to involve Industry more fully in the operation of the program so that the experiments conducted will result in operational applications.

CCRS is also progressing towards implementing a scheme whereby the CCRS aircraft will be available to Canadian Industry on a cost-recovery basis. This will allow companies to use CCRS aircraft to develop a market for remote sensing techniques without making an initial large capital investment in aircraft modifications and sensors. A fee structure has been worked out and Treasury Board approval for this mode of operating is being sought.

4.4.3 AMOP (Arctic Marine Oil Spills Program)

This is a project being managed by the Environmental Protection Service of DFE. CCRS is being funded by this project to determine the conditions under which remote sensing techniques can be used to detect and track oil in ice-infested waters and to specify an operational remote sensing system for oil pollution surveillance. The sensors being considered are:

Convair 580 - 1. ERIM SAR
2. Dual channel linescanner (8-10.5 microns (I.R.)) (350 nanometers (U.V.))
3. Scatterometer 13.7GHz
4. Radiometer 19GHz (borrowed from NASA (Langley))
5. Camera (RC-10)
6. Colour T.V. System (Record in B&W)

RS-A - 1. Fluorosensor
2. Multispectral Scanner, 8 channels - 1-U.V.; 6 visible, I.R. (3.5u)
3. 2 channel MEIS (Multi Element Electro Optic Imaging System) (to look forward at various angles)
4. OMA - Optical Multichannel Analyser - Measure fraunhaufer lines, 500 channels in visible, 1 nanometer resolution, (forward looking). Normalize observed spectra by measuring spectra of downwelling radiation.

RS-A - 5. L.L.L.T.V. - Both spectral and polarizing filters used; also used for track recovery.
6. 70mm Vinten vertical camera.

The DC-3 will be operating from Clyde River on Baffin Island to conduct experiments over a naturally occurring oil seep in September 1978. The Convair will also fly in from Thule to participate. The oceanographic ship "Hudson" will be taking samples of the seep.

A second experiment will be conducted in June of 1979 when there should be 50% ice cover. Attempts are being made to arrange a controlled spill in moving pack ice in 1980.

Duration (original) - to October 1980 (22 months).
Extended to 1981.

4.4.4 Photo Hydrography Project

The Photo Hydrography Project is a cooperative venture between CCRS and the Marine Sciences Directorate of DFE. The objective is to establish the feasibility of mapping depth contours in shallow water coastal areas using stereo photographic techniques. However, this method requires accurate knowledge of the attitude, altitude and position of the camera at the time of each exposure. Over land this information is usually obtained by aero-triangulation of photo identifiable ground points. This technique cannot be used over water so the required parameters must be measured directly using an inertial platform and precision altimeter. This system will be tested experimentally this coming Summer.

The above technique will be supported by measurements from a lidar bathymeter which will continuously measure the water depth under the aircraft. This measurement can then be used to improve the accuracy of the photo-hydrography measurements.

4.5 RESEARCH AND DEVELOPMENT

4.5.1 Ground-based Spectrometer Capability

A facility consisting of a visible and I.R. spectrometer mounted on a cherry picker with a computerized data acquisition system has been acquired and will be operating this Summer in support of Landsat D evaluations.

4.6 SUPPORT SERVICES

4.6.1 Three Year Plan

The CCRS three year plan put before CACRS last year was not approved by Treasury Board because Treasury Board does not approve plans-only programs. This document is being updated and will be an internal CCRS document. Copies, however, will be distributed to CACRS members.

4.6.2 User Assistance and Marketing Unit

This Unit was established under the Program Planning and Evaluation Unit mainly as a result of CACRS Recommendations. It is described in a separate handout.

Bernie Hodson and Tom Alföldi have been seconded to the Unit. A competition will be held to select a Head and one other person for the Unit.

4.7 SURVEILLANCE SATELLITE PROJECT STATUS

4.7.1 Introduction

The Surveillance Satellite (SURSAT) Project is an interdepartmental project of the Canadian Government initiated in April 1977, for which EMR (CCRS) is lead agency. The principal activities of the SURSAT Project are performance of a set of experiments utilizing the NASA satellite SEASAT-A and a complementary set of airborne Synthetic Aperture Radar (SAR) experiments utilizing the CCRS Convair 580 aircraft. Results of these experiments will define the technical feasibility of satisfying Canadian surveillance requirements by satellite. Technical considerations, assessment of comparative economics, and review of potential international partners will lead to definition of Canada's options for participation in a surveillance satellite system in the 1980's.

4.7.2 Status of Hardware Preparations

The Shoe Cove Satellite Station is presently being modified to receive and record data from SEASAT-A. During the period July - September 1978, SAR data will be recorded only in analogue form. For the remainder of the experiment period (to December 1979), SEASAT SAR data will be recorded in both digital and analogue forms.

Both optical and digital facilities for processing of SEASAT SAR data are under development. It is anticipated that the optical processing facility being developed by DND will be available in October 1978. The digital processor being developed by MDA will accept first digital SAR data in October 1978.

Mobilization of the SAR-580 facility is well underway. The ERIM four channel X-L SAR is presently being installed in the CCRS Convair 580 aircraft in preparation for the commencement of SURSAT experiments in mid-July 1978.

4.7.3 Experiment Planning Status

In response to the SURSAT solicitation of experiments, 101 proposals were received which requested SEASAT and aircraft data far in excess of those available to the project. A complex review process which included combining proposals by discipline and geographic location of experiment sites has been concluded. Definition of specific experiment objectives, time frames, site locations, and detailed mission planning are now underway with management largely provided by user departments. The following shows the approximate number of experiment proposals submitted by each institution participating in the SURSAT project:

DFE	27
EMR	12
DND	6
CDA	4
DOT	3
DOC	2
Provincial governments	10
Industry	6
Educational institutions	18
Foreign	7

To satisfy data requirements, Canada will request approximately 500 "turn-ons" of the SEASAT SAR over experiment sites and 20,000 line kilometres of airborne data will be collected and processed.

4.8 Landsat Follow-on

The U.S. National Aeronautics and Space Administration has announced plans to follow the current successful Landsat program with a higher resolution series of Landsat-D satellites. Also, CNES of France has announced plans to launch a series of SPOT satellites with even higher spatial resolution. These are envisaged as the preview of operational satellite remote sensing systems which might be implemented in the late 1980's.

The Canada Centre for Remote Sensing started planning for participation in these follow-on programs in the fall of 1977. In order to ensure that the Canadian user community would be fully involved in the plans to be developed by the Centre, a Landsat Follow-On Workshop was organized and conducted in March 1978. A report will be published during the summer of 1978 which provides the background material presented at the workshop and outlines the conclusions reached by the participants. A preliminary draft of this report was circulated to members of CACRS at the meeting.

Many compromises will probably have to be made in the design of the system which will be developed to make data available to Canadian users from Landsat-D and SPOT. Trade offs will depend upon costs, funds available and requirements as expressed by the user community. The workshop held in March was an early attempt to obtain an expression of user needs and interest. The attendees discussed a number of questions, and reached conclusions which are summarized briefly here.

With very few exceptions, almost all applications are seen to benefit from the higher spatial and spectral resolutions planned for Landsat-D and SPOT, but there are very few new applications foreseen. Perhaps it will be possible to differentiate between snow and cloud cover using the new bands of Landsat-D which opens some new possibilities for operational snow mapping, particularly in mountainous regions. Some marginal applications might become more practical, for example, in the land use, coastal and inertidal zone mapping areas.

Current methods of facsimile transmission of real-time data cannot open up new application possibilities. To take advantage of the increased resolution, sub-scenes must either be transmitted (meaning smaller amounts of area coverage) or on-site interpretation must be available. Such on-site interpretation will only occur if the user agency sees a significant advantage.

It is clear that quick-look data transmitted by facsimile will have to be changed in character in order to benefit from the improved characteristics of Landsat-D. It is difficult to determine if one band from quick-look will be sufficient; users seldom order only one band today. Cost differences between quick-look and tape processed data must be examined. In order to process 10 scenes or 30 sub-scenes per day, it will be necessary to expend $1.5 to 2 million to upgrade the PASS facilities. Even more will have to be spent if full Canadian coverage or any foreign coverage is required. To process all data from Landsat-D in a manner similar to that now done for Landsats 1 to 3 would require a much greater expenditure of funds.

It was noted that MSS bands 4 and 6 alone are of little value to forestry. Users generally welcomed the information that both 1600 BPI and 6250 BPI tapes will be available.

In discussing the orbital patterns, it was generally agreed that a uniform skip pattern was preferable to one which provided adjacent scenes on adjacent days. For some applications, it does not really matter, in particular for those where coverage is required only once per year or once per season. This conclusion was confirmed at the CACRS meeting where preference was indicated for a 708 k orbit which would provide 9-11 day repeat coverage for most of Canada.

On the question of full-scene or sub-scene data, there was some disagreement. Many users welcomed the suggestion of providing sub-scene data as this would eliminate the very high cost of deleting the data not required from a tape. Very often only a small section of the scene is of interest for any particular study, and the computer processing costs to remove the extraneous data can be quite high. On the other hand, some users felt that it was even more important to have full-scene coverage: in applications such as geology, it is the synoptic view that is most important. In forestry, sub-scenes on the order of 1/4 of 1:250,000 topographic map are practical, but forestry work tends to look at large areas at a time.

There was considerable discussion on possible mechanisms for maintaining user involvement in the decisions to be made by CCRS with regard to the Landsat Follow-On Program. One suggestion involved direct user involvement in the CCRS project review committee. It was pointed out that at one time CACRS attempted to exercise greater control on the deployment of the aircraft, however, the large user group was found to be far too unwieldy for such activities. While any external committee could not act effectively on day-to-day operations, it could

oversee general policy. Some of the various national policy committees with which the users were familiar were mentioned. For example, the National Committee on Forest Fires does operate quite effectively in controlling policy. Some of the NRC associate committees also exercise reasonable control over the policy and direction taken under their jurisdiction. Most of these committees, however, are made up of people whose major task is related directly to the subject considered. User agencies use remote sensing as a tool; it is not their major concern. Some of the NASA technical users group committees which provide advice on major projects are possible models for ensuring adequate user input.

The question of technology-push versus applications-pull was discussed. It is highly desirable for the applications people or users to clearly define their needs in order to guide the technocrats. Historically, the major advances have come from the innovation generated by technology-oriented people. The moral is "if the users don't like technology-push then they ought to pull". It has been suggested that the technologists have the advantage of being centralized, whereas the users are diffused throughout the country and through many agencies. It was suggested that it is not really technology which is centralized, but rather the capacity to innovate.

It was generally agreed that Canadian data must have the highest priority and that there should be full coverage available for Canada. This could be obtained through receiving sites at Prince Albert and possibly Frobisher Bay, by augmenting direct readout at PASS by a domestic satellite link to White Sands, or by providing a Canadian Telecommunication Data Relay Satellite System (TDRSS) Station. It is recognized that use of TDRSS either through the domestic satellite or directly may pose serious problems for NASA.

Agriculture is the only group which has a positive requirement for foreign data, other than that bordering Canada (for ice reconnaissance, data are required for the Beaufort Sea and the Davis Straight). Canadian data must have highest priority, and it was felt that agriculture must clearly define its requirements for foreign data. It must also demonstrate a clear plan for the utilization of any foreign data acquired. Thus, the sampling schemes proposed and the system to use such foreign data must be defined. It was suggested that agriculture should provide the incremental cost to the system required in order to obtain such foreign data.

Some attendees expressed the opinion that CCRS should greatly strengthen its research efforts in the area of machine analysis of remotely sensed data. Work to date has been very beneficial to some forestry groups in particular. CCRS should give very high priorities to the development of new hardware analysis systems for the Landsat-D time frame.

The subject of cost-recovery is of great concern to some operational users. They are concerned that they will be encouraged to develop operational programs using satellite remote sensing data when such data products are heavily subsidized. Once they have developed systems to use this technology, the costs will skyrocket putting them in an almost untenable situation. It was pointed out that NASA, by charging station fees, has already increased the costs to CCRS. In fact, the US is considering total cost-recovery in the future. The users would like to have a strong say in this decision.

It was pointed out that remote sensing is generally for the national good. The major users are governments at all levels, and the benefits from remote sensing tend to accrue to the nation as a whole, not to individual agencies or specific groups. While some industries, such as the geophysical exploration companies, can benefit directly, remote sensing is much like weather forecasting where the country as a whole benefits. Therefore the basic cost should be underwritten by the federal government. It would seem to serve little purpose to have one government agency charging other government agencies for remote sensing services.

Ice reconnaissance is the application most adversely affected by the planned frequency of coverage for Landsat-D. SPOT might help to fill in the gap. However, the infrequent coverage likely to be provided up to 1985 will seriously limit this application, and continued aircraft reconnaissance will be required. In fact, it is doubtful that aircraft surveillance can ever be displaced by satellite.

The workshop was unable to make any definite suggestions as to which bands in the visible and infrared spectrum might be preferred for the future. It was generally felt that not enough research had been carried out in Canada to make such suggesions, and that at least for Landsat, NASA had probably made reasonable decisions based upon the work done in the U.S.A. Canada should do more work in this area in order to answer questions about requirements in this country.

5.1 REPORT OF THE WORKING GROUP ON AGRICULTURE

5.1.1 AIRBORNE REMOTE SENSING

The number of airborne projects successfully completed over agricultural areas increased in 1977 as compared to 1976 (26 vs. 21) with some reduction in line mileage (2667 vs 3679 nm). The reduction in mileage was mainly the result of fewer large blocks (i.e. >200nm) being flown (1 vs 6 in 1976). Thus, the Airborne Unit of CCRS continued to provide its unique capability of quality airborne imagery to various agencies interested in the development of research and pilot operations. These studies were on assessing crop and vegetative conditions, crop loss, rangeland productivity, crop classification, insect infestation and land-use. Assurance of acquiring imagery within optinum time frames especially required for detection of selected biological phenomena remains a difficult problem due to a variety of weather, atmospheric, and human and physical-resource constraints. Several important projects, consequently, were abandoned during the year. Acquisition of imagery for uses no longer considered experimental were tranferred from CCRS to commercial air-survey agencies. These agencies however, did not, adequately provide the required quality of imagery, thus raising serious questions on their present capability or on the present contracting and specification procedures. Generally, the quality of imagery acquired by CCRS was of satisfactory quality indicating that the procedures being used for correcting the film for dye-layer imbalance and for atmospheric density has improved the overall color airborne system.

Aerial color-IR phology was used for a wide variety of applications such as in land-use and peat area studies in Manitoba, monitoring effects of potash mining on crops in Saskatchewan, detecting and estimating crop losses from alfalfa "sickness (4), alfalfa winter-kill (9,15), bean diseases (10,16), pea losses (1), rangeland productivity (14, 17), and crop losses from insects (Saskatchewan). Research on spectral characterization of crops for future film-filter airborne studies was conducted on cereal crops (2) and horticultural crops (3,4). Particular attention was given to techniques for detecting spectral properties under a minimum of soil "noise" conditions with solar illumination.

5.1.2 SPACEBORNE REMOTE SENSING

Development continued on a pilot system for determining crop conditions from Landsat imagery for spring in spring wheat growing regions based on site data from western Canada (8,12,13). Under the Canadian Area Crop Information Remote Sensing Program, crop records from an additional 30 sample segment sites (5x6 mile areas) were obtained in Saskatchewan for future verification of crop estimates based on extrapolation from the main test sites. Development of the Homogeneous Land Area concept continued (11) with the Land Units being defined and mapped for two map sheets in Saskatchewan (Melfort and Wynyard NTS maps) based on physical soil climatic parameters and evaluated in relation to enhanced Landsat data. Studies were started on evaluating a suitable network of ground-based soil moisture control sites and establishment of a reference computer data-file in cooperation with Canadian agrometeorology specialists as part of a program for assisting in yield estimations (7). This network and data base will be used to provide ground control information for such future satellite programs using the Heat Capacity Mapping Mission of CCRS. Development of thematic map overlays on Landsat imagery (digitally) was begun for delineating specified areas, municipalities, crop districts, land units etc. and for separating unwanted or extraneous land areas on Landsat imagery during automatic classification. Such interfacing of thematic information with satellite imagery, geometrically corrected, has seriously hindered acceptability of such remotely acquired data. Landsat data was used also during the year for determining change in farming practices (between 1973 to 1976) in areas of Alberta readily subject to severe wind erosion. Estimates were made of selected areas in the Peace River region for acreage of Creeping Red Fescue. Studies continued in evaluating rangeland productivity and for classification of range areas in southern Alberta (14) and in the Kamloops area of B.C. (17).

5.1.3 TECHNICAL DEVELOPMENT

The technical developments made by CCRS for evaluating the quality of a aerial film (color) prior to exposure and for determining the proper film-filter combination in relation to the dye-layer balance and atmospheric density have been a significant step towards improving overall image quality. Pro-

per exposure control still remains a serious factor in operational acceptability for most agricultural applications as the failure rate among commercial operators still remains excessively high. Satisfactory progress was made in the initial phases of a long-term program to reduce uneven luminosity on airborne color photography (6).

5.1.4/5.1.5 APPLICATION AND BENEFIT ANALYSIS

5.1.6/5.1.7 USER LIAISON AND TRAINING

Studies using a combination of airborne, spaceborne and ground control data have shown the feasibility of mapping and classifying selected rangeland conditions in southern B.C. (17) and Alberta (14). Such studies need to be extended to other rangeland eco-systems. The application of Landsat data for evaluating the growing conditions of vegetation in spring needed cereal growing region was shown to be successful based on Canadian control data (8). However, to obtain information on a near-real time basis, reliability would still require additional 2-5 years for acquiring the equipment and training Canadian personnel. During the year no special workshop program was conducted for agricultural applications. The Agricultural Working Group of CACRS, met in Edmonton, November 22 and 23, 1977 at the Alberta Center for Remote Sensing (5). A number of papers were presented at the Fourth Canadian Symposium on Remote Sensing, Quebec City.

5.1.8 CONCLUSIONS AND FORECAST

5.1.9 RECOMMENDATIONS

1. Whereas an increase in spatial and spectral resolution of satellite remote sensing systems would greatly improve the use of satellite data for crop studies by allowing for the identification of relatively small fields and the classification of crop type based on refined spectral characteristics, and

Whereas satellite multispectral scanner data have been demonstrated to be suitable for many agricultural applications with operational systems developed for its utilization, it is recommended that:

(a) The Canadian remote sensing community actively participate in the LANDSAT-D program;
(b) A multispectral scanner be incorporated with the thematic mapper on LANDSAT-D;
(c) All satellite data for Canada by recorded even though all thematic mapper data may be processed on a selected scene basis;
(d) Satellite data, as computer compatable tapes, be processed to provide imagery that is geometrically corrected, edge-enhanced and contrast-stretched, on a 1:50,000 NTS map sheet basis.

2. Whereas the Agriculture Working Group recognizes the potential of the unique type of data provided by microwave systems, especially the all-weather capabilities of such systems by which data may be obtained in addition to current visible and infrared data, it is recommended that:

(a) The Canada Centre for Remote Sensing, Agriculture Canada, and other agencies fully support developmental research on microwave remote sensing for agricultural applications.

3. Whereas the number and frequency of requests for airborne data appear to severly strain the capabilities of the data acquisition division of C.C.R.S. and

Whereas the needs for airborne data have not always been reliably met by the air survey industry, it is recommended that:

(a) The air survey industry be encouraged to provide operational remote sensing data of the kind currently provided by the data acquisition division of C.C.R.S.;
(b) The data acquisition division of C.C.R.S. critically evaluate requests for airborne data to ensure the development of the air survey industry in operational remote sensing;
(c) The air survey industry actively support operational remote sensing projects.

4. Whereas provincial/regional remote sensing centres have proven to be effective structures for the promotion of remote sensing and the dissemination of research results, it is recommended that:

(a) The Canadian Advisory Committee on Remote Sensing encourage the establishment of provincial/regional remote sensing centres in those areas of the country not presently served by such;
(b) Agriculture Canada include operational applications of remote sensing in the CANADEX Series.

5. The Agriculture Working Group recommends that appreciation be expressed to Mr. Cal Bricker, the staff of the Alberta Remote Sensing Center of the Alberta Department of Environment for hosting the 1977 meeting in Edmonton.

5.1.10.2

APPENDIX II: BIBLIOGRAPHY CITED

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5.1.10.3 APPENDIX III. LIST OF GROUP MEMBERS (APRIL 1977)

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2. Mr. P. Crown, (Secretary), Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta, T6G 2E3 (403-422-2886) March 75 - March 78.

3. Mr. E. Brach, Engineering Research Service, Canada Department of Agriculture, Ottawa, Ontario, K1A OC6 (613-994-9561) March 75 - March 78.

4. Mr. John Buchan, Plant Industry Branch, Saskatchewan Department of Agriculture, Administration Building, Regina S4S OB1 (306-527-1661) March 76 - March 79.

5. Mr. O. Code, Agricultural Division, Statistics Canada, #5 Temporary Building, Ottawa, Ontario, K1A OL7 (613-994-9983) September 75 - March 78.

6. Mr. Robert Gordon, Land Use Service, P.F.R.A., Motherwell Bldg., 1901 Victoria Ave. Regina, Saskatchewan, S4P OR5 (306-522-2584) April 77 - March 80.

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9. Mr. T.V. Beni, Canadian Wheat Board, 7th Floor N., 423 Main Street, Winnipeg, Manitoba R3C 2P5 (204-985-3432) September 75 - March 78.

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11. Dr. R. Protz, Department of Land Resources Science, University of Guelph, Guelph, Ontario (519-824-4120) Ext. 2481 N1G 2W1 March 76 - March 79.

12. Dr. Awni Raad, Director, Soil & Crops Division, Department of Agriculture & Forestry. P.O. Box 1600, Charlottetown, P.E.I. (902-892-1267) March 75 - March 78.

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14. Dr. R.S. Rust, Economics Branch, Canada Department of Agriculture, Sir John Carling Bldg., Ottawa, Ontario K1A OC5 (613-994-5571) April 77 - March 80.

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16. Dr. R. Ryerson, Canada Centre for Remote Sensing, Energy, Mines and Resources, 717 Belfast Road, Ottawa, Ontario, K1A OY7 (613-995-1212) March 75 - March 78.

17. Mr. A. McLeod, Research Coordinator, Saskatchewan Wheat Pool, 2625 Victoria Ave., Regina, Saskatchewan, S4P 2Y6 (306-596-4411) March 76 - March 79.

18. Mr. J. McKinnon, Prairie Agri-Photo, P.O. Box 817 Carman, Manitoba, ROG OJO (204-745-2479) September 75 - March 78.

19. Mr. C.Tarnocai, Department of Soil Science, University of Manitoba, Winnipeg, Manitoba (204-474-8153) R3T 2N2 March 74 - March 78.

20. Dr. V. Wallen, Chief, Crop Diseases Loss Section, Ottawa Research Station, Canada Agriculture, Ottawa, Ontario K1A OC6 (613-994-5555) April 77 - March 80.

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

5.1.10 APPENDICES

5.1.10.1 Appendix I: Current Airborne Projects Related to Land-use Crops and other Agriculture Activities.

Project Number	Requesting Agency	Principal Investigator	Geographic Area	Alt. ASL (ft)	Camera Format	Lens (inch)	Film type	Dates flown (1977)	Line Miles
77 -8	Alta.R.S. Center Edmonton	Bricker, C.D.	Alta: Clagary, Camrose, Grande Prairie	12,000 12,500 36,000	9x9 70MM 70MM 70MM 70MM	3.5 3.0 3.0 3.0 3.0	2443 2445 2405 2405 2424	Oct. 22	126
-11	Agriculture Can. Ott. Res. Sta.	Basu, Dr. P.K.	Ont: Carp, Vernon, Ottawa	3,250 3,300 3,350	9x9 IRLS	6.0	2443	Sept 15	54
-12	Alta., D.O. Environment	Woolnough,D.F.	Alta: Vegreville	8,000 15,000	9x9 70MM 70MM 70MM 70MM IRLS	6.0 3.0 3.0 3.0 3.0	2443 2445 2405 2405 2424	Jul. 14 Sept 13	10
-14	Guelph Univ. Dept. of Land Resource Science	King, K.N.	Ont: Lake Erie(N.Shore)	11,600 35,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	Apr. 29	436
-16	Man., D.O. MREM	Gruszaka, F.	Man: Dauphin	35,000	9x9 70MM 70MM 70MM 70MM IRLS	3.5 3.0 3.0 3.0 3.0	2443 2405 2405 2424 2445	May 13	300
-17	Alta. R.S.Center Edmonton	Bricker, C.D.	Alta: Lloydminster	27,000	9x9 70MM 70MM 70MM 70MM	6.0 3.0 3.0 3.0 3.0	2443 2445 2405 2405 2424	Jul.14	13

-18	Alta. R.S. Center Edmonton	Bricker, C.D.	Alta: Drumheller	27,500	9x9 70MM 70MM 70MM 70MM	6.0 3.0 3.0 3.0	2443 2445 2405 2405 2424	Sept. 13	18
-28	Agriculture Can. Land Res.Res.Ins.	Mack, Dr. A.R.	Man: Spring Wheat Test Sites	32,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	Sept. 11	34
-29	B.C., Ministry of Environment	Bennett, R.C.	B.C.: Peace River	9,000 23,000	9x9 IRLS	6.0	2445	June 6 Sept. 9 Sept. 10	166
-30	Agriculture Can. Land Res.Res.Inst.	Mack, Dr. A.R.	Sask: Spring Wheat Test Sites	32,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	July 21 Sept. 11	50
-31	Agriculture Can. Land Res.Res.Inst.	Mack, Dr. A.R.	Alta: Spring Wheat Test Sites	32,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	July 27 Aug. 17	38
-32	Agriculture Can. Land Res.Res.Inst.	Mack, Dr. A.R.	B.C.: Spring Wheat Test Sites	32,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	July 23	12
-46	Agriculture Can. Leth Res. Sta.	Sommerfeldt, Dr. T.G.	Alta: Claresholm/Raymond	13,200	9x9 IRLS	6.0	2443	July 13 Sept. 13 Sept. 14	164
-47	Agriculture Can. Leth Res. Sta.	Johnston, Dr. A.	Alta: Stavely	7,500 14,500	9x9 70MM IRLS	6.0 3.0	2443 2443	July 13 July 14 Sept. 13	60
-48	Maritime Resource Manda. Service N.B. Dept Agric.	Mosher, Dr. P.N.	N.B.: Grand Falls	10,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	July 1 July 23 Sept. 4 Oct. 5	162
-49	Maritime Resource	Mosher, Dr. P.N.	N.B. Potato Bert	31,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	Cancelled (574)	
-55	Agriculture Can. Econ. Branch	King, G.	Ont: Bradford/Simcoe	5,700 9,700	9x9 9x9 70MM 70MM 70MM 70MM IRLS	6.0 6.0 3.0 3.0 3.0 3.0	2445 2443 2402 2402 2424	June 16 July 19 Aug. 20	96

-58	Sask. Research Council, Saskatoon	Taylor, W.E.	Sask. Potash Sites	14,000 23,000	9x9 9x9 IRLS	6.0 3.5	2445 2443	June 20	324
-59	B.C. Univ. Dept. of Forestry	Leckie, D.G.	B.C.: Kamloops	8,500 19,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	June 11	80
-60	B.C. Univ. Dept. of Forestry	Watson, K.	B.C.: Kamloops/Douglas Lake	4,000 5,000 34,500	9x9 9x9 IRLS	6.0 6.0	2443 2445	June 11	33
-62	McMaster Univ.	Karup, E.	Alta: Slave Lake/Smith	7,000 12,000	9x9 IRLS	6.0	2443	June 17	36
-63	E.M.R.-C.C.R.S Ottawa	Ryerson, Dr. R.A.	Ont: Chatham/Bayfield	31,000	9x9 9x9	3.5 6.0	2443 2445	Cancelled	(28)
-64	Calgary Univ.	Jacques, Dr. D.	Alta: Red Deer	31,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	Oct. 22 Oct. 25	96
-87	Agriculture Can. Ste-Foy Research Sta.	Ladouceur, G.	Que: Eastern Townships	5,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	Oct. 5 Oct. 13 Oct. 14 Oct. 18 Oct. 23	26
-89	Bishop's Univ. Dept. of Geog.	Saunders, I.	Que: Lennoxville	2,000	9x9 IRLS	6.0	2443	Apr. 6 Apr. 7	4
-98	Winnipeg Univ.	Hathout, S.	Man: Winnipeg	1,600	9x9 IRLS	6.0	2443	Apr. 7 Apr. 8	16
-105	Sherbrooke Univ.	Bonn, F.J.	Que: Sherbrooke	2,600 11,000	70MM 70MM 70MM 70MM IRLS	3.0 3.0 3.0 3.0	2405 2405 2424 2443	Oct. 29 Oct. 30	54
-115	Guelph Univ. Dept. of Land Res.	Brisco, B.	Ont: Lake Erie N. Shore	10,700	9x9 IRLS	6.0	2445	Cancelled	(174)

5.2. REPORT OF THE WORKING GROUP ON ATMOSPHERIC SCIENCES

During 1977, Mr. Graeme Morrissey, Chairman of this working group, reached the end of his term and resigned. A new chairman has not yet been appointed. For this reason, no meetings of the working group were held in 1977 and no report was prepared but it is expected that the activity of the working group will resume as soon as a new chairman is appointed.

5.3 REPORT OF THE WORKING GROUP ON CARTOGRAPHY AND PHOTOGRAMMETRY

5.3.1 AIRBORNE REMOTE SENSING

Hydrography Project: Tests to determine the accuracy of an inertial system were carried out using the Casa Grande test range in Arizona. After two hours of flight standard errors of rotation were as follows: 44 arc seconds for roll, 46 arc seconds for pitch, 50 arc seconds for azimuth. Improvements of these accuracies using KALMAN filtering is expected.

Theoretical analysis of the errors in coordinate measurements due to errors in exterior orientation parameters as determined by the INS was carried out, including the effect of using additional information from LASER bathymetry and points on the waterline. These were compared with the practical results obtained by introducing similar errors into an actual model using the analytical plotter. This allowed determination of the effect of vertical parallax on the reading of heights, an effect that cannot be determined theoretically.

Research is presently being carried out to determine the optimum analytical or analog procedure for combining waterline, as determined by IR photography, with the depth measurement from colour photography. The optimum procedure is applicable to the planned system in which both colour and infrared photography will be taken simultaneously. It is expected that ±1/2 m standard error in depth can be achieved when the data from the INS are combined with additional information (LIDAR and shoreline points).

5.3.2 SPACEBORNE REMOTE SENSING

Under the sponsorship of the Surveys and Mapping Branch, research in the combined use of SKYLAB photography and aircraft photography for mapping control (aerial triangulation) was completed at the University of Laval. The procedures developed resulted in reaching standard planimetric coordinate errors as small as about 20 m, which would be sufficient for small scale mapping purposes (1:100,000 and smaller, and eventually even for 1:50,000 reconnaissance mapping).

In the Surveys and Mapping Branch, during 1977, LANDSAT imagery was used to make position determinations for two island features separated from mainland control by considerable distances. The use of LANDSAT to assist in the location of new roads in remote areas continued.

5.3.4 APPLICATIONS

Although no direct use of remote sensing data was made in the National Geographical Mapping Division, a definite application appears to exist in the area of forest cover mapping. A joint project with the Forest Management Institute involving delineation of Canada's forest area is at present being considered.

5.3.5 CONCLUSION

With respect to the cartographic uses of remote sensing data, the situation remained relatively unchanged during 1977, with no new applications reported.

In 1978, new sensor information in the form of higher resolution RBV imagery from LANDSAT C, and SAR imagery from SURSAT project may lead to renewal interest in remotely sensed data in the cartographic community.

5.3.6 APPENDICES

5.3.6.1 APPENDIX I

Current Projects: Airborne Hydrography program of CCRS working in conjunction with the Survey Engineering Department of UNB.

5.3.6.2 APPENDIX II

Current Bibliography: Masry, S, "Coastal mapping from stereo models established using inertial platform data: error analysis". Technical Report 49 Dec. 1977 UNB.

Fleming, E.A., "Positioning Linckens Island by LANDSAT". Internal report, Topographical Survey EMR, June 1977.

5.3.6.3 APPENDIX III

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

5.4.1 INTRODUCTION

The working group met four times since the last CACRS meeting. Most of the work of the members involved becoming more familiar with the efforts of the Centre in planning for the SURSAT program, Landsat-D and SPOT, the CCRS Image Analysis System (CIAS) and the Digital Image Correction System (DICS), and in the CCRS efforts toward development of Computer Compatible Tape (CCT) formats.

The group discussed the possibility of playing some direct role in assisting the Centre in its Landsat-D and SPOT development plans, in the same manner that its predecessor groups of the Program Planning Office made major contributions to the original Canadian Landsat Reception, Processing and Dissemination facility. However, it was decided that a more realistic role for the group would be that of providing informal technical reviews of the CCRS plans as they develop. While the group as a whole felt it could not take on specific design or study tasks at this time, some individual members have offered to assist in the planning directly by becoming members of the CCRS in-house project charged with the task of planning the Landsat-D facilities.

The Working Group has dropped its plans to hold a Synthetic Aperture Radar Workshop, as the SURSAT Project Office is now responsible for this type of activity.

5.4.2 SUB-WORKING GROUPS

The Sub-Working Groups on Data Handling Impact of Senosr Development, Data Analysis and Satellite Systems did not meet during the past year. It was decided that these sub-groups will be abandoned, but that new sub-groups may be formed at any time, to tackle specific problems. Normally, such groups will disband after accomplishing their assigned tasks. Such sub-groups will be composed of regular members of the main working group.

5.4.2.1 Sub-Working Group on Computer Compatible Tapes

A new, specialized sub-working gruop on CCT's was formed during the year, under the leadership of Mr. Fred Potts. This group will be advising CCRS, through CACRS on problems related to the use of CCRS CCT products. In addition to the two regular working group members, a number of new members have been appointed. They are regular users of CCRS CCT's who perform their analyses primarily on non-CCRS equipment. The sub-group will advise on formats, tape media and software input/output specifications.

5.4.3 Recommendations

5.4.3.1

LANDSAT-D represents a significant advance in remote sensing technology and is likely to form the technological basis of future operational systems. Thus it is essential that Canada participate to the fullest extent possible in the U.S. NASA Landsat-D program. The Working Group recommends that Canada obtain the facilities necessary to receive, process, distribute and analyze Landsat-D thematic mapper data of high quality and in a timely fashion providing the greatest possible Canadian territorial coverage.

5.4.3.2

Canada should exercise the greatest influence possible to ensure that SPOT and Landsat-D have sufficient compatibility to make it economically and technically feasible to receive, process, distribute and analyse the data from both satellites.

5.4.3.3

Specifications for a Geographic Gridded Digital Data Base should be formally established for Canada to ensure effective merging of gridded geographic data with remotely sensed data. The specification should include the definition of a standard tape format for gridded geographic data, and also for line (polygon or chain) oriented data.

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5.5 REPORT OF THE WORKING GROUP ON ENGINEERING APPLICATIONS

5.5.1 Subsequent to the presentation of a proposal from the Ontario Ministry of Transportation and Communications during the annual meeting of the CACRS in 1977, it was decided that a new "Working Group on Engineering Applications" be formed. The chairman was appointed in July, 1977 and in February, 1978 the group has 7 members. Membership will be expanded in future as required to accommodate additional programs.

The first official meeting of the group will be held in February, 1978. At that time, tasks will be identified, committees will be formed and work assigned.

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5.6 RAPPORT DU GROUPE DE TRAVAIL SUR LES ECOSYSTEMES TERRESTRES (FORESTRY, WILDLANDS AND WILDLIFE WORKING GROUP)

5.6.1 Introduction

Après une certaine période d'inactivité, les membres du groupe de travail se sont rencontrés à Montréal en novembre dernier, en parallèle avec la tenue du premier congrès de l'Association québécoise de télédétection. Cette réunion marquait la réorganisation du groupe de travail, avec une nouvelle équipe et une réorientation des activités.

Le groupe de travail a décidé de porter ses efforts sur:

1- l'identification des problèmes auxquels font face les usagers canadiens de la télédétection dans le domaine des écosystèmes terrestres.

2- la dissémination de l'information portant sur les projets en cours dans ce domaine que sur les réalisations passées.

3- l'organisation ou la participation à l'organisation de séminaires sur des problèmes spécifiques et les méthodes d'acquisition, d'interprétation et de transfert de technologie.

Les activités de télédétection appliquées à la foresterie sont déjà bien couvertes dans d'autres parties du rapport général du CCCT sans qu'il soit nécessaire de les reprendre ici. Certains points méritent cependant d'être soulignés brièvement.

5.6.2 Applications

Un important projet de transfert de technologie, en cours de réalisation, est celui visant à l'intégration de la télédétection à la gestion des ressources forestières au Québec. Le Centre canadien de télédétection ainsi que le ministère des Pêches et de l'Environnement sont déjà engagés dans ce transfert.

D'autre part le Canada s'implique de plus en plus dans cette voie, sur le plan international, pour des applications touchant les écosystèmes terrestres. Il semble en fait que dans certains cas le potentiel d'application de la télédétection soit plus élevé pour les pays en voie de développement que pour les pays industrialisés. A cet égard, les projets poursuivis par l'Agence canadienne de développement international en Indonésie, au Népal, en Tanzanie, en Haute-Volta, au Honduras et au Pérou sont des exemples significatifs des efforts déployés par le Canada dans cette direction.

5.6.3 Liens avec les utilisateurs

En collaboration avec le Centre canadien de télédétection, le groupe de travail a accepté de préparer et de publier une description des principales applications de la télédétection aux écosystèmes terrestres, au moyen de comptes rendus des projets réalisés dans ce domaine ou en voie de l'être, au cours des dernières années. Cette publication constitue le canal de communication que veut privilégier le groupe de travail avec les utilisateurs actuels et potentiels de la télédétection au Canada dans ce secteur d'activités.

5.6.4 Conclusions

Le groupe de travail s'est donné cette année une base d'appui aux efforts qu'il déploiera en 1978. L'intégration et la diffusion de l'information sur une technique à haut potentiel, mais dont on perçoit souvent mal la capacité réelle et les limitations conséquentes, constituent une étape importante du processus de transfert de technologie. C'est à cette tâche que s'emploieront les membres du comité cette année.

5.6.5 Appendice I
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5.6 REPORT BY THE FORESTRY, WILDLANDS AND WILDLIFE WORKING GROUP

5.6.1 Introduction

Following a period of inactivity, members of the working group met in Montreal last November at the same time as the first symposium of the Association québécoise de télédétection (Quebec Association for Remote Sensing). This meeting saw the reorganization of the working group, with a new team and a new direction to its activities.

The working group decided to focus its efforts on:

1 - the identification of problems facing Canadian users of remote sensing in the area of forestry, wildlands and wildlife

2 - the distribution of information dealing with current projects in this field rather than with past accomplishments.

3 - the organization or participation in the organization of seminars on specific problems and techniques of acquisition, interpretation, and technology transfer

Remote sensing activities as applied to forestry are already covered in other parts of the CACRS report, and it is not necessary to go over them again here. Certain points, however, deserve brief mention.

5.6.2 Applications

An important project now being carried out, involving a transfer of technology, is the one aimed at incorporating remote sensing techniques into forest management in Quebec. The Canada Centre for Remote Sensing and the Department of Fisheries and the Environment are already committed to this transfer.

In addition, Canada is becoming increasingly involved in remote sensing activities at the international level as regards forestry, wildlands and wildlife applications. In some respects, it seems that remote sensing has more applications in developing countries than in industrialized countries. Examples of major efforts made by Canada in this area are the Canadian International Development Agency projects in Indonesia, Nepal, Tanzania, Upper Volta, Honduras and Peru.

5.6.3 User Liaison

In collaboration with the Canada Centre for Remote Sensing, the working group has agreed to prepare and publish a description of the main applications of remote sensing to forestry, wildlands and wildlife, in the form of reports on projects carried out or initiated in the past few years. This will provide a channel of communications between the working group and current and potential users of remote sensing in Canada in this area of activities.

5.6.4 Conclusions

This year, the working group laid the foundation for the efforts it will set in motion in 1978. The co-ordination and distribution of information on this highly promising technique, the actual and consequent limitations of which are often poorly perceived, constitute an important step in the process of technology transfer. This is the task to which the members of the committee will devote themselves this year.

5.7 REPORT OF THE GEOGRAPHY WORKING GROUP

5.7.1 Airborne Remote Sensing

As in previous years, the airborne program appears to have run smoothly, the only complaints that members have heard being against the weather. The number of geography related projects that were flown is not known.

Concern was expressed last year about pricing policy during the transfer of the airborne program to industry. Although no changes have apparently been made, the Working Group reiterates the recommendation that costs of flying related to definite research studies be kept at a minimum.

The question of availability of data will no doubt become a more important question as radar data are acquired for the SAR 580 program. It is appreciated that investigators will wish to have exclusive use of the data for a period of time, but it is recommended that this be kept to a minimum. Good quality radar imagery has not been generally available in Canada to date and the chance to study it will be of interest to many members of the remote-sensing community.

The recent publication of an up-dated version of the Information Bulletin is welcomed. As well as providing information specifically on the airborne program, members in the past have felt that it is also a useful reference document.

5.7.2 Spaceborne Remote Sensing

A concern expressed by several members of the Working Group was the increase in costs of Landsat data during 1977. It is appreciated that with the service being provided through industry and the increasing costs of obtaining the data, some price increases are necessary. If these are made too rapidly, however, potential purchasers could be deterred and total income could decrease. The Working Group recommends that price increases be kept to a minimum and that these only be made when improvements in quality and/or service are also introduced.

Last year it was recommended that costs of all remote sensing products and services be established as far in advance as possible, preferably a full fiscal year. The C.C.R.S. response to this is noted, which indicates an annual review in May, at which time prices are changed if necessary. The establishment of a new price structure in May of one year for introduction in the following May would still seem to be a feasible proposition that would allow more advanced planning on the part of remote-sensing users.

Several members of the Working Group make use of the IMAGE 100 analysis system at C.C.R.S. During the past year they have noted several improvements, such as the establishment of the IMAGE 100 Users Committee. The advice and assistance of members of the Applications Development Section provided through this Committee is valuable and appreciated. Improvements in terms of output products are also noted and further developments to relate information to map data are encouraged.

At the present time, problems encountered by IMAGE 100 users primarily relate to hardware. Unreliability of the system can become a frustration and costs can rapidly escalate if the investigator has to travel a distance to carry out the analysis. It is realized that such factors are beyond the control of the personnel at C.C.R.S., who make every effort to overcome the difficulties. The situation, however, is hardly encouraging to the user.

5.7.3 Technical Developments

The Working Group itself is not directly concerned with introducing technical developments. In terms of ideas, however, it would like to recommend the development of innovative and rapid ways to output useable data from digital analysis systems such as the IMAGE 100 without interrupting the analysis that is being carried out.

5.7.4 Applications

Geographers directly involved with developing applications for remote sensing continue to be few in number. The majority appear to be involved with biophysical or ecological land classification at various levels of detail. Although such studies can provide baseline data for a

variety of environmental purposes, there is perhaps a need to develop a more problem-oriented approach. In other words, start with the problem and then use the most appropriate remote-sensing data source and analysis procedure in the solution of that problem.

Although mapping is often a short term need, the long term value of a satellite program is concerned with monitoring. For this to be done effectively there is need for storage, retrieval and manipulation of data through a geographic information system. The Working Group recommends that more thought be given to the integration of remote-sensing data with geographic information systems.

5.7.5 Benefit Analysis

Few members of the Working Group are in a position to comment on benefit analysis. No specific studies were noted.

5.7.6 User Liaison

Members of the Working Group were pleased to note the recent establishment of a User Assistance and Marketing Unit. Similar suggestions have been made in the past by the Working Group and it is hoped that some of the previous recommendations with regard to dissemination of information about Landsat can be put into effect.

It is appreciated, however, that the User Assistance and Marketing Unit is being established with little or no additional investment of man-power. This is regretable in that other programs must necessarily be reduced or diverted, although policy reasons for this are realized. The Working Group wishes the Unit every success and hopes that it will provide effective and realistic liaison between C.C.R.S. and the user community.

Liaison between the Working Group and the user community was a major area of emphasis in 1977. At the Annual Meeting of the Canadian Association of Geographers in Regina in June, the Working Group sponsored a short technical session and also held an open meeting of the Working Group. The technical session on remote sensing for environmental studies was well attended and there was a useful interchange of ideas at the open meeting. In particular the desire for a workshop on remote sensing was apparent. As indicated last year, it is felt that "it is in the area of user liaison that the Working Group can make its most valid contributions, by acting as a catalyst for technical sessions at scientific meetings and by preparing or assisting in workshops".

5.7.7 Training

In response to last year's recommendations to C.A.C.R.S., the Working Group notes that "C.C.R.S. has observed with pleasure a marked increase in the number of training courses organized by provincial centres, professional societies and industry". As part of this trend, the Geography Working Group is planning a two-day workshop to be held at the time of the Annual Meeting of the Canadian Association of Geographers. This will fill a need expressed recently by a number of geographers.

As pointed out by the ad hoc committee which considered the question of a Canadian training centre and reported to C.A.C.R.S. last year, this is only one of a variety of types of training program that are required. It would appear that for more formal courses and programs in remote sensing, an interested individual has to be in the right place with the right financial climate to make any progress. This is hardly planned development, but there is probably little practical action that C.A.C.R.S. can take on this aspect.

5.7.8 Conclusions and Forecast

During 1977 there were few changes in remote sensing programs and policies that affected the geographical community. This will change in 1978 with the launch of Landsat C containing a thermal band, the launch of Seasat A and the acquisition of airborne radar imagery as part of the SURSAT project. The advanced planning that has apparently gone into the SURSAT project is seen as an important way to make effective use of existing resources. The consideration being given to applications is important. Members of the Working Group hope that the project will continue as successfully as it has started.

Last year, the Working Group emphasized the importance of encouraging applications development to attempt to reduce the gap between technology and applications. With the increasing need for data acquisition in the new satellite and airborne programs being introduced in 1978, this recommendation

should still be borne in mind.

5.7.9 Recommendations

Given the somewhat limited resources at C.C.R.S., it would appear that attempts are being made where possible, to institute the recommendations made last year. Thus, these will not be repeated in this report. In terms of policy, the Working Group makes the following suggestion.

5.7.9.1

It is recognized that there are increasing attempts to consider the ultimate applications of the data being acquired in the new programs at C.C.R.S. This policy is to be encouraged and it is recommended that efforts be made to continue and, if possible, increase the emphasis given to applications development.

5.7.10 Appendix I
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5.8 REPORT OF THE GEOSCIENCE WORKING GROUP

5.8.I Airborne Remote Sensing

Six geoscience-related projects were flown by the airborne operations unit of C.C.R.S. this year. Details can be obtained from the C.C.R.S..

5.8.2 Spaceborne Remote Sensing

There is a developing interest in Seasat and its associated airborne microwave programme. Nine geoscience projects have been accepted by the Sursat office representing most of the regions of Canada.

5.8.3 Technical Developments

A large proportion of the users of Landsat images would prefer one good cloud-free, snow-free image to a handful of prints of mediocre quality. The product most urgently needed from the Landsat programme is one or more complete sets of colour composites, destriped, geometrically corrected, band-stretched and precision printed for the whole of Canada. It is hoped that priority will also be given to building national image collections from all future satellite systems.

The stereoscopic analysis of imagery from Landsats I,2 and 3 has provided little of interest to most geoscientists, mostly because of the poor vertical resolution (I50-250m.) of the images. As satellites with spatial and vertical resolutions better than 40m. become available, stereoscopic techniques will be as important to users of space imagery as they are to present-day users of airphotos.

5.8.4 Applications

For most geoscientists, digital techniques are best applied to the pre-processing of data,ie:to the production of data sets free of tape imperfections and with acceptable standards of geometry and range of reflectance values.

Most operational applications depend on visual analysis rather than on computer classification techniques, largely because few rock units can be correlated with specific reflectance signatures.

5.8.5 User Liaison

The Working Group is conscious of the need to generate more publicity about its meetings, especially when such meetings are held outside Ottawa. More effort will be directed towards associating the group with meetings held by other scientific societies.

5.8.6 Training

The establishment of a remote-sensing course at the Nova-Scotia Land Survey Institute is welcomed. We would urge those universities and colleges giving courses on remote sensing to place the maximum possible emphasis on the teaching of basic image interpretation skills.

5.8.7 Conclusion and Forecast

The close contacts with the C.C.R.S. enjoyed by the Working Group is greatly appreciated. However the Group would welcome more frequent opportunities to exercise its advisory function, possibly at an informal level, but certainly more often than happens at present.

The Working Group is also interested in contacting and working with other organisations inside and outside Canada that have similar aims and activities.

5.8.8 Recommendations

5.8.8.I There is much current concern over the quality of satellite image products and services in Canada. A C.C.R.S. technical subcommittee should be formed to establish reasonable technical standards for the production of satellite image products. Such standards are required as a basis for an objective approach to the solution of recognised problems.

5.8.8.2 In recognition of the continuing importance of visual interpretation of Landsat imagery, C.C.R.S. should be encouraged and assisted to produce a complete set of colour composite Landsat images, destriped, geometrically corrected and contrast optimised covering the whole of Canada.

5.8.8.3 It should be recognised that repetitive coverage from Landsat type satellites will effectively end with the conclusion of the Landsat C programme.

Future systems will stress selective (and expensive) coverage with higher resolution systems. The value of existing archived data should not be neglected.

5.8. Landsats 2 and C will provide limited coverage of under-developed nations. Landsat I tapes deserve to be reprocessed in the light of more recent technical advances.

5.8.8.5 It is recommended that a request be made to the EROS Data Centre to permit the production of images from the EDIPS facility for selected non-U.S. areas, particularly those of the Third World.

5.8.8.6 In order to more fully access existing expertise, Working Group representation should be included in the C.C.R.S. Project Review Committee. This would permit Working Groups to express their collective opinionsat an early stage, regarding the value of C.C.R.S. and other projects submitted to the Project Review Committee.

5.8.8.7 This Group urges that CACRS acknowledge to the Department of Energy, Mines and Resources the importance of the N.A.P.L. film processing facility to the Remote Sensing community. The Department should be encouraged to maintain this vital service intact.

5.8.9 Appendix I
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5.9.1 REPORT OF THE WORKING GROUP ON ICE

5.9.1 AIRBORNE REMOTE SENSING

5.9.1.1 Passive Microwave Radiometry

A joint project is being planned, with NASA Langley, to install a 19.4 GHz radiometer on the CCRS Convair 580. The object of this work is to gather simultaneous active and passive microwave data from a vareity of sea ice types and conditions.

In April 1977 the NASA Convair 990 (with the scanning multifrequency microwave radiometer simulator on board) flew from Fairbanks, Alaska to Thule, overflying the Beaufort Sea shear zone, Arctic archipelago and Sverdrup Basin. From Thule the route covered Pond Inlet, the Hudson Bay shore head and a Manitoba snow course.

5.9.1.2 Scatterometry and Infrared Radiometry

The CCRS scatterometer has been modified and installed in the Convair 580. A successful test flight program has been completed and this sensor will be available to experimenters during and subsequent to the SURSAT/SAR 580 program.

A microwave backscatter study of sea ice, water and oil is being carried out by C-CORE for CCRS as part of the AMOP (Arctic Marine Oil Spill Program) study. This is a theoretical study to help determine microwave performance in oil pollution studies in ice infested waters.

During 20-21 April 1975, three remote sensing aircraft (CCRS C-47, DND ARGUS, NASA CV-990) overflew the main Arctic Ice Dynamics Joint Experiment (AIDJEX) remote sensing test site at Big Bear (76^{o} 29'N, 144^{o} 24'W). All three aircraft had active microwave sensors on board. The Canadian Centre for Remote Sensing C-47 was equipped with a 13.3 GHz scatterometer, the Department of National Defence ARGUS had a real aperture side looking airborne radar (SLAR) on board, and the National Aeronautics & Space Administration CV-990 operated an L-band synthetic aperture radar (SAR). Two approximately 12km long ground lines were overflown, profiled and imaged. Surface measurements were obtained along certain segments of these lines in form of ice types based on physical properties of sea ice.

During 1977, analysis of the results obtained with the scatterometer have shown systematic changes in microwave backscatter which have a strong correlation with fairly gross ice type categories. In particular, multiyear ice showed significantly higher backscatter than first-year ice. The typical differences in backscatter were 8-10db for the like polarized signals, and 15-18db for the cross polarized signals. On the other hand, imagery obtained from both the imaging radars have shown that there can be ambiguities and overlap in the magnitude of the backscatter from regions of first-year and multiyear sea ice over much of the imaged swath. This observation appears to be consistent with the fact that the surface roughness of both forms of sea ice is highly variable and one of the dominant mechanisms related to microwave backscatter is the surface roughness and relief. Some of these results, together with supporting passive microwave profiles, visible and infrared imagery, will be used to illustrate the variation in backscatter with incidence angle, and to compare and discuss the sensitivity to ice types. On the basis of the 1975 active microwave remote sensing data, projections will be made on the data product to be expected from seasat-A SAR images of ice.

5.9.1.3 Radars

The APS 94-D radar has been transferred from D.N.D. to operate on an A.E.S. ice reconnaissance aircraft. Flight testing is expected to be completed and the system operational by mid-February 1978. Under the agreement between the departments A.E.S. will continue to provide a limited number of flying hours for DND experiments with the 94-D. It is anticipated in the coming year that experiments will be carried out confirming its usefulness in fully coherent SAR mode with high resolution in range as well as in azimuth. Tape recorders have been installed on board the Lockheed Electra aircraft for recording the laser profilometer signal in analogue form on magnetic tape.

Many exploration companies are actively pursuing the acquisition of SLAR imagery and evaluating it for operational purposes, and for extending our historical data base on regional ice conditions.

C-CORE carried out a radar program during the months of February and March, 1977. The program was carried out over Hopedale, Twillingate, the joint NORDCO/C-CORE

"Ship-in-the-Ice" and transit areas in-between. The radar was the Environmental Research Institute of Michigan four channel X and L-band parallel and cross polarized system which will be installed in the CCRS Convair 580 for the SURSAT Program. Support aerial photography was obtained by ERIM over some of the flight lines. Extensive ground truthing was carried out at Hopedale, Twillingate and at the "Ship-in-the-Ice" site.

C-CORE carried out extensive impulse radar tests on the sea ice near Twillingate, Newfoundland. The system used was the GSSI Impulse Radar. The system was mounted on a helicopter and results similar to the surface experiments were obtained. The radar was also mounted on a helicopter and the draft of a small iceberg was determined which was in agreement with supporting side scan sonar data.

The Department of Geophysics and Astronomy, University of British Columbia, measured the maximum ice thickness of the Columbia Icefield with their monopulse radar, a depth of 365m. Efforts are now being directed at developing a magnetic tape cassette recording system for the sounder to reduce its total weight.

5.9.1.4 Photography

NORCOR-Engineering and Research Ltd. has developed a special aircraft for Arctic survey work. The machine is equipped with a VLF/Omega navigational system, on board computer and data logger, two 70mm track cameras with automatic annotation, three complete video systems with full annotation and a low level beacon tracking unit.

The system, which has been in operation since June, has been used on a wide range of sea ice and related studies in the Beaufort Sea and Arctic Islands. Special attention has been given to ultra low level video and still equipment. In a series of test flights, in the Beaufort Sea in January 1978, usable imagery was obtained as far north as 78°. The company will be adding a second similar system in spring 1978.

Glaciology Division has continued its program of aerial photography in the High Arctic (Axel Heiberg and Ellesmere Islands) and along the Mackenzie Valley as in previous years. A study of the Liard River has been initiated to determine the timing and severity of ice break-up from the headwaters to the junction with the Mackenzie River at Fort Simpson, N.W.T. Routine work on terrestrial photogrammetry of the Athabasca, Saskatchewan, Sentinel, Sphinx, Bugaboo, Kokanee and Nadahini glaciers has continued. New aerial photography and thermal infrared imagery was obtained during the summer for the Wapta and Columbia Icefields. This has already permitted remapping of the Columbia Icefield, together with helicopter-based inertial system survey control, ice thicknesses determined by the U.B.C. radio echo-sounder and snow densities by a portable profiler.

Airborne sea ice reconnaissance surveys conducted by Polar Continental Shelf Project from April to October 1977 observed ice conditions in the Arctic channels, Baffin Bay and Arctic Ocean.

Aerial photography has been used by various exploration companies to gather information on ice conditions in the Beaufort Sea, Arctic Islands and off the Labrador coast.

5.9.2 SPACEBORNE REMOTE SENSING

5.9.2.1 Nimbus-G

The objectives of the Nimbus-G Mission are to develop, fabricate, test, and launch an observatory into a 995 km altitude, sun-synchronous orbit, and operate the observatory to conduct a variety of experiments in the pollution, oceanographic, ice and meteorological disciplines. The program includes the processing of the instrument measurements to a format suitable for the application of the observations to the solution of problems concerning pollution, ocean resources and the dynamics of ice, weather and climate.

The particular Canadian applications are: in the prelaunch period, attention will be focused on improving the retrieval of sea ice concentration, sea ice surface temperature, and multi-year ice fraction from the multispectral data obtained both from the Nimbus-G SMMR and the NASA CV-990 SMMR simulator. The time rate of change of the sea ice concentration in Canadian waters obtained from the Nimbus-5 and -6 ESMR's will be studied in detail to determine the utility of such information in ice warning systems for resource extraction activities from the Canadian continental shelf.

In addition, both prelaunch CV-990 and postlaunch SMMR data obtained over the extensive snow fields of Canada will be studies along with surface measurements of the snow properties in order to determine which snow parameters can be usefully extracted from remotely obtained SMMR data.

5.9.2.2 Seasat-A

In May 1978, NASA plans to launch Seasat-A in circular near-polar 800 km orbit inclined at 108°. In addition to five earth viewing sensors, tracking aids will assist the ground system in determining where the satellite is and where the sensors are scanning so that data can be accurately ground located.

The active sensors include a pulse-compressed radar altimeter, a microwave radar scatterometer and a synthetic aperture imaging radar. Passive sensors consist of a scanning multifrequency microwave radiometer and a visible/infrared scanning radiometer.

Seasat-A has been included as part of the surveillance satellite project. Twenty two proposals concerning ice have been submitted to the project office. All sensors on board are used in the Canadian study. Sea ice and icebergs are well studied, lake ice is classed as a target of opportunity, and glacier ice is not covered. A detailed description of the total SURSAT experiment package will be published in the Experimental Plan, Part II.

5.9.2.3 Landsat and NOAA

The Institute of Ocean Sciences, Victoria has used Landsat and NOAA infrared imagery for a study of ice conditions in Lancaster Sound.

ARCTEC Canada Ltd. used Landsat and NOAA IR for 1972 to 1976 to create weekly ice condition files along proposed LNG shipping routes in Parry Channel, Baffin Bay and Eastern seaboard for input to its ARCTRANS simulation model. This will be updated for the 1977-78 ice year.

Landsat and NOAA imagery is also being used by various resource exploration companies to monitor overall conditions in all the three regions.

5.9.2.4 Sursat Project

See Special Report on SURSAT in this publication.

5.9.3 Technical Developments

AES has participated with CCRS and DSS in the letting of a contract to OPTECH of Downsview, Ontario, for a pulse laser profiling system.

AES is a participant in the MOT funded contract to INNOVATIVE VENTURES INC. of Montreal for a further study into an ice thickness measuring system using either a continuous wave VHF by frequency radar or synthetic pulse radar concept.

5.9.4 Applications

C-CORE has been carrying out a Satellite User Application Program concerned with sea ice, icebergs and sea surface temperature using data available from the new Shoe Cove Satellite Receiving Station. The work is being carried out under a subcontract from NORDCO Ltd. of St. John's who are the operators of the satellite station.

Real time NOAA VHRR imagery is utilized on a routine year round basis by Ice Forecasting Central in their analysis and forecasting program. Real time Landsat imagery is also utilized for Arctic operations during the June to October period.

Ice climatology and applications division utilize and archive NOAA and Landsat imagery and laser profilometer ice roughness trace. Laser data are forwarded to shipping and oil industry interests for use in operational and planning modes.

5.9.5 Training

The Working Group on Ice held a Workshop on Remote Sensing of Sea Ice at Calgary, 25-27 October 1977. Industry participation was stressed; six government agency personnel instructed 34 participants on active and passive microwave radiometry, laser profilometry, radar and scatterometer imagery, AES and US ice forecasting operations, iceberg detection, NASA's ice related programs and Canadian SURSAT program.

C-CORE held a course entitled "Impulse Radar - Principle and Applications" during January 1978.

A training film was prepared by Department of Fisheries and Environment, Ocean and Aquatic Sciences, to show ice

variations from September 1973 to December 1974 at 3 day intervals, in Canadian waters, based upon NIMBUS-5 ESMR (electronically scanned microwave radiometry) imagery.

AES Ice Branch Supervisory Personnel have participated in training for interpretation of SLAR imagery. Routine ice observing courses have been given to ice observers from AES and Canadian Coast Guard personnel.

5.9.6 Forecast

Successful completion of SURSAT project by 1980! Action will be initiated for a greater awareness in data processing and user data products.

5.9.7 Recommendations

The Working Group on Ice recommends that:

5.9.7.1
since the main sea ice data gap is sensing the ice thickness and distribution in winter darkness and overcast conditions, great emphasis should be placed upon the development and installation of an impulse radar for aircraft operation.

5.9.8 Appendices

5.9.8.1 Appendix I - Current Projects

"Glacier Studies", compiled by C.S.L. Ommanney for Canadian Geophysical Bulletin 1977, 13 pp.

"Glaciological Investigations in Canada, 1977", submitted by C. Simon L. Ommanney to Ice, News Bulletin of the International Glaciology Society, February 1978.

5.9.8.2 Appendix II - Current Bibliography

List in above publication "Glacier Studies". Bibliography of 1975 publications is in press for Glaciology Division, D.F.E., the 1976 Bibliography is due in August 1978.

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5.10 REPORT OF THE WORKING GROUP ON OCEANOGRAPHY

5.10.1 Introduction

During 1977 the oceanography working group held its tenth meeting at the Bedford Institute of Oceanography. The meeting was arranged to include an information meeting on the Canadian SURSAT project and a presentation by Dr. K. Raney of the SURSAT office on the technical problems of sensing the ocean surface using synthetic aperture radar. The business of the working group included a discussion of the experiments proposed for inclusion in the SURSAT project, as well as a more general discussion of other types of remote sensing work, reports from CCRS on new developments and from members on work in progress. The presentations at the BIO led to some lively discussions on the role of satellites in oceanographic research.

5.10.2 SEASAT/SURSAT

The U.S. oceanographic satellite, SEASAT, is due for launch in May 1978 and will provide microwave sensing of the ocean as follows:

SAR, a synthetic aperture radar, to give 25 m resolution in a 100 km wide swath at a wavelength of 25 cm (L Band). Imagery can be received while the satellite is in view of a ground station - data from all other sensors on SEASAT will be recorded continuously. The radar is designed to show wave and ice cover patterns and will also give radar images over land.

SMMR, a scanning multi-channel microwave radiometer, to give coarse resolution (20-130 km) maps of sea ice, atmospheric water vapour, ocean surface temperature and wind speed.

SASS, the SEASAT-A scatterometer system to provide maps of wind speed and direction.

ALT, the radar altimeter to provide sea surface height and roughness information, for geodesy, ocean dynamics and waveheight measurements.

VIR, a visible and infrared radiometer for reference to cloud and surface features visible to more conventional remote sensing.

The Canadian SURSAT project will evaluate the usefulness of this type of satellite for satisfying Canadian needs. Previous discussions on a Canadian environmental satellite have emphasized the need for "all-weather" operation, particularly cloud penetration, and the microwave sensors on SEASAT provide the opportunity for experimenting with this capability. A radar equipped aircraft, "SAR-580" is also provided as part of the SURSAT project. This is a Convair 580 aircraft equipped with a synthetic aperture radar leased from a U.S. research institute (ERIM). The aircraft has 1300 nautical mile range and will give radar images of 3 meter resolution of about a 6 km image swath. Radar images are cross and parallel polarizations at two wavelengths: 3.0 cm (X band) and 23.5 cm (L band).

Experiments on oceanographic sensing that have been submitted to the SURSAT project include the following:

Radar-surface wave study off the coast of Canada.
J.F.R. Gower, OAS/DFE; R. Wilson, OAS/DFE; R. Lowry, CCRS/EMR

Radar internal wave and coastal feature study.
B.A. Hughes, DREP/DND; J.F.R. Gower, OAS/DFE

A study of the ability of SAR to image the ocean surface.
R.T. Lowry
CCRS/EMR

Analysis of radar back-scattering from the sea for application to surveillance satellite problems.
R.B. Gray
CRC/DOC

Wave height, seastate & over-water winds.
A.H. Campbell
AES/HMAD

Sea surface temperature
S. Peteherych
AES/DFE

SEASAT-A Sensor data for wave forecasting.
S. Venkatesh, AES/DFE; S. Peteherych, AES/DFE

Remote sensing of SST & Seastate by satellite and aircraft for military operational applications.
M.R. Morgan
DND

Detection, location & classification of ships by satellite-borne synthetic aperture radar.
B.G. Young
DREP/DND

A study of the influence of depression angle on the radar imagery from selected targets.
L. Gray
CCRS/EMR

Evaluation of SEASAT-A data for aiding the oil and gas industries offshore activities in the southern Beaufort Sea.
L.G. Spedding, G. Davis, G. Pilkington
Imperial Oil Canadian Marine Drilling
E.D. Wright
Gulf Oil Can. Ltd.

Surface winds in ice infested waters.
S. Peteherych
AES/DFE

Provision of information required off the Canadian east coast for validation of SEASAT-A Data.
L.G. Spedding
Imperial Oil Ltd.

SURSAT Project - Danish Proposal.
P. Gudmandsen
Univ. of Denmark

Definition of ocean surface current boundaries using SAR over the tail of the Grand Banks.
J. Gower, P. Laviolette
OAS/DFE NORDA/DOD

Radar surface wave study at Jasin.
J. Gower, D. Stanley
OAS/DFE Harwell, GB

5.10.3 Membership Changes

M. Therriault, FMS/DFE temporarily replaced M. Boulva as representative from Quebec.

5.10.4 Recommendations

The following recommendations were submitted by members of the group.

1. CCRS should expedite analysis of data from test flights of the aerial hydrography system and provide a definitive report on the overall feasibility of the project. OAS is unhappy at the apparent lack of progress in this work.

2. High priority should be given to improving capabilities of the Shoe Cove Station to take advantage of coming ocean related satellite systems. Capabilities should include on-site data processing and distribution.

3. Because of the dynamic nature of ocean phenomena emphasis should be placed on rapid dissemination of ocean data and imagery.

4. Plans for receiving and processing of data at Shoe Cove from ocean related satellites should be circulated regularly to the ocean community.

5. CCRS should provide image analysis support services for SURSAT projects according to a planned and declared set of priorities.

6. Oceanographic remote sensing experiments of the SURSAT project should be designed where possible to make use of the best ground truth sources available internationally.

7. Canadian experience in water colour measurements should be drawn together and intercompared in time for application to the Nimbus G Coastal Zone Colour Scanner data.

8. CCRS should undertake to arrange access for Canadian scientists to Nimbus G Coastal Zone Colour Scanner data, and should assist in analysis and evaluation of this data.

5.10.5 Appendix I

Oceanographic Working Group Membership List (1977)

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5.11 REPORT OF THE MEETING OF THE WORKING GROUP ON PHOTO REPRODUCTION AND MARKETING OF REMOTELY SENSED DATA

5.11.1 The working group met, for the first time, at the Prince Albert Satellite Station, on March 15, 1978.

Three new members, Don Ross, Peter Murtha, and Ken Slidders, each having considerable expertise in their respective specialities of Photo-Optics, remote sensing research and applications, and marketing, have jointed the group, and attended the meeting, which was chaired, also for the first time, by Don Fisher. Regrettably, there was no representation at this meeting from the Airborne Section.

Prior to, and during the break in the meeting, the group was given a conducted tour of the PASS facility. The group examined the new Multi-Image Processing System (MIPS) and the new image processing and reproduction equipment, all now in place at PASS, and ready to go into full scale operation by early April.

The agenda for this meeting was the group's term of reference. These were first drawn up some eight years ago, and it was felt appropriate to review them. In the ensuing time period, extensive changes have taken place in both Satellite and Airborne Remote Sensing Programs. Many of these changes have taken place during the past year. Among the most notable of these are:

1. The demise of Landsat 1 and the launching of Landsat 3.
2. The opening of the new Shoe Cove Satellite Receiving Station in Newfoundland.
3. The installation of the MIPS system in Prince Albert.
4. The transfer of industry of the Airborne Remote Sensing Program.
5. The transfer of marketing and reproduction functions to industry in the Satellite program.
6. The introduction of cost recovery programs in both the Airborne and Satellite programs.
7. Increased concern for customers, and marketing problems.

These are significant changes, and some were probably never envisaged 8 years ago. All of these will impact the Canadian Remote Sensing Program, and will occupy the group's attention in the days ahead. It was the consensus of the group that the Canadian Landsat Program is now at an advanced stage of technical sophisticantion, and that it will soon be capable of meeting the high resolution demands of users requiring this information in a variety of standard formats in real-time, and certainly, within days of data acquisition.

Despite this, concern was expressed that it would still take users a long time to obtain their information requirements because of:

1. Difficulties in accessing and selecting information specific to their needs.
2. Delays in ordering and receiving these orders through the normal channels.

In view of these problems, and the growing complexities of the data base, the group has decided to prepare and publish a booklet that will concern itself with the following items:

1. The best way to search for and to order Remote Sensing data.
2. The various formats Remote Sensing Data is available in.
3. Quality Control standards for all products.
4. Special processing and special handling options available.
5. Potential delays in delivery of data ordered.
6. Data delivery options available to users.

It is the conclusion of the group that the present low volume of Remote Sensing product sales-and general usage-is due largely to the fact that insufficient effort and financial support has been directed towards prompting the achievements of Remote Sensing where it counts - in the marketplace. Efforts will be made by the group to select a number of successful applications of Remote Sensing, and to prepare case histories of these for use in support of any marketing and promotional drive, designed to establish Remote Sensing as a viable technology in selected vertical markets.

The alternative means in existence at this time of storing, cataloguing and accessing Landsat information were felt to be adequate for each of these -

1. The IISS computer system maintained by CCRS,
2. The printed catalogues published by CCRS,
3. ISISFICHE - the complete Band 6 visual record of all Landsat data recorded in Canada since 1972 -

were discussed in detail.

Concern was expressed, however, that 1 and 2 above were not maintained up to date and that 3 was a little to expensive for users with limited budgets.

The group's attention was directed toward the development of new products and the consensus is that, while there is justification to use digital methods of enhancing Remote Sensing data, this should not be done exclusive of efforts to develop low cost photo-optical products for use in various applications.

5.11.2 NAPL Report

During the year, NAPL was active in a number of areas in support of Remote Sensing activities in Canada and overseas. Chief among these is the establishment of an R & D centre, fully equipped and staffed with experienced personnel, to assist anyone to resolve photographic problems, or to assist in the creation of new photo products. NAPL is prepared to provide on the job training for photo technicians from outside sources. Use was made of this program by personnel from Newfoundland, Alberta, Brazil, several community colleges, and ISIS Ltd. of Prince Albert. Personnel from NAPL have also been sent to Brazil and to Prince Albert to establish processing and quality control standards, for black and white, and colour Landsat products.

A complete set of microfilmed survey imagery and viewing equipment has been sent out to the Department of Land Forest and Water Resources in Victoria, B.C. Soon another identical package will be established at the Geological Survey Office in Vancouver. The cost to the Survey and Mapping Branch of these two microfilmed data packages is $28,000.00.

NAPL is currently microfilming all of 1977 imagery, and will be available for sale by April 1, 1978.

Colour microfilming of all of 1977 flight line index maps will commence shortly and will be available for sale by May 1, 1978.

The reason these microfilmed flight line index maps have been delayed again this year is due to late delivery of these maps to NAPL, by CCRS.

Attached are the statistical records of all Remote Sensing Image Data Formats produced and sold by NAPL during the year. The decline in sales of Landsat black and white imagery reflects the complete takeover of these functions by ISIS Ltd. The decline in the production of Landsat colour imagery is due to the policy of only producing master colour images upon demand. (SEE APPENDIX A)

5.11.3 ISIS Report

The past year has been a significant one in terms of completion of longterm capital expansion plans. The new image processing and reproduction facility was completed at PASS in September and there is ample space within it to meet present and near future demands. Two new automated B & W film and print processors, and one colour processor, have been installed and all of these are operating satisfactorily. Everything is in readiness to produce MIPS data when this system goes into operation, early in April of 1978. ISIS now also provides complete on-site image processing and reproduction support at the Shoe Cove Satellite Receiving Station in Newfoundland.

In May 1977, ISIS took over the complete marketing responsibility of all Landsat and NOAA products produced in Prince Albert, Ottawa and Shoe Cove. Despite price increases, systems delays, and other distribution factors, there has been some stabilization of sales in Landsat products. (SEE APPENDIX B)

Facsimile transmission of satellite information continues to be a major source of revenue for ISIS Ltd.

Plans are in hand, within the limits of financial resources available, to launch an aggressive marketing and promotional effort once the MIPS becomes fully operational.

5.11.5 Recommendations

The group concluded that the following recommendations should be made to CACRS which, if implemented, would help the Canadian Remote Sensing Program to make significant progress in the future:

1.(a) That Treasury Board be advised not to judge the success of the Remote Sensing Program on the basis of products, but on benefits realized through various applications.

1.(b) That Treasury Board rescind its present policy of cost recovery based on product sales.

2.(a) That CCRS maintain the Landsat catalogue and to ensure that it is updated, printed, and published quarterly.

2.(b) That CCRS maintain IISS up to date.

2.(c) That CCRS support, through a subsidy program, the establishment of ISISFICHE in the University centres having viable remote sensing programs.

3. That CCRS consider the establishment of a grants system, to assist universi-

ties conducting remote sensing courses, to purchase remote sensing products, similar to that in effect at NAPL.

4. That the problem of marketing and promotion of remote sensing products be faced and that the following be implemented:

(a) Case histories relating to the successful applications of remote sensing be prepared by CCRS, and outside contractors, for use in a major promotional drive.

(b) A modest marketing and promotional budget be set up and used for the purpose of establishing an impact in certain vertical markets, in conjunction with the producers of remote sensing products.

5.(a) Attention should be directed towards the development of viable photo interpretive techniques and products by CCRS, and, by means of financial support, through outside contractors.

5.(b) Enhanced digital products should be developed, and the on site capabilities of doing this work should be accelerated at Prince Albert and Shoe Cove.

6. The terms of reference of the Photo Marketing and Reproduction Working Group be updated to reflect the current times.

5.11.5 MEMBERS ATTENDING THE March 15, 1978 MEETING OF THE PHOTO MARKETING AND REPRODUCTION WORKING GROUP OF CACRS

D.E.Fisher, ISIS Ltd., Chairman
G.Nitschsky, NAPL
A.B.Collins, CCRS
D.Ross, Photo-Optical Consultant
F.Ahern, CCRS
Dr.A.Gregory, Gregory Geoscience, Secretary
K.Slidders, Powell and French
P.Murtha, U.B.C.

APPENDIX A
LANDSAT PRODUCTION

REPRODUCTION CENTRE (NAPL)

PRODUCT	1974-75	1975-76	1976-77	1977-78*
Customer Product				
B&W Contact Print	51,998	21,393	3,183	133
Colour Contact Print	8,630	6,267	5,424	1,508
B&W Transparency	11,791	8,561	43	33
Colour Transparency	4,320	3,964	2,869	621
B&W Dupe Negatives	507	303	287	65
Colour Dupe Negatives	95	69	139	15
B&W Enlargements	898	940	46	26
Colour Enlargements	338	290	437	367
Total Customer Products	78,577	41,787	12,428	2,768
% of Unit Workload	6.7	3.9	1.4	0.4
Total Customer Revenue	$156,005	$138,260	$58,465	$27,215
Production Products				
Continuous Printing	26,771	44,869	9,485	
Film Processing	63,019	81,483	87,964	58,727
B&W Master Negatives	79,364	59,003	9,649	873
Colour Master Negatives	16,604	14,106	13,200	715
Total Production Products	185,758	199,461	120,298	60,315
Total Production Revenue	$148,863	$220,201	$109,179	$21,154
Landsat Mosaic **		892	3,005	1,650
Landsat Mosaic Revenue		$14,968	$19,380	$18,693
Total Products	264,335	242,140	135,731	64,733
Total Landsat Revenue	$304,868	$373,429	$187,024	$67,062

*Annual figures are a projection from twelve of thirteen CPC production periods.

** Reproduction of Landsat Mosaic commenced in July 1975.

APPENDIX A

AIRBORNE REMOTE SENSING PRODUCTION

REPRODUCTION CENTRE (NAPL)

PRODUCT	1974-75	1975-76	1976-77	1977-78*
B&W Contact Prints	3,409	1,697	1,918	1,724
Colour Contact Prints	7,169	1,981	11,919	9,761
B&W Continuous Printing	20,398	16,996	4,035	15,761
Colour Continuous Printing	13,597	14,852	27,828	22,501
B&W Contact Transparency	794	310	345	1.011
Colour Contact Transparency	1,271	417	1,266	2,087
B&W Dupe Negatives	85	2	333	1,632
Colour Dupe Negatives	1		19	167
B&W Enlarging	26	142	86	480
Colour Enlarging	75	112	317	462
B&W Film Processing	21,729	17,454	20,326	28,010
Colour Film Processing	21,647	19,509	30,837	41,683
Total Products	90,201	73,622	99,573	125,278
% of Unit Workload	7.7	6.9	11.1	16.6

* Annual figures are a projection from twelve of thirteen CPC production periods.

APPENDIX B

ISIS LTD.

LANDSAT PRODUCTION

April 1st 1977 - February 28th 1978

PRODUCT		QUANTITY
B & W	Contact Prints	9,548
Color	Contact Prints	784
B & W	Transparencies	878
Color	Transparencies	405
B & W	Dupe Negatives	24
B & W	70 mm Pos. Transparencies	698
Color	Dupe Negatives	--
B & W	Enlargements	408
Color	Enlargements	246
		12,991
NOAA	Prints	1,059
Computor Compatible Tapes		86
Special Custom Prints		13
Total Landsat Products		14,149
Facimile Transmissions		4 months
Isisfiche		195 months

5.12 REPORT OF THE WATER RESOURCES WORKING GROUP

5.12.1 AIRBORNE REMOTE SENSING

In Alberta comparative lake-bed contour maps of Obed Lake made by conventional hydrographic sounding techniques and by photogrammetric means using the analytical plotter at the University of New Brunswick showed that the traditional hydrographic methods could be in error by as much as 33%.

In Saskatchewan three airborne studies were reported the Saskatchewan Research Council monitored pollution from potash mining and tailing ponds; Ducks Unlimited studied wildlife habitat in the Pasquia Hills; and Canadian Wildlife Service monitored seasonal changes of sloughs in their studies of migratory birds.

In Ontario the Ministry of the Environment and the Ontario Centre for Remote Sensing (OCRS) together undertook a developmental program to delineate bio-mass (potamogeton) distribution and quantity in rivers. Kodak water-penetrating film and colour photography were used in overflights at different altitudes in the Grand River Watershed. The preliminary results are encouraging. The OCRS capabilities are also being used in re-evaluating the colour photography flown for the IFYGL to delineate cladophora in Lake Ontario. In addition overflights, using the daedalus line scanner were continued in Lake Huron for the delineation of thermal plumes from nuclear generating plants. Recently developed CFSR process (digital colour processing) was used as an output from the line scanner data. This program is in the developmental stage for surveillance planning as well as an eventual surveyance tool to assess compliance to government regulations.

The Atmospheric Environment Service, Airborne Radiation Thermometer (ART) flights are being continued over the Great Lakes and are probably now considered "operational". They are being used as ground data for initial investigations of the use of satellite IR imagery (particularly NOAA-5) to determine absolute lake surface temperatures. Problems still exist in adjusting for the effect of atmospheric attenuation. In the Niagara fruit belt AES has also used the daedalus line scanning radiometer at altitudes of 600, 2,000 and 5,000 metres to examine the feasibility of using thermal imagery to define frost prone zones during spring radiation frost conditions. Zones of different temperature were definable for the purpose for identifying frost prone areas to delineate future areas for growing grapes.

The Inland Waters Directorate of Department of Fisheries and the Environment has initiated a gamma ray survey of the Lake Superior Drainage Basin. The results of this will be used to improve the inflow estimates to Lake Superior for the regulation of that lake and also in the six month predictions of Great Lakes Water Levels. While still considered a research project it is anticipated that it will be made "operational" on a lake by lake procedure if warranted. Under contract, Northway Surveys flew the basin in November 1977 for the pre-snow condition and will fly it in February or March for the snow cover condition. Ground data are being collected by the Water Survey of Canada, Glaciology Division, and the U.S. Army Corps of Engineers during the week prior to the first airborne survey and for the late winter flight. Initial data compilation and analysis will be done by Northway Surveys and the gamma counts to water content relation will be done by the Snow and Hydrology and Instrumentation Section of the Glaciology Division. The cost of the project is approximately $40,000 per year.

In Quebec a balloon platform was used with a multi-spectral camera over the Lac Saint Jean area and over the Île d'Orleans. In the Lac Saint Jean area the University of Quebec studied currents and also found that the discharge of uria could affect fish 10 miles away. The Groundwater Service used the photos of 1'Île d'Orleans to see if they could indicate groundwater phenomena. Photos have been placed on the multi-spectral synthesizer but to date no positive results have been obtained. This work done by the Groundwater Service using photos taken by the Remote Sensing and Cartography Service of the Quebec Ministry of Lands and Forests in cooperation with CCRS.

The University of Sherbrooke applied thermography to hydrology for the study of the currents of the river Magog at Sherbrooke.

5.12.2 SPACEBORNE REMOTE SENSING

In British Columbia NOAA VHR Satellite Imagery is being used for snow cover delineation. Operational needs for flood control and hydro electric power generation require data relay networks to provide true time observations and since network stations are widely scattered, particularly in the North, and communications with them are very difficult workers continually emphasize the need for hydrometric networks to use DCP's and relay the information by satellite.

In Alberta where automated

hydrometeorologic telemetry network is being developed one DCP is being tested for a six month period with water quality and precipitation monitoring stations using the Anik C satellite.

In Saskatchewan Remote Sensing funds are very limited and to date the greatest use of satellite images have been in wildlife habitat studies.

In Ontario digital landsat imagery has been successfully used in the Lake Superior Basin for delineating pulp mill effluent plumes greater than four kilometres in extent. Density slicing of the LANDSAT imagery was first used to separate the effluent plumes from the turbidity patterns. This is part of a developmental program leading to an eventual "operational" surveyance program.

In Quebec the Department of Environment has initiated a diversified program of remote sensing ranging from snow cover to waste water effects on salmon. The data transmission program using data collection platforms is continuing and 20 stations will probably be "operational" by the summer of 1978, most of them in the northern part of Quebec. Presently the data collection platforms are transmitting wind, temperature, precipitation and humidity data.

Under the aegis of the Eastern Snow Conference a schedule of collecting field data at the time of LANDSAT passes has been undertaken, in the Saint Jean River Basin. Some work has been done on snow cover using LANDSAT imagery and the imagery is being used to provide physiographic data for input to models.

University of Laval has developed an information system for analysing the characteristics of lakes both quantitative and qualitative parameters some of which might have interesting hydrological applications.

INRS-Eau is studying the dynamics of lac Saint Jean using LANDSAT images and are starting to use LANDSAT images to verify and complete the physiographic data extracted from maps for input to the CEQUEAU a hydrological model. They are also interested in the possibilities offered by NOAA imagery for studying snowmelt snow cover and particularly the retreat of the snow pack.

5.12.3 TECHNICAL DEVELOPMENTS

Atmospheric Environment Service is continuing tests at the Woodbridge Experimental Station of a portable gamma spectrometer to determine snow water equivalent. Temperature fluctuations appear to cause variations in the spectrometer readings; continuous calibration checks would be required to minimize the problem. More extensive testing of the instrument in comparison with other ground based measurements is being conducted during the winter 1977/78. AES announced that they expected to be receiving and processing GOES East imagery by the fall of 1978. Three sectors will initially be available: one for research and development; the other two for weather offices, and only GOES East data will be received. A second station to receive GOES West data is being actively considered and it is hoped to expand to 6 sectors from the present 3. Images will be received every half hour.

The general reduction in funds available for contracts and research has had a retarding effect on technical developments both in industry and the government. One company reported that despite expressed interest from a number of agencies no contracts were obtained during the year for research and development related to water resources. To compound the problem the submission of proposals is costly and when there is no positive return the result is a major erosion of capital and consequent reduction in in-house research and development. Under these conditions it might be more productive to shift the emphasis in remote sensing from the high cost technology area to the lower cost area of developing applications for the known technologies.

5.12.4 APPLICATIONS

In B.C. snow cover mapping by means of satellite imagery is still being conducted during the snow melt runoff season by the U.S. National Environmental Satellite Service (NESS) and the analyses are in good agreement with data from other sources. Snow lines have been monitored by B.C. Hydro for 20 drainages in British Columbia since 1969 on a daily basis with verification by aircraft flights twice annually for each drainage basin. B.C. Hydro has also established records of average daily precipitation for 20 drainage basins in British Columbia using a runoff simulation model and hopes that these will be of use as comparative data in the estimation of areal precipitation from satellite imagery.

During the summer of 1977 a pilot project was undertaken in Alberta to provide precipitation data for operational flood forecasting using the weather radar of the Alberta Research Council at Penhold.

AES is in the process of ordering Bristol Aerospace Automatic Meteorolo-

gical Stations that will transmit the data via GOES East. The Stations will be installed at Cape St. James, Rosespit, Lake Eon, Caribou Island and Ice Island T-3 during 1978. Although the antenna at AES is capable of receiving data, initially a system to process DCP data will not be available and data will be via Washington. The stations will be measuring wind speed and direction, temperature, humidity, pressure and precipitation.

Gregory Geosciences reported that Northwatch, the small scale snow and ice cover mapping project completed its third full season of about 8 months with the principal support of CWS, DINA and GSC, and minor support by industrial subscriptions. The snowmelt forecasting model was refined using data for degree days above melting and snow thickness at meteorological stations. Seasonal changes were predicted with an accuracy of ± 2 days in general although larger local errors were experienced because of sudden meteorological disturbances, such as snow storms. A paper reviewing the three full seasons of Northwatch at the observed seasonal changes has been prepared for publication. A postdoctoral fellow, Dr. B. Dey, a climatologist, is working on several studies directed to increasing the time frame over which the forecast of break-up in the Mackenzie River can be made with acceptable accuracy. He is working on the relationship between the movements of ice flows and weather systems and on the relationship between snowline and weather systems.

Gregory Geosciences noted a general decline in research into the practical applications of remote sensing related to water resources and interpret this to mean that in times of budget constraint priorities for work are being assigned to areas other than remote sensing which implies a lack of confidence in the potential of remote sensing which they believe to result from past emphasis on digital processing and technology. They also point out that many operational objectives may be achieved through visual interpretation of remote sensing, particularly LANDSAT and NOAA. For example, a discontinued research project has tentatively established a high correlation between spring runoff and certain indices visually interpreted from LANDSAT data. In combination with selected meteorological data this work could lead to flood prediction with a long lead time. It is hoped to develop this to the stage where an unsolicited proposal could be prepared, however, there is little incentive to make the investment under present conditions. They conclude that it seems essential that research and development related to applications of remote sensing should be completely reoriented to focus on really practical missions. Such missions require further definition and demonstration projects and will require funding but they are also relatively simple and many can be solved by visual analysis of photographic products. Photographic products are more widely used than digital data and thus warrant a major effort to improve their technical quality. This also will require funding and in time of budget constraints implies a redirection of effort if the marketing of remote sensing is to successfully achieve the essential requirements of consumer acceptability and technical quality of the product and at the same time keep the cost of the product within consumer budgets. In Quebec the Hydrometric and Meteorological Services are establishing a system of collecting hydrometric and meteorologic data in remote regions via the GOES satellite. Six stations are actually in operation, five in Northern Quebec and one in the Lac Saint Jean area, three of these stations are mixed hydrometric and meteorologic and three are hydrometric only. Eight others, mostly hydrometric only, are being installed during the course of the winter in tributary basins in Lac Saint Jean. Five more will be installed in south west Quebec including three mixed stations and one mixed station will be installed in Gaspe for operation in the Spring. A meteorologic station is being installed at Duchesney near Quebec during the winter for research and testing of various instruments for measuring the snow cover precipitation temperature, wind etc. Five other stations are planned for the forest south of the 50 parallel for use by the Forest Protection Service for fire protection. These stations will transmit temperature, precipitation, wind speed and direction and humidity. If this project is successful it is expected to increase this to 25 stations during the next few years.

5.12.5 BENEFIT ANALYSIS

No studies are known of but the gamma ray survey in the Lake Superior Basin is expected to provide information for future benefit analysis.

5.12.6 USER LIAISON

User liaison was continued by holding one Working Group meeting as an information meeting open to anyone interested. This years meeting was in Halifax.

5.12.7 TRAINING

Nova Scotia Remote Sensing Committee hopes to sponsor a series of seminars, open to the public, that would bring experts in particular areas of remote sensing to the Maritime area. Seminars would be every six to

to eight weeks and be hosted by various member agencies.

5.12.8 CONCLUSION AND FORECAST

The former Working Groups on Hydrology and Limnology have been combined in the new Water Resources Working Group whose terms of reference are similar to the previous ones except that they relate to water resources and put more emphasis on the encouragement or initiation of special courses and organizing seminars on remote sensing as applied to water resource problems.

As has been mentioned in previous reports snow water equivalent and soil moisture continue to be the two greatest needs in the field of hydrology. At present some snow cover projects are considered "operational". In discussions during the year and in preparing this report the term "operational" was used quite freely but we realize that it means different things to different people. As we progress this term is becoming used more and more and we feel that there needs to be a definition of "operational" for use within CACRS and CCRS so that all working groups can report on the same basis.

It is obvious from the reports received that there is a great interest in snow investigations as a step to snow water content and that most of the work being done in this area is done from visual images rather than from digital data. It is also obvious from the comments that many agencies are hampered by the lack of adequate hydrometeorological observation networks particularly in remote areas and areas where access is extremely difficult and as noted above while there is a considerable move towards the use of data relay platforms by several agencies in Canada there is still a need for more. Another example of the need for redirection of effort?

One of the most used remote sensing tools for snow cover is NOAA Imagery as it has proven to be the only imagery to produce operational information twice daily, however, water resources personnel are confused on how to get this data. There is a need for a clear definitive statement from CCRS on the acquisition of NOAA imagery from ISIS. It should explain whether ISIS is obtaining all NOAA data and archiving it or whether they are only receiving selected regions to fill current orders. AES has a capability of supplying this material and their policy is still changing but apparently if an agency has ordered imagery from ISIS and has not received any or is unable to receive a particular region from them then the agency may request it from AES at a cost similar to that charge by ISIS. The important point is that the agency must be able to show that it tried ISIS first but without success.

AES reports that over 12 SURSAT proposals have been submitted through the AES SURSAT committee for consideration by the SURSAT project office. About half of the proposals are directed towards ice investigations, e.g. ice thickness, ice roughness, ice forecasting. Projects to study wave heights, sea state, sea temperature and over water wind are also proposed. Three projects to study snow cover properties have been submitted. Two relate to the feasibility of mapping the snowline in areas where there is the problem of determining snow cover under forested and cloud cover conditions. The third is to examine feasibility of determining seasonal snow cover properties and their variation in relation to the basin land use in Cold Creek Basin in Southern Ontario. All of the above intend to use SEASAT-SAAR imagery; the latter also proposes comparison with VHRR, LANDSAT and SAR-580 imagery. Intensive co-incident ground data gathering would be conducted for the proposed Cold Creek project. If sufficient snow investigations are proposed and accepted it might prove worth while for the Water Resources Working Group to act as a point of contact for investigators performing various snow investigations in different parts of the country. It could act as a quick information exchange centre and this would be a logical extension of the cooperation and coordination achieved by the Hydrology Working Group of the WMO Snow Survey by Satellite project.

There is a general feeling that there is a need for development of cheaper equipment to do nearly the same work as present sophisticated apparatus. Perhaps this develops from the much greater use of visual images rather than digital hardware in the field of water resources and some concern has been expressed that the optical projection aspect of satellite imagery is not being stressed while much emphasis is being placed on the digital mode. Most of the close to "operational" programs used the visual capacity rather than the digital and it is much easier to input other parameters such as overlays into optical projection. Presently raw data images are being used as a standard product and some people feel that they are worse now then when LANDSAT started. There is need for more research into what can be done to improve images such as haze removal, stretch image removal, better definition, good contrast range and more attention to quality control and the consistency of quality control.

The Working Group felt that

in their field digital methods will never be as popular as visual because of the requirements for complex hardware and software and if the user demand is in visual imagery then it seems obvious that a better product on the market will attract more users.

It seems clear that for some time to come the predominant use of remote sensing in water resources work will be through the use of visual interpretation of images using comparatively simple hardware and that the use of digital methods and the more sophisticated expensive hardware will remain with a few advanced centres. These centres with the sophisticated instrumentation and specialized expertise will probably find the pressure increasing to provide services of a specialized nature on a national basis.

5.12.9 RECOMMENDATIONS

The Water Resources Working Group recommends that CCRS concentrate more of its effort in the area of visual image interpretation by:

(i) a continuing high level of effort in the quality and consistency of image reproduction - a better product will attract more users:
(ii) development of photo interpretative aids and techniques - in house by contract, and by unsollicited proposals:
(iii) initiation and/or support of demonstration projects and educational workshops, courses, etc. - the more people aware of and able to make greater use of a product the better the market.

The Water Resources Working Group also recommends that a definition of "operational" suitable to CACRS and CCRS be prepared and used by all Working Groups.

5.12.10 APPENDICES

5.12.11 APPENDIX 1 - CURRENT BIBLIOGRAPHY

The following are those items submitted by Working Group Members in their reports and is not an attempt to give a complete bibliography for the current year.

Bricker, C., Bibliography of Remote Sensing in Alberta, Alberta Remote Sensing Centre; 11th Floor, 9820-106 Street, Edmonton, Alberta, T5K 2J6

Dey, B., Moore, H., Gregory, A.F., The Use of Satellite Imagery for Monitoring Break-up on the Mackenzie River, N.W.T. Arctic, vol. 30(4), December 1977.

Ferguson, H.L., Lapczak, S., 4th Canadian Hydrology Symposium, Quebec City: Satellite Imagery Analysis of Snow Cover in the Saint John and Souris River Basins

Whiting, J., The Effect of groundwater inflow on evaporation from a saline lake; preprint 2nd conference on hydrometeorology October 25-27, 1977, Toronto, published by American Meteorological Society, Boston, Massachusetts.

5.12.10.2 APPENDIX 2 - LIST OF GROUP MEMBERS

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6.1 REPORT OF THE ALBERTA REPRESENTATIVE

6.1.1 Airborne Remote Sensing

In 1977, twenty-five requests for airborne remote sensing flights in Alberta were submitted to Airborne Operations, Canada Centre for Remote Sensing. Twenty-four of the flights were completed.

The 1977 Alberta Airborne Program was, as in past years, coordinated by the Alberta Remote Sensing Center. The Center's staff provided assistance and advice to requestors in the selection of airborne sensors, flight planning and cost calculations for projects. As well, liaison was maintained among requestor, airborne operations and the flight crews when flights were being carried out.

This type of coordinated program, carried out in Alberta for a number of years, has proven advantageous to all agencies concerned.

6.1.2 Spaceborne Remote Sensing

There was an increased use in the Alberta Remote Sensing Center's Landsat facilities, which provide for mail, telephone, or in-person viewing and ordering of imagery. Daily acquired Canadian scenes may be viewed and selected from the Landsat catalogue, catalogue updates and Integrated Satellite Information Services (ISIS) isisfiche received daily for each satellite.

The Center also uses a terminal and dedicated line to CCRS's RESORS for imagery selection. A Landsat prime scene index of Alberta, with updates, is distributed through the Newsletter. Landsat black and white contact prints and transparencies of all Alberta as well as multidate and multiband including C1 and C2, of selected scenes are held in the library for user viewing and analysis. Paper prints are being phased out in favor of transparencies.

6.1.3 Alberta Remote Sensing Center

The Alberta Remote Sensing Center's facilities are free of charge to anyone in the province - provincial government, federal government, educational institutions, private industry, and the interested private citizen.

The Center assists provincial users in the acquisition, application, and analysis of remote sensing in the survey and management of the Alberta environment. The Center has specialized analysis equipment and offers staff assistance in its operation. A technical library and document retrieval system is available.

The Alberta Remote Sensing Center is located at:

11th Floor, Oxbridge Place
9820 - 106 Street
Edmonton, Alberta T5K 2J6
(403)427-2381

It's facilities are available for meetings such as those held in the Center in 1977 by the Working Group on Agriculture and Working Group on Geoscience.

6.1.4 Training

The Alberta Remote Sensing Center in cooperation with the Faculty of Extension, University of Alberta, conducted the Sixth Alberta Remote Sensing Course. It was oversubscribed with participants from across Canada.

Instruction was provided by University of California scientists headed by Professor R. N. Colwell, CCRS scientists headed by Mr. E. A. Godby, and Canadian scientists from educational institutions, government, and private industry.

The Canada Centre for Remote Sensing provided excellent support.

A number of workshops and briefings in various aspects of remote sensing were held in the province during 1977. Courses in remote sensing were conducted at many educational institutions. Particulars may be obtained from the Alberta Remote Sensing Center.

6.1.5 Special Projects

Information concerning projects carried out in Alberta may be obtained from the Alberta Remote Sensing Center. Also available is a "Specialists Involved in Remote Sensing in Alberta" publication.

6.1.6 Conclusions

There was an increase in the use and interest in remote sensing.

6.1.7 Appendix I

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6.2.1 REPORT OF THE BRITISH COLUMBIA REPRESENTATIVE

6.2.1 AIRBORNE REMOTE SENSING

Twelve projects were requested and flown by CCRS consisting of 1717 nautical miles. Several of these projects involved thermal imagery as the primary sensor, including one project of over 800 nautical line miles.

6.2.2 SPACEBORNE REMOTE SENSING

There is only a slowly growing interest in satellite imagery. In spite of the fact that the Forest Management Institute (Pacific Region) in Victoria is able to communicate directly with the CCRS computer most users are hampered by the inconvenience of trying to find out what is available. There is a need for an accessible set of ISIS Fiche in Victoria and Vancouver to determine whether an image may be cloud free and of use in the project area. Due to the topographic variation in BC, cloud cover varies over very short distances.

6.2.3 TECHNICAL DEVELOPMENTS

Sebachrome prints can now be made from the colour additive viewer in the faculty of Forestry at UBC. Access to the CCRS RESORS IV and IISS programmes is undertaken on a daily basis through the Victoria office of the Forest Management Institute.

6.2.4 APPLICATIONS

Many of the applications listed in last years report are ongoing, and several similar projects have been begun. A new project of interest is the work being done by BC Hydro with thermal imagery of Greater Vancouver to map heat energy wastage from domestic dwellings.

6.2.5 USER LIAISON

This is still minimal. There is a definite need for an official representative in this province to work full time in remote sensing coordination to let users throughout the province know what is available in airborne and satellite imagery; and also to keep up with the work being done by various individuals and agencies.

The Province has created a task force under the chairmanship of Dr. A.N. Boydell to look into the provincial use of remote sensing.

6.2.6 Miss C.M. Redmond
Resource Analysis Branch
Ministry of the Environment
Parliament Buildings
Victoria, B.C.
V8V 1X4

6.3 REPORT FROM THE MANITOBA PROVINCIAL REPRESENTATIVE

6.3.1 AIRBORNE REMOTE SENSING

During 1977 there were seven requests submitted through the Manitoba Remote Sensing Centre for Airborne Remote Sensing Projects. The total estimated line miles for these projects was 585. Success was realized on 3 projects with a resulting 350 line miles completed. One request was cancelled due to costs and the other three due to the time restrictions that the users placed on their projects. For the second time in the last three years, Manitoba weather was poor during the flying season. May was the only month which could be considered good. This factor combined with aircraft unavailability resulted in the over runs on the three time bounded requests. With the recent budget restrictions applied by the new government, re-submission plans have not yet been formulated at this time.

The three projects completed are as follows:

1) Use of colour and colour IR photography to support data acquisition in relation to an aerial crop information system.

2) Use of remote sensing imagery in mapping pleistocene geology in the Dauphin area of Manitoba.

3) Use of multispectral imagery for detection of radiation damage in the experimental area of Lac du Bonnet. This was the 4th year of this rather intensive study.

The Centre's 70 mm camera system received requests from some 29 agencies requiring over 7,000 line miles of imagery. Unfortunately, having been plagued with weather problems, particularly during late July and most of August, only 4,830 were completed. Principle users this year were:

Department of Municipal Affairs - Municipal Planning
Dept. of Renewable Resources - Surveys and Mapping;
- Forest Management;
Dept. of Agriculture - Agricultural Crown Lands:
Dept. of Mines, Resources & Environmental Management - Sand and Gravel Evaluation;
- Water Resources
Dept. of Tourism, Recreation & Cultural Affairs - Parks Branch

Additional equipment and aircraft modifications made this year now allow the system to operate:

1) As two separate cameras in two aircraft.
2) As a dual or tri-camera package.
3) With a closed circuit television camera system used primarily for navigation; however, video recording may be obtained when required.

Most of this equipment was introduced late in the season and the Centre has received few requests for its use. However, with some publicity through the Centre's newsletter, we foresee considerable demand for these packages in the near future.

6.3.2 SPACEBORNE REMOTE SENSING

The Centre once more maintained its subscription to Isisfiche. This system is particularly useful to the Centre in providing information of Landsat imagery availability. Usage of the Centre's search facilities has increased in this area now that the Centre is functioning so closely with the University of Winnipeg's Remote Sensing courses. Students enroled within this field of study are required to complete various remote sensing projects and many turn to Landsat coverage as their basic imagery package.

Past conventional users are still returning to this information source and orders for imagery have increased.

The Centre's newly acquired Transfer Scope has opened doors, particularly in map updating, to various cartographic areas. This discipline area requires current imagery in order to produce the most beneficial update information.

6.3.3 TECHNICAL DEVELOPMENTS AND NEW EQUIPMENT

This year the Manitoba Centre acquired a Bausch and Lomb ZT4-H Zoom Transfer Scope. This instrument combined with the Centre's existing Zeiss - Jena Interpretscope have formed an instrument package permitting the highest degree of interpretation accuracy and versatility for resource-type mapping. Information transfers, at ratios of up to 14 to 1 can now be easily accomplished. On its own, the Transfer Scope has greatly increased the applications for information

transfer from Landsat imagery. Capable of handling either print or transparency material, and enlarging the same up to 7 times, 1:1,000,000 original information may be directly transferred to a broad range of existing map bases.

The Manitoba Remote Sensing Centre is also pleased to announce the addition of a new staff member, Miss Sue-Ann Weselake. Sue-Ann now brings our staff total to four. A recent University of Winnipeg Bachelor of Arts graduate, majoring in Geography as well as having a background in library operations, Sue has quickly whipped our RESORS Technical Information Service into shape and has taken on the responsibilities of editor for the Centre's newsletter.

The Centre's operations staff, Mr. Roy Dixon and Mr. Robert Douglas, were given training on and had a later opportunity to operate an AGA Thermovision 750 Thermal Scanner. This program was conducted through the department's Forest Protection Group. Although the instrument was hoped to be effective with many prospective applications, budget conditions at this time have prevented its purchase. Future considerations are still prevailing and hopes for the acquisition of such an instrument in the near future are still high.

The University of Manitoba, Soils Science Department, purchased, on the recommendations from the provincial and the federal Remote Sensing Centres, a Petite Ballon Rouge this past summer. Though not established with the Manitoba Centre, tentative arrangements have been made with the University to rent this platform and several test projects are planned for this coming season.

Discussions are now being carried out with Manitoba Data Services, a division of the Manitoba Telephone System, to acquire a portable Access terminal for direct communication from the Centre to the RESORS computer in Ottawa. Once more hopes are high for adding this facility to the Centre's overall capabilities.

6.3.4 USER LIAISON

The Manitoba Remote Sensing Centre continued to maintain its existing interpretation equipment and to offer these facilities at no charge to users. However, the 70 mm camera program has been restricted to use by government agencies and operates on a cost less salaries recovery system.

With the addition of staff, and the completion of a formal computerized mailing list, the Centre has gone into a quarterly newsletter with some 750 regular recipients. Subscriptions are free for the asking by contacting Sue-Ann Weselake (204) 633-9543 Ext. 229.

This past year the Centre serviced over 1200 patrons. Requests were of a four format nature ranging from general information and aerial coverage requests to technical advice and project assistance. Also 1977 provided what we feel was a major breakthrough for our staff. For the first time research projects and practical applications were performed by the Centre to fulfill requirements of various disciplines which in the past could not investigate, through lack of expertise or funding, their own techniques.

6.3.5 TRAINING

During the past year in conjunction with the University of Winnipeg the Centre conducted a one day seminar on Remote Sensing Sensor Packages and Platforms. Speakers were invited from Ducks Unlimited (Canada) Limited, Canada Centre for Remote Sensing, Manitoba Remote Sensing Centre, University of Winnipeg, Resource Programs Research and Development, as well as Prairie AgriPhotc Ltd.

Two private in shop sessions on the Petite Ballon Rouge studies were given to the Department of Agriculture University of Manitoba.

Through a co-operative interaction program set up by the University of Winnipeg, the centre gives group tours and training to students enroled in advanced Remote Sensing courses. The Centre handles approximately 100 students per year on this basis.

Policy has been established within the Centre that any group requiring educational seminars on Remote Sensing for their discipline may request them through the University of Manitoba's Continuing Education Division. We welcome the opportunity to set up and conduct seminars throughout the year.

6.3.6 CONCLUSION AND FORECAST

The overall facilities and services of the Manitoba Remote Sensing Centre have been used at approximately the same level by interested patrons. However, with increased staff and streamlined systems in shop responsibilities have taken a shift to user development techniques on a practical basis. The results of this shift are as yet to be felt, however, even a conservative estimate would have to include increases in the near future. Through program adjustments in broad service areas such as the establishment of the Centre as the aerial photography coverage information source, the RESORS contact centre and via increased publicity in our Newsletter, we foresee ourselves playing an extremely active and important role on a continuing basis.

6.4 REPORT OF THE NEW BRUNSWICK PROVINCIAL REPRESENTATIVE

6.4.1 Airborne Remote Sensing

Three requests for imagery were submitted to C.C.R.S.; one was a military project and the other two were part of a continuing program of the Provincial Department of Agriculture and Rural Development concerning the potato industry. A complete set of good imagery was obtained for the first time in the life of the program, so a comprehensive analysis of the data will be done in the near future.

The coverage of the Province with conventional black and white aerial photos was completed in spite of unsatisfactory weather, with the result that the programs of photo interpretation and preparation of forest type maps, at a scale of 1:20,000, are progressing satisfactorily.

6.4.2 Spaceborne Remote Sensing

User interest in LANDSAT imagery has not been as great as in past years although some projects are continuing. The program for the assessment of snow cover and snow melt in the St. John River Basin is on an operational basis and is using imagery from the NOAA, GEOS and LANDSAT satellites.

6.4.3 Technical Developments

A member of the faculty of Survey Engineering at the University of New Brunswick is continuing a study on the geometric aspects of Infra-red scanner and SLAR imagery.

Consideration is being given to installing facilities to obtain the imagery required for the snow cover program on a real time basis so the interpretation can be done locally.

6.4.4 Applications

The St. John River Basin snow-cover project is on an operational basis and has produced useful data for run-off and flood forecasting through a series of maps showing the extent and persistence of snow-cover over the spring season.

The New Brunswick Department of Agriculture potato project is expected to be operational if the analysis of this year's data is satisfactory. The items being studied include crop acreage, crop development and monitoring for diseases.

6.4.6 User Liaison

User liaison continues on a low key, request basis.

6.4.10.1 Appendix I - Current Projects

The interpretation of conventional black and white aerial photography continues to be the most common use of RS imagery. The forest fire fuel mapping project mentioned last year is presently dormant but the mapping of areas that are non-susceptible to spruce budworm attack has continued, using all types of data.

6.4.10.2 Appendix II - Current Bibliography

Schneider, S.R., 1977. Operational Satellite Assessment of Snow-cover and River Ice in the Saint John Basin. Prepared in support of the World Meteorological Organization/ World Weather Watch/Saint John Basin Pilot Project.

6.5 REPORT OF THE PROVINCE OF NEWFOUNDLAND, 1977

6.5.1 AIRBORNE REMOTE SENSING

During 1977, airborne programs were carried out over both land and sea by the various agencies involved in remote sensing in the province. The Newfoundland Forest Service continued its ongoing forest inventory program and acquired 1:12,500 scale colour aerial photography collecting approximately 22,000 line kilometers in central Newfoundland. The Agriculture department continued with its program to produce agriculture capability maps by collecting 1:50,000 scale black and white aerial photographs.

The Centre for Cold Ocean Resources Engineering (C-CORE) carried on an active program in airborne remote sensing using aircraft, and helicopter platforms. These programs were involved with the collection of photographic data, synthetic aperture radar imagery and impulse radar data.

6.5.2 SPACEBORNE REMOTE SENSING

Newfoundland Ocean Research and Development Company (NORDCO) received a contract to operate the new Shoe Cove Receiving Station. This involves the receipt of LANDSAT and NOAA data. Subsequently, NORDCO has become involved with the SEASAT A development program being carried out at Shoe Cove.

C-CORE through a subcontract from NORDCO is involved with a user oriented satellite applications project geared towards the involvement of Atlantic Region agencies in the use of data available from Shoe Cove. The program is centered about the collection of data concerning sea surface temperature, sea ice distribution and iceberg/ship identification.

The Ocean Engineering Information Centre, Memorial University is maintaining its standing subscription of LANDSAT-FICHE and selected LANDSAT and NOAA imagery.

6.5.3 TECHNICAL DEVELOPMENTS

C-CORE's undertaking of Project SAR 77 to obtain synthetic aperture radar (SAR) imagery and digital tapes of sea ice and icebergs off the coast of Newfoundland and Labrador using the Environmental Research Institute of Michigan four channel X and L-band radar has allowed the study of imagery of this type in advance of the SURSAT program. The data set is available to interested users through Henry Hengeveld of AES or Richard D. Worsfold of C-CORE and Field Data Reports detailing the surface verification information have been published.

C-CORE has carried out the successful sounding of an iceberg for keel depth using an impulse radar system. Results agreed with simultaneously collected side scan sonar data. The development of this technique to determine iceberg shape is presently being carried out by C-CORE.

The Provincial Department of Forestry and Agriculture has set up a photographic facility for the processing and printing of black and white aerial photography and the printing of colour aerial photography. The facility is expected to be fully operational by 1 April 1978. The facility is designed to service all provincial departments and any individual agency on a cost basis comparable to the National Air Photo Library. With the addition of this capability, the transfer of all provincial photography stored in NAPL Ottawa is taking place. Within the next year almost all photography taken in the province will be available in Newfoundland for use by government departments, commercial concerns, educational concerns and private individuals.

6.5.4 APPLICATION AND BENEFIT ANALYSIS

A brief summary of 1977 projects carried out by various agencies follows:

6.5.4.1 Agriculture

The soil survey program to produce agriculture capability maps was continued in 1977. This program is carried out using black and white photography at a scale of 1:50,000. Field work is ongoing in certain areas. A more detailed land use study using colour aerial photography at a scale of 1:12,500 is now underway.

6.5.4.2 Forestry - Provincial

The ongoing forest inventory was carried out in 1977 and will continue through 1978. Colour photographs at a scale of 1:12,500 were obtained over central Newfoundland. A special project using colour infrared was attempted but beset with technical difficulties. It is hoped this project can be repeated in 1978.

6.5.4.3 Forestry - Federal

This agency completed two projects in 1977. The first program was a Regeneration Problem Site Assessment involving the use of color infrared program. The purpose was to determine problem areas; areas of overstock and areas of understock forest resources. The program was carried out on behalf of the Provincial Government. The second was a habitat study concerning the snowshoe hare population in a selected area of the Cape Breton Highlands in relation to a Lynx study being carried out by the Canadian Wildlife Service. This involves a detailed analysis of black and white photography.

6.5.4.4 Department of Fisheries and Environment - Lands Directorate

This agency completed in 1977 a LANDSAT analysis of the biophysical provinces of Labrador. The continuation of this study has been directed at a 1:12,500 scale Land System analysis of Groswater Bay - Cape Harrison area using black and white aerial photography to carry out a more detailed analysis of certain areas of the LANDSAT interpretation. This region was chosen because of its importance as a potential port site called Port Labrador.

6.5.4.5 C-CORE

C-CORE carried out several remote sensing programs during 1977. The major program was Project SAR 77. This program involved the analysis of synthetic aperture radar data from the system that will be installed on the CCRS Convair 580 in 1978. Preliminary analysis is almost complete and detailed analysis will be carried out on iceberg backscatter, sea ice return and characteristic backscatter, ocean waves passing through unconsolidated sea ice and their attenuation, and digital computer analysis of certain well defined targets and "poor man's" methods of digitally presenting this data.

A helium balloon program was aborted because of weather conditions and cannot be continued because of CCRS's loss of the balloon and decision not to procure another.

A microwave backscatter study is being carried out for the CCRS AMOP program. This is a theoretical study to determine radar backscatter characteristics for sea ice, open water and oil and the combinations of the three. Some analysis of SAR imagery will be carried out of specific sites to implement some of the recommendations made in the theoretical study.

The satellite applications project was commenced on October 17, 1977 and will continue to October 16, 1978. Phases I and II have been completed. This involved the development of the ability to read computer compatible tapes at C-CORE/Memorial University and the collection and understanding of all possible ground truthing sources. Phase III has commenced and it will involve the non-real time analysis of sea surface temperature, ice distribution and icebergs using LANDSAT and NOAA and the determination of what applications are most suitable to the real-time analysis that will be carried out in Phase IV. The purpose of the program is user application development and the transfer of this development to interested commercial users.

A preliminary study was carried out on behalf of Transportation Development Centre (TDC) to define a technique for the development of a sea ice thickness sensor. This is a new effort by TDC to develop an operational sensor for measuring sea ice thickness from helicopter and aircraft.

6.5.5 User Liaison

In 1976 user liaison was well established by the Newfoundland Remote Sensing Winter Works Project. Because there was no continuation of this program by any level of government the potential users returned to former positions. There was no program in 1977 to try and regroup the user community. The Ocean Engineering Information Centre at Memorial University has attempted to fill this vaccuum by providing minimum service to users. This support has continued but it has put a strain on the Centre's facilities.

6.5.6 TRAINING

The regular Remote Sensing course offered by the Engineering Department of Memorial, maintained its high level of enrollment.

C-CORE sponsored a "Radar Systems Course for Remote Sensing" in January 1977. Lectures were given by Dr.'s R.K. Moore and F. Ulaby of the University of Kansas. A second radar course was sponsored by C-CORE in January 1978. The course was entitled "Impulse Radar Principles and Applications" and lectures were given by R. Morey, Dr. P. Annan, L. Davis and Dr. J. Rossiter.

6.5.7 CONCLUSIONS AND FORECASTS

The remote sensing activity in Newfoundland and Labrador has greatly increased because of the involvement of NORDCO and C-CORE. As a consequence of this activity and the development of high technology in remote sensing within these organizations the time is appropriate for a technology transfer from this Provincial Crown Corporation and this non-profit research centre. This transfer will take the form of a commercial operation called REMOTEC APPLICATIONS INC. The company will be involved in all aspects of remote sensing and will concentrate its efforts on providing a service to companies and agencies that wish to use remote sensing in their operations and will enter into joint contractual bids; to provide a new dimension to normal operations and aid in improving data processing. REMOTEC will also concern itself with the development of systems, sensors and methodologies with the interest to turn them into a commercial service. The company will explore and develop new ideas that have the potential of industrial involvement and use. Also, the company sees a role in operating remote sensing facilities on a contractual basis.

With the technological transfer which is taking place between CCRS and industry and the potential increase in this transfer, the development of a commercial remote sensing operation servicing, especially Canada's East Coast and Arctic regions, is a favourable benefit to the region. This will provide the region with a remote sensing capability with the depth and experience that has not existed in this area before.

6.5.8 RECOMMENDATIONS

The following recommendations are submitted to CACRS from Newfoundland:

1) In light of commercial and educational developments in the province, Government support for major research and development projects directed to meeting user requirements in the fishery, offshore petroleum and shipping industries should continue and increase. Efforts in this direction to date have shown the potential of a viable remote sensing community in Newfoundland.

6.6 REPORT OF THE NOVA SCOTIA REMOTE SENSING COMMITTEE

6.6.1 Airborne Remote Sensing

Only three airborne remote sensing (RS) projects were carried out in the province this past year. Two were carried out by CCRS and one by Capital Air Surveys Ltd. The former involved flights in the Annapolis Valley and in Cape Breton. Comparisons of normal colour and colour IR were made along with an evaluation of thermal IR for forestry work. The latter project involved flying 40% of Cape Breton at a scale of 1 mile to the inch using colour IR to assess Spruce Budworm damage. All these projects were supported by the Nova Scotia Department of Lands and Forests.

6.6.2 Spaceborne Remote Sensing

The study by the federal Department of Energy, Mines and Resources of suspended sediment concentrations (SSC) in the Minas Basin area has established a highly correlated relationship between chromaticity and SSC which is capable of determining SSC to 18% accuracy from Landsat data. Studies are continuing to evaluate the universality of this fit by examining relationships found in other areas. Landsat High Gain data was of negligible effect on the SSC calibration.

Nova Scotia Department of Lands and Forests initiated an analysis of Landsat imagery in an attempt to evaluate its potential with respect to studies of the Spruce Budworm infestation in Cape Breton. Initial findings are that this imagery is not directly comparable to colour IR photography and needs to be interpreted in a different manner. The imagery however is proving more readily applicable to studies of cut overs, burns and road development.

6.6.3 Applications

The federal Department of Fisheries and Environment (Lands Directorate) is presently engaged in the thematic mapping of the coastal zone of Nova Scotia in the Northumberland Strait area. Maps on a scale of 1:250,000 will be available in the near future.

6.6.4 User Liaison

The lack of visibility of the committee to the general user or the public has to some extent restricted the development of RS in the province. To rectify this problem and to provide a stronger base of support the committee will be attempting to form a Nova Scotia Remote Sensing Society in the near future.

6.6.5 Training

The Nova Scotia Land Survey Institute (NSLSI) in Lawrencetown, Nova Scotia initiated a training program in the fall of 1977 for a photo interpretation/remote sensing technician. The two year study program received considerable interest but enrollment was restricted to nine. Mr. E.J. McLaren, formerly of CCRS, is one of the key staff members involved in the program.

The development of this program has been greatly assisted by the efforts of CCRS and their continued interest will insure the success of the program.

6.6.6 Conclusion and Forecast

This past year has seen some expansion of interest and work in the field of RS but with the submission of three proposals to the SURSAT program, the formation of a Nova Scotia Remote Sensing Society and the establishment of the program at NSLSI the coming year promises to promote much more RS activity in the region. This activity could also be bolstered by a decision to hold one of the annual meetings of the Canadian Remote Sensing Society in the region.

6.6.7 Recommendations

(1) Detailed flight maps of RS flights in the province should be forwarded to the provincial coordinators and (2) Minutes of specialty working group meetings should continue to be circulated to provincial coordinators.

6.6.8 List of Members

Mr. T. Alfoldi
CCRS

Ms. L. Baechler
NS Dept. of Environment

Mr. E. Bailey
NS Dept. of Lands and Forests

Mr. D. Dargi
DREE

Ms. J. Davidson
NS Dept. of Municipal Affairs

Mr. A. Daykin
Atlantic Air Survey Ltd.

Mr. G. Doyle
Canadian British Consultants

Mr. D. Keppie
NS Dept. of Mines

Mr. N. Lefler
Maritime Resource Management Service

Mr. E.J. McLaren
Nova Scotia Land Survey Institute

Ms. N.A. Prout
Dept. of Fisheries and Environment
Lands Directorate

Mr. P.E. Vandall, Jr.
Dept. of Fisheries and Environment
Bedford Institute of Oceanography

Mr. J.F. Wightman
Nova Scotia Land Survey Institute

6.7 REPORT FROM THE PROVINCE OF ONTARIO

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

No. of agencies contacted:		20
No. of replies:		10
Government:	4 of 4	
Universities:	1 of 6	
Industry:	5 of 10	

6.7.1 Airborne Remote Sensing

The Great Lakes Survey Unit, Water Resources Branch, of the Ministry of the Environment, had very little new aerial photography flown, but requested CCRS to fly monthly thermal sensing missions over a nuclear power plant outfall. Computer-compatible tapes of the analogue data were requested as well as processing in image format.

The Horticultural Research Institute of the Ministry of Agriculture and Food requested thermal and colour photographic coverage on two occasions, the line miles totalling 200 miles.

The Ministry of Transportation and Communications reports the use of aerial photography from federal and provincial government sources, and from private companies.

The Ontario Centre for Remote Sensing (OCRS) requested two thermographic missionsand four photographic missions, one specifying multi-spectral photography with twelve different film/filter combinations. Approximately 200 hours of supplementary aerial photographic missions were flown by the Centre itself. Extensive use was made of standard provincial photography and colour photography from CCRS.

Dr. J. Vlcek of the Faculty of Forestry and Landscape Architecture, University of Toronto, reports having applied thermal imagery to the assessment of the Environmental impact of a highway, and also to the study of the thermal properties of soil and vegetation (e.g., thermal response of vegetation to moisture stress).

Barringer Research Ltd. reported having conducted aerial survey photography. Gartner Lee Associates Ltd. reported having received about 2,000 prints of Ontario Government photography and 10,000 prints (1:40,000-scale) from the National Airphoto Library, as well as 1,000 prints from private companies. All of these photographs were panchromatic. Acres Consulting Services Ltd. derived approximately 10% of the black and white aerial photographs employed in their project work from CCRS, 40% from the Ontario Government, and the remainder from private sources.

6.7.2 Spaceborne Remote Sensing

The Great Lakes Survey Unit in the Ministry of the Environment reports the use of Landsat imagery in microfiche form for initial survey of coverage quality, then 9" x 9" prints or transparencies. Research is being done on the analysis of Landsat data in magnetic tape form for the detection of pollution plumes in water.

The OCRS made extensive use of Landsat imagery during 1977, purchasing coverage with a total cost of approximately $10,000, predominantly in the form of 70mm diapositive strips. Computer-compatible tapes of numerous images were acquired for specific research projects. The Centre continues to receive microfiche coverage on which to base image selection.

Barringer Research Ltd. employed Landsat imagery in the performance of contracts in Spain, Algeria and the Southwestern United States. Beak Consultants Ltd. reports having employed a small number of Landsat images for the observation of such features as forest cutovers and sedimentation in waterbodies.

6.7.3 Technical Developments

The OCRS is involved in numerous developments in its technical capability, including investigations in preparation for purchase of a digital analysis system compatible with the CCRS Image 100, and plans to establish a system for radar holographic interpretation. In 1977, the Centre installed a master terminal for receiving GOES weather satellite imagery, by means of a telephone link with the receiving station in Washington, D.C.

There have been several technical developments with regard to the Centre's SAP system (re-named RSAP - remote sensing airborne program). The design and production of an electronic control unit for the automatic adjustment of firing interval in multi-format and multi-lens photography neared completion. Improvements were made to mounts for the 70mm and 35mm camera systems, and work began to

adapt the U.S.-made Toler mount, providing motorized tip, tilt and crab control, for use with the OCRS systems. Comparative testing of exposure meters was initiated, and preparations were made to purchase 100-ft. film magazines for the Hasselblad systems.

Barringer Research Ltd. reported numerous developments in remote sensing instrumentation systems:

- improvements to the INPUT airborne electromagnetic prospecting system
- development of a 6-channel differential gamma ray spectrometer
- development of the VAPOURTRACE airborne geochemical exploration system
- conceptual studies into the development of a remote sensing gas filter correlation spectrometer (GASPEC) for measuring Halocarbons in the stratosphere from a satellite
- modification of an airborne laser fluorosensor built for CCRS
- a combined AIRTRACE-SURTRACE aerogeochemical test program for uranium exploration.

Moniteq Ltd. reports advances in the technology of the monitoring of atmospheric quality, such as the development of a multigas electro-optical pollution monitor.

6.7.4 Applications and Benefits

The Great Lakes Survey Unit (Ministry of the Environment) applied infrared scanner data to the mapping of thermal plumes off the Bruce Nuclear Power Development site on Lake Huron. Aerial photography obtained by CCRS in 1972 was evaluated for the preparation of a Cladophora monitoring strategy. Aerial photography was commissioned from the OCRS for the study of pulp and paper mill effluents. Research was initiated into the digital analysis of Landsat and digital thermographic data for the detection of waterborne plumes. The benefits reported are cost savings over alternative data collection technologies and greater efficiency in the planning of in situ sampling programs.

The Hydrology and Monitoring Section of the Water Resources Branch, Ministry of the Environment, conducted a developmental program in conjunction with the OCRS, to delineate biomass distribution and quantity in rivers by means of colour and water-penetrating photography, from various altitudes. The results are reported to be encouraging, but evaluation is as yet incomplete.

The Horticulture Research Institute (Ministry of Agriculture and Food) reported having found thermography coupled with false colour infrared photography to be potentially useful in the detection of frost pockets in agricultural lands in Southern Ontario.

The Ministry of Transportation and Communications applied the interpretation of aerial photography to the planning, design, construction and maintenance phases of its programs. This is a well-established technique with proven benefit to the Ministry. The applicability of thermal imagery is under study.

The OCRS undertook an extensive and diversified program of remote sensing application and research in 1977. The following are highlights:

- development of a methodology for forest regeneration success assessment using digital analysis of Landsat data
- development of a forest typing methodology based on digital analysis of Landsat data
- comprehensive survey of the application of remote sensing to parks planning and management
- wildlife habitat classification by means of analogue analysis of Landsat imagery.

The principal program of the OCRS which began in 1977, to be continued for approximately five years, is the completion of the surficial geology mapping of Northern Ontario, the mapping of the wetlands of the James Bay/Hudson Bay Lowlands, and the preparation of a description of the physiography of Northern Ontario. The program employs Landsat imagery for initial mapping and the planning of field-survey strategy, 1:60,000-scale federal government photography for detailed delineation, and intensive ground-sampling. In the summer of 1977, field sampling was conducted over an area of 200,000 sq. km in Northwestern Ontario, for which manuscript maps are presently being prepared. The benefits of

efficiency and economy gained by the use of remote sensing for this program are incalculable: the costs of time and money involved would otherwise preclude the undertaking of the work at all.

Acres Consulting Services Ltd. applied the interpretation of black and white aerial photography from several sources, to environmnetal studies; for initial reconnaissance of study areas, descriptions of land use and vegetation and habitat evaluations; to route selection for roads and transmission lines; to assessment of future reservoir shorelines, study of river channel configurations and ice conditions; and to the location of aggregate deposits.

Moniteq Ltd. reported having developed a methodology for the use of commercially-available sensors as a routine, cost-effective method of measuring source emissions of SO_2, including the comparison of infrared with ultraviolet sensors.

Beak Consultants Ltd. report having employed aerial photography from the Ontario Government and from the National Airphoto Library for several environmental assessment projects, such as pre-engineering environmental studies for a flood control program, the monitoring of erosion from landfill sites along the Toronto waterfront, and route selection for mining access corridors and arterial road alignments.

6.7.5 Training

The first remote sensing course for regional resource managers and field staff was given by the OCRS for the Ministry of Natural Resources; courses were also delivered to Geological Branch and the Division of Forests. In addition, the Centre participated in seminars on the application of thermography to the detection of building heat loss, and conducted lectures for several universities - University of Toronto, York University, Waterloo, Guelph, McMaster and Lakehead Universities.

The Centre also participated in remote sensing symposia: the Fourth Canadian Symposium on Remote Sensing in Quebec City and the XI International Symposium on Remote Sensing in Michigan. Presentations were also given to the CACRS Geoscience and Forestry Working Groups.

Barringer Research Ltd. reported having presented numerous papers and attended remote sensing symposia in Canada, the United States and other countries; in addition, Barringer has provided consulting services all over the world.

6.7.6 Conclusions and Forecast

The conclusion of the Great Lakes Survey Unit (Ministry of the Environment) from its activities in 1977 is that there are many areas of application of remote sensing to the water resources field in Ontario, but that economic and time restrictions control the rate of growth of application.

The Hydrology and Monitoring Section of the Ministry of the Environment comments on the disproportion between the growth of remote sensing technology and progress in the operational application of remote sensing to hydrology and hydrogeology, and expresses the requirement for demonstration projects to prove cost benefit to potential users.

The OCRS anticipates that its major physiographic mapping program in Northern Ontario, which will provide the first comprehensive baseline data for northern development planning, will provide conclusive evidence of how essential remote sensing is to Ontario's future.

6.7.7 Recommendations

Great Lakes Survey Unit (Ministry of the Environment):

CCRS should curtail airborne sensing services to a level at which high quality standards could be maintained. Alternative suppliers in the public sector should be supported in order to provide a competitive field from which users could obtain remote sensing services suited to particular needs. The Industrial Airborne Services Section may serve this function.

Hydrology and Monitoring Section (Ministry of the Environment):

The national remote sensing program should place emphasis on practical demonstration projects in all disciplines as a means of extending the operational use of remote sensing.

Ontario Centre for Remote Sensing:

1. CCRS should report regularly to CACRS on steps taken to increase the quality of Landsat data. The quality of imagery produced by the EROS Data Centre should be considered as a standard.

2. CCRS should report regularly to CACRS on the preservation of the Landsat archive: as to what measures have been taken to protect the data from damage, deterioration or loss, and as to the identification of frames that have been damaged or destroyed.

3. CCRS should concentrate its budgetary resources on the improvement of the Landsat product, as a priority over involvement in new programs, in order to better serve the remote sensing user community.

4. CCRS should make software for digital data analysis developed in-house available to the user community at no charge, as a significant part of the transfer of remote sensing technology.

6.7.8 1977 Publications

Barringer, A.R. AIRTRACE. Exploration '77, Ottawa.

Barringer, A.R. AIRTRACE - An Airborne Geochemical Exploration Technique. First Annual William T. Pecora Memorial Symposium.

Barringer, A.R., J.H. Davies, G. Floyd. Evaluation of Instrument Improvements to the Basic Correlation Spectrometer (COSPEC) Family. Fourth Joint Conference on Sensing of Environmental Pollutants, New Orleans.

Cihlar, J., R.J. Brown, G.R. Lawrence and B. James. Use of Aerial Thermography in Canadian Energy Conservation Programs. IX International Symposium on Remote Sensing of the Environment, Ann Arbor, Michigan.

Davies, J.H., A.R. Barringer. An Airborne Laser Fluorosensor System for Oil Pollution Monitoring. Offshore Conference '77, Aberdeen, Scotland.

Davies, J.H., A.R. Barringer, R. Dick. Development of an Airborne Laser Fluorosensor for Oil and Water Pollution Monitoring. Fourth Joint Conference on Sensing of Environmental Pollutants, New Orleans.

Davies, J.H., G. Floyd, A.R. Barringer. Recent Developments and Applications with GASPEC - A Gas Filter Correlation Spectrometer. Fourth Joint Conference on Sensing of Environmental Pollutants, New Orleans.

Davies, J.H., W. Morrow, M. Tai. Development of a Second Generation Remote Sensing Correlation Spectrometer. First International COSPEC Symposium, Atmospheric Environment Service, Toronto.

Davies, J.D., W. Morrow. Recent Developments and Applications of Gas Filter Correlation Spectroscopy (GASPEC). First International COSPEC Symposium, Atmospheric Environment Service, Toronto.

Dick, R., H.W. Goldstein, R.N. Grenda, M.H. Bortner. CIMATS: A Correlation Interferometer for the Measurement of Atmospheric Trace Species. Fourth Joint Conference on Sensing of Air Pollution, New Orleans.

Lawrence, Garth R. Detection of Heat Loss from Buildings through Aerial Thermography: Applications and Methodology. Fourth Canadian Symposium on Remote Sensing, Quebec City.

Palabekiroglu. Simsek. A Key Study on the Interpretation of Regional Soil Moisture on Satellite Imagery. Presented to the Fourth Canadian Symposium on Remote Sensing, Quebec City.

6.8 REPORT OF THE PRINCE EDWARD ISLAND REMOTE SENSING COMMITTEE

6.8.1 Spaceborne Remote Sensing

The Agricultural Land Use Program remained as the main user of resource satellite imagery during the past year. Following a planning phase between the P.E.I. Department of Agriculture and Forestry, and Dr. Bob Ryerson, C.C.R.S., a project plan was developed early in 1977. Basically, the project would involve use of the Image Analysis System (Image 100 Computer) to define planting dates, growth stages and harvesting dates of various agricultural crops, the extent and type of forest cover, and the location and area of fallow soils on P.E.I. This data was to play a vital role in assessing the potential of soil erosion events and to enable our Department to formulate and implement control mechanisms with much improved accuracy and effectiveness.

Due to a combination of computer problems and unfavorable weather conditons, only two sets of maps have been received to date; i.e., May and June, 1977. These have proven useful in defining the location of crop seeding acreages and developing an approximation of the rate of surface cover establishment. However, a problem of map scale was apparent from the start. Although the printout scale was near 1:125,000, the set for May, 1977 exhibited severe skewedness, thus making it impossible to locate problem areas on anything more than a very rough approximation. The skewed nature of the printout could not be corrected with our zoom transfer scope. The maps for June, 1977 were much closer to the indicated scale than those of May, 1977. However, the printout scale was not continuous throughout the series of computer printout sheets, and the development of a mosaic was not possible. Nonetheless, it appears that these problems are being attacked by C.C.R.S. and with obviously positive results.

Since the project offers very real promise, we anticipate its continuity into the forseeable future. Scale of mapping is perhaps more critical on P.E.I. than in other areas of Canada. Our land area is relatively small, contains a mix of rural and urban areas and thereby demands a high degree of accuracy when locating and defining soil and crop problems in order to effectively develop and implement control techniques.

6.9 RAPPORT DU QUEBEC

6.9.1 Télédétection aérienne

La section des Opérations aéroportées du Centre canadien de télédétection (C.C.T.) a été demandée sur 17 projets au Québec en 1977, pour un total de 2370 milles nautiques (4385 kilomètres). La plupart de ces missions ont pu être complétées ou sont en voie de l'être. La mission de thermographie des pertes de chaleur qui devait être effectuée à l'automne pour le Centre québécois de coordination de la télédétection (C.Q.C.T.), a été reportée au printemps suivant.

Le C.Q.C.T. a acquis un ballon captif de 12 m^3 et l'utilisera au cours de l'été 1978 dans le cadre d'un programme expérimental.

6.9.2 Télédétection spatiale

Le C.Q.C.T. a maintenu en 1977 son abonnement aux microfiches de Landsat-2 et doit continuer à le faire.

Afin de prévenir les délais habituels dans l'acquisition d'imagerie nouvelle, le C.Q.C.T. aura une commande permanente des images de Landsat-3 sur le Québec, en format 70 mm compatible avec son synthétiseur multispectral. Le synthétiseur multispectral acquis par le C.Q.C.T. en 1977 permettra à l'usager de tirer lui-même ses propres copies en couleur ou en noir et blanc du cliché sur lequel il aura travaillé avec cet appareil.

On souhaite avec ce système s'approcher du temps réel, comme cela a été si souvent dit, mais à tort jusqu'à maintenant.

6.9.3 Développement technique

Deux universités (Laval et Montréal) sont à développer un système de traitement numérique des données de télédétection avec afficheur couleur. Ces systèmes sont branchées à des mini-ordinateurs, avec liaison possibles avec de gros ordinateurs.

Le C.Q.C.T. a développé un système permettant d'effectuer, à distance par terminal branché au système MICA du C.C.T., un certain nombre d'opérations, en préparation à une séance de travail au C.C.T.

6.9.4 Applications

Il y a eu peu de nouveau du côté des applications en 1977. Ce fut plutôt une année de lancement de projets.

Le projet "Télédétection-foresterie", issu de la proposition de l'Association québécoise de télédétection (A.Q.T.) de mars 1977 s'est structuré et intéresse principalement les organismes suivants: le ministère des Terres et Forêts, le Centre de recherches forestières des Laurentides, le Centre canadien de télédétection et l'Université Laval. Bien qu'orienté premièrement sur les applications des données spatiales et numériques, le projet accordera une place importante à la télédétection aérienne à haute altitude. A cet effet, 4 missions aériennes totalisant 360 milles nautiques (1590 kilomètres) ont été demandées au C.C.T.

A l'instar de l'Ontario, le Québec s'est engagé dans la réalisation d'un projet pilote devant vérifier l'utilité de la thermographie aérienne dans une campagne d'information sur l'économie de l'énergie. Les opérations, n'ayant pu se dérouler à l'automne et l'hiver parce que le survol n'a pu être réalisé à l'automne, se déroulera au printemps 1978. Le ministère des Terres et Forêts et le Bureau des économies d'énergie coopèrent dans la réalisation de ce projet. Nous pourrons profiter de l'expérience et des précieux conseils des gens du Centre ontarien de télédétection (O.C.R.S.).

Six expériences ont été soumises par des organismes ou des chercheurs québécois dans le cadre du projet SURSAT.

Un projet d'application d'un balayeur multibande aérien à la surveillance de la qualité de l'eau a été préparé grâce à la collaboration d'un expert du G.D.T.A. (Groupement pour le développement de la télédétection aérospatiale, France).

6.9.5 Information

Le 4^{ième} Symposium canadien sur la télédétection, tenu à Québec en mai 1977, a été un succès. Plus de 250 participants ont pu suivre les 60 exposés que comportait le programme.

L'A.Q.T. a tenu un congrès de deux jours à Montréal en novembre 1977. Cet organisme compte maintenant 250 membres.

Six numéros de LA TELEDETECTION AU QUEBEC ont été publiés en 1977.

Afin de permettre un meilleur accès au fichier RESORS, le C.Q.C.T. a créé le système SYDOSAT (système de documentation sélective automatique sur la télédétection). Il permet à ses 150 abonnés de recevoir régulièrement des références récentes correspondant à leur profil d'intérêt.

Plusieurs rencontres entres des représentants du Québec, d'Ottawa et de France ont permis de faire évaluer le dossier de la terminologie de la télédétection.

6.9.6 Enseignement

L'A.Q.T. a tenu une nouvelle série de cours intensifs en novembre 1977.

6.9.7 Perspectives d'avenir et conclusion

Le niveau des applications de la télédétection dans la province n'est pas à la mesure du niveau technologique du programme fédéral. Ce programme risque de tourner à vide encore longtemps s'il ne s'adapte pas aux besoins d'aujourd'hui des provinces. Le fédéral est rendu dans les années 1980 alors que la plupart des provinces sont encore en 1972!

Au Québec la situation en est à un stade de recherche et de développement des applications, ce que le gouvernement encourage d'abord en vue de préparer des applications opérationnelles.

6.9.8 Recommandations

6.9.8.1 Sans négliger les techniques de demain, que le Centre canadien de télédétection oriente son action de façon prioritaire sur le transfert des méthodologies existantes.

6.9.8.2 Que le Centre canadien de télédétection encourage la formation de systèmes de traitement numérique régionaux en mettant ses logiciels à la disposition de ces systèmes et en développant spécifiquement des logiciels pour ces petits systèmes au lieu de continuer à mettre tant d'énergie sur des super systèmes (MAD, IMAGE-100) qui, a toutes fins pratiques, sont inutilisables pour la plupart des usagers.

6.9 REPORT OF THE PROVINCE OF QUEBEC

6.9.1 Airborne remote sensing

The Airborne Operations Section of the Canada Centre for Remote Sensing (CCRS) was asked to perform seventeen projects in Quebec in 1977, covering 2370 nautical miles (4385 km). Most of these missions have been completed or are about to be. The heat-loss thermography mission, which was supposed to be carried out in the fall for the Centre québécois de coordination de la télédétection (CQCT) (Quebec centre for remote sensing coordination), has been postponed until next spring.

The CQCT has acquired a twelve-cubic-metre captive balloon and will use it during the summer of 1978 in an experimental program.

6.9.2 Spaceborne remote sensing

The CQCT maintained its subscription to LANDSAT-2 microfiche in 1977 and will continue to do so.

In order to prevent the usual delays in acquiring new imagery, the CQCT will have a standing order for Landsat-3 70mm images of Quebec for use with its multispectral synthesizer. The multispectral synthesizer was acquired by Quebec in 1977 and will allow the user to obtain his own copies in colour or in black and white from the negative he has been working on with this machine.

With this system, we hope to approach real time, as has often been spoken of - wrongly until now.

6.9.3 Technical developments

Two universities (Laval and Montréal) are developing a digital processing system for remote sensing data, with colour display. These systems are connected to minicomputers, and can be linked with large computers.

The CQCT has developed a system allowing a number of operations to be carried out remotely, using a terminal connected to the CCRS MICA system, in preparation for a working session at the CCRS.

6.9.4 Applications

There was not much new in the area of applications in 1977. Rather, this was a year for launching projects.

The "Télédétection-foresterie" ("Remote Sensing for Forestry") project, which grew out of the March 1977 proposal by the Association québécoise de télédétection (AQT), is now underway and is of interest mainly to the Department of Lands and Forests, the Laurentian Forest Research Centre, the Canada Centre for Remote Sensing and Laval University. Although the project is devoted mainly to the applications of digital satellite data, it will also place emphasis on airborne remote sensing data from high altitudes. In this connection, four airborne missions of this type, covering 860 nautical miles (1590 km), were requested from CCRS.

Like Ontario, Quebec is working on a pilot project aimed at verifying the usefulness of aerial thermography in an information campaign on energy conservation. Since the overflights could not take place in fall or in winter, the operations will not get underway until the spring of 1978. The Department of Lands and Forests and the Office of Energy Conservation are working together on this project. We will profit from the experience and valuable advice of the people at the Ontario Centre for Remote Sensing (OCRS).

Six experiments have been submitted by Quebec organizations and researchers under the Sursat project.

A project applying a multispectral scanner to monitor water quality has been prepared with the collaboration of an expert from the GDTA (Groupement pour le développement de la télédétection aérospatiale) (development group for aerospace remote sensing) in France.

6.9.5 Information

6.9.5 The Fourth Canadian Symposium on Remote Sensing, held in Quebec City in May 1977, was a success. More than 250 participants heard the sixty papers that made up the program.

The AQT held a two-day symposium in Montreal in November 1977. There are now 250 members in this organization.

Six issues of La Télédétection au Québec were published in 1977.

To allow greater access to the RESORS file, the CQCT created the SYDOSAT (Système de Documentation Sélective Automatique sur la Télédétection) (Automatic System for Selective Documentation on Remote Sensing). It enables its 150 subscribers to receive up-to-date references on a regular basis corresponding to their individual interests.

Representatives from Quebec, Ottawa and France have held several meetings to assess the remote sensing terminology file.

6.9.6 Training

The AQT held a new series of intensive courses in November 1977.

6.9.7 Outlook for the future and conclusion

Remote sensing applications at the provincial level have not yet reached the technological level of the federal program, which runs the risk of being underutilized for a long time unless it is adapted to the current needs of the provinces. The federal program has forged ahead into the 1980's, while most of the provinces are still in 1972!

Quebec is at the stage of research and development of applications, which the government is encouraging to begin with, in order to prepare for operational applications.

6.9.8 Recommendations

6.9.8.1 That the Canada Centre for Remote Sensing give first priority to the transfer of existing techniques, without neglecting future technology.

6.9.8.2 That the Canada Centre for Remote Sensing encourage the formation of regional digital analysis systems by placing its software at the disposal of these systems and by developing software specifically for these small systems instead of continuing to spend so much energy on supersystems (MAD, Image-100) which for all practical purposes are not usable by most users.

7.1 REPORT OF THE AES REMOTE SENSING PANEL

7.1.1 AIRBORNE REMOTE SENSING

Collection of ice data by remote sensing from the ice reconnaissance aircraft has continued as in past years. Increased emphasis has been placed on acquisition of surface roughness data provided by the laser profilometer. A four-channel analog magnetic tape recorder has been installed on each aircraft to record the laser and airborne radiation thermometer data in raw format. In addition, an APS-94E Motorola SLAR system has been added to one of the platforms. The SLAR system is a conventional APS-94D system with roll compensation and a dry silver film real-time display data. It will be used in routine ice reconnaissance data collection.

7.1.2 SPACEBORNE REMOTE SENSING

(a) The Western HRPT readout station built by MacDonald Dettwiler and Associates Ltd. was completed and temporarily installed at the Pacific Weather Centre in Vancouver for final testing during the summer of 1977. In November the station was transferred to the Arctic Weather Centre in Edmonton. This move was in line with the AES policy of situating readout stations near the major data user. The Arctic Weather Centre requires full resolution coverage of Canadian Arctic areas in real-time to support its weather forecasting activities. Data are retransmitted via land from Edmonton to Ice Forecasting Central, the Pacific Weather Centre,Whitehorse and other weather offices.

(b) MacDonald Dettwiler and Associates Ltd. have been awarded a contract to provide TIROS-N signal processing equipment to both the Arctic Weather Centre and the Satellite Data Laboratory. The system will provide the capability of mapping the 10 bit image data into 8 bit pixel values with a different relationship for each of the five HRPT channels for use in real-time operations. TIPS and TOVS data will be available from a separate part. Full 10 bit resolution data will be available via a third computer compatible part to support research and development studies.

(c) The Satellite Data Laboratory is being equipped with a GOES-VISSR direct readout capability. The 10 m antenna system was built and installed by Toronto Iron Works (TIW Systems). SED Ltd. has been awarded the contract to develop the sectorizing and data processing system with Muirhead Ltd. providing the computer-facsimile interfaces for real-time distribution of satellite imagery to forecast offices. The system will also provide computer compatible tapes for research and development.

A full account of the AES real-time data readout and transmission facilities is given in reference 5 in section 7.1.9 below.

7.1.3 TECHNICAL DEVELOPMENT

The Satellite Data Laboratory image analysis and display system capabilities have been expanded with the purchase of an Interdata 8/32 to replace the Interdata 7/16 central processing system. This system is used to support research and development underway in the Atmospheric Research Directorate of AES.

Arrangements have been made with the University of Wisconsin to acquire their meteorological satellite/conventional data display software package known as MCIDAS (Man-Computer Interaction Display and Acquisition System). This package will be used for the Satellite Data Laboratory image analysis system. The major advantage of MCIDAS is the ability to map conventional meteorological data and analyses onto weather radar and meteorological satellite imagery, thus providing a very powerful tool for meteorological research. It is in use in a wide number of meteorological research facilities around the world.

A contract has been let to Optech Inc. of Downsview for the development of a new laser profilometer system to replace the current systems on the aircraft. The new system will be a pulsed laser type with an operational capability up to 10,000 ft. altitude and through thin cloud layers. Completion of the project is expected in 1979. Discussions are also underway with industry on the development of a system for removal of aircraft altitude perturbations from laser profiles, thus allowing near real-time digital processing of the laser data. Finally, contracts funded by the Research Development Centre of Transport Canada have been let to two companies for the further investigation of synthetic pulsed radars for applications in measurement of sea ice thickness from airborne platforms.

7.1.4 APPLICATIONS

(a) Under an AES contract, McGill University's Stormy Weather Group has begun studies on uitlizing weather radar data to ground truth GOES-VISSR data in real-time applications. The satellite data were provided by the University of Wisconsin as part of a joint McGill-Wisconsin research program in this area. Acquisition of the MCIDAS software by the Satellite Data Laboratory will provide AES with the basic software necessary to conduct real-time tests of the techniques developed by the Stormy Weather Group.

(b) The Aerospace Meteorology Division is developing an Ice Status system to permit computer assisted assimilation of HRPT imagery from TIROS-N into real-time ice analysis programs. The first system software contract was awarded to MacDonald Dettwiler Associates Ltd. The Ice Status system will be operated in development mode on the Satellite Data Laboratory image analysis and display system.

(c) Laser data collected during ice reconnaissance flights are catalogued and archived for future reference. Processing of some of these data have also been undertaken for various ice roughness studies. Development of a capacity for digital processing of tape recorded laser data is now being undertaken in cooperation with CCRS and should be completed in 1978.

7.1.5 BENEFIT ANALYSIS

The major benefit analysis of remote sensing technology underway in the AES is an examination of the cost-effectiveness of the use of SEASAT-A type data in support of AES forecast activities. This examination is being carried out as part of the AES contribution to the SURSAT project.

The microwave sensors on SEASAT-A should be capable of yielding a considerable amount of information about the atmosphere, the ocean surface and polar ice cap. Some of the parameters that the SEASAT-A sensors are expected to provide are: surface winds, ocean gravity waves, sea-surface temperature, sea-ice, atmospheric water vapour and liquid, and ocean features such as shoals and currents. Measurements of these parameters are important to the Atmospheric Environment Service for a variety of operational requirements. A special feature of microwave remote sensors is their all-weather capability.

The Atmospheric Environment Service will be conducting a number of evaluation experiments during 1978 and 1979 to determine the feasibility of using microwave remote sensing for the extraction of meteorological and related data. The following is a summary of the proposed experiments and the principal investigators associated with each experiment:

Continental Snowline Mapping (Peter Scholefield)

Ice Motion Modelling (V.R. Neralla)

Surface Winds in Ice Infested Waters (S. Peteherych)

Wave Heights, Sea State & Over-water Winds (A.H. Campbell)

Comparative Evaluation of Coincident Side-looking Radar Data Sets (H. Hengeveld)

Sea Surface Temperature (S. Peteherych)

Snow Cover in the Saint John River Basin (B.E. Goodison, G. den Hartog)

Snow Cover Mapping in the Cold Creek Basin, Ont. (B.E. Goodison, G. den Hartog)

Ice Roughness Using SEASAT-A Altimeter (S. Peteherych, H. Hengeveld)

SEASAT-A Sensor Data for Wave Forecasting (S. Venkatesh, S. Peteherych)

Evaluation of Application of SEASAT SAR Data for Ice Forecasting (A. Beaton)

Sea Ice Roughness Using SEASAT-A SAR (U. Feldman)

As part of the above program the AES will be assembling a data processing facility for image analysis and interpretation.

7.1.6 USER LIAISON

The AES has identified a satellite specialist in each major weather office across the country to keep abreast of developments in the area of satellite meteorology and to act as the main point of contact with the Aerospace Meteorology Division.

7.1.7 TRAINING

The AES Training Branch conducts courses and workshops in the interpretation and use of satellite imagery. The courses are developed by the Training Branch staff with the assistance from the AES Satellite Data Laboratory which supplies copies of satellite imagery. A high priority is placed on specialized courses dealing with the use of

satellite imagery in the weather analysis and forecasting. During the 1976-77 period the Training Branch staff conducted VHRR and SR satellite imagery interpretation courses at the Weather Offices at Halifax, Montreal, Toronto, Trenton, Winnipeg, Edmonton and Comox. More than 200 professional meteorologists and technicians attended these courses. Currently, intensive developmental work is being carried out on the interpretation and use of the GOES imagery and a series of GOES Satellite Imagery User's Workshops are being planned for 1978.

7.1.8 FORECAST

Over the past few years the AES meteorological satellite activities have continued to grow in magnitude and scope at an increasing rate. Nevertheless, the main effort has been towards development of techniques to assimilate satellite data into AES operations. At the present time it appears that this emphasis will continue through the next few years since adequate assimilation of technology for satellite data is the major obstacle which needs to be overcome before AES can reduce its reliance on costly conventional meteorological networks.

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7.2 REPORT OF THE INSTITUTE OF OCEAN SCIENCES - PATRICIA BAY

7.2.1 Introduction

The remote sensing section of the Institute has responsibility for development of remote sensing techniques for oceanography and for evaluation of techniques originating elsewhere.

During 1977 the work of the section included projects involving measurement of waves by radar altimetry and synthetic aperture imaging radar, chlorophyll measurements by spectroscopy, mapping of near surface winds from aircraft, provision and processing of satellite imagery and provision of specialized aerial photography in support of the Institute's oceanography programs.

7.2.2 Satellite Oceanography

The first satellite specifically designed for studying the ocean, the United States National Atmospheric and Space Administration (NASA) SEASAT, will be launched in 1978. This has particular interest for Canada since its sensors will operate at high radio frequencies, in the microwave region of the spectrum, and therefore will not be affected by cloud cover that so frequently prevents aerial or satellite imaging using visible light over areas of interest to us. A Canadian program designed to investigate the capabilities of using satellites for surveillance (SURSAT) will evaluate SEASAT and contribute expertise to NASA's scientific planning teams for this satellite. J.F.R. Gower is a member of the team that is planning the imaging radar experiments.

Some of the potential uses of this imagery were demonstrated during an aircraft flight over the west coast of Vancouver Island when a synthetic aperture radar of the type to be launched on SEASAT produced pictures showing internal and surface wave patterns and coastal current boundaries. The wavelength deduced for the surface waves was in good agreement with data collected by the waverider buoy off Tofino. Images of similar resolution, but covering much larger areas will be provided by the satellite.

In addition to an imaging radar, SEASAT will carry a radar altimeter to measure wave and sea surface height, a scatterometer to measure sea surface wind, and a multichannel microwave scanning radiometer to measure sea surface temperature and to map ice cover. Different groups in Canada are studying the various applications of these and similar sensors. NASA has selected J.F.R. Gower to be one of the scientists to work on GEOS-3 radar altimeter data and the Remote Sensing Section has been evaluating this instrument for wave measurements and has developed an improved method of data analysis. These results will also apply for the SEASAT altimeter.

Another satellite to be launched by NASA in 1978 is Nimbus G which will carry an instrument for mapping ocean colour, specifically those changes that are caused by varying amounts of floating plant life or phytoplankton in the water. The Remote Sensing Section has been evaluating the technique using a 256 channel spectrometer. During 1977 the first results of this study were published and the equipment is now being improved for further measurements in Europe and in the Arctic.

For the display and analysis of satellite imagery, the Section has put a digital picture production system into operation, which will allow special purpose enhancements to be made for a variety of ocean and Arctic projects.

Various other uses made of satellite imagery during 1977 include an analysis of vortex streets visible on the National Oceans and Atmospheric Administration (NOAA) polar and synchronous satellites and continuing observations of sea surface temperature patterns using thermal infrared scanning.

7.2.3 Airborne Oceanography

Operations in airborne coastal oceanography use a specially instrumented aircraft leased from the Provincial Government. During 1977 this was used principally for low level wind observations to be applied to modelling the movement of oil spills. The sighting system on the aircraft allows the positions of targets to be measured to an accuracy of 10 meters. Various tracking operations on drifting surface drogues were carried out to assist in the compilation of coastal current charts.

Other airborne work included photography of Knight Inlet to follow motion of the glacial silt repeated on 3 dates during the summer months. The silt colours the water very strongly and indicates fronts and internal waves as well as tidal currents.

7.2.4 Remote Sensing of Ice

Satellite imagery continues to be used for mapping ice cover and movement. Studies of the Arctic generally and Lancaster Sound in particular were made using NOAA VHRR imagery.

A considerable library of NOAA and Landsat imagery is now being held by the Institute library.

7.2.5 Buoy Location and Data Collection Systems

Ten 'COSRAM' drift buoys were deployed in eastern Barrow Strait in the Arctic and tracked by NOAA satellite. Their drift tracks over the summer period provided many surprises, being contrary to expected drifts inferred from historical data. Plans are being made for further buoy deployment in 1978.

Work for the First Garp Global Experiment (FGGE) buoy project continued in 1977. The project calls for deployment of 300 buoys south of 20° north latitude by January 1979 to be tracked by the ARGOS system on Tiros N. These buoys will measure barometric pressure and sea surface temperature.

During 1977, 20 prototype Canadian buoys had been deployed at sea and by the end of the year an average of 220 days of observation was obtained from each buoy. 9 buoys were still operating and 7 had been washed ashore. J. Garrett of Offshore Oceanography is the manager of the international buoy observing system which involves buoys from 8 countries deployed by ships of at least 15 countries.

7.2.6 Aerial Hydrography

A technician was again seconded to CCRS from IOS to assist in the aerial hydrography project. Test flights were conducted in the spring over the Casa Grande Military Photo Test Range in Arizona and in the fall over coastal targets on Vancouver Island. This data is now being analysed and should provide to a final demonstration of the overall feasibility of hydrographic charting in shallow waters using inertially controlled stereo-photography.

7.2.7 Publications

Gower, J.F.R., 1977. The computation of ocean wave heights from GEOS-3 satellite radar altimeter data. IN: AIAA Conference on Satellite Applications to Marine Technology. New Orleans, November 1977. (in press)

Gower, J.F.R. 1977. Microwave sensing of sea surface wave patterns. IN: 4th Can. Symp. on Remote Sensing, Quebec City, May 1977. pp. 395-406.

Gower, J.F.R. & R.A. Neville, 1977. A method for the remote measurement of the vertical distribution of phytoplankton in sea water. IN: 4th Can. Symp. on Remote Sensing, Quebec City, May 1977. pp. 532-542.

Grasty, R.L., J.F.R. Gower & B.M. Oliver, 1977. Inertial Navigation for flight path recovery. Geol. Sur. of Canada, Paper 76030. 12 pp.

Marko, J. & R.E. Thomson, 1977. Rectilinear Leads and Internal Motions in the Ice Pack of the Western Arctic Ocean. J. Geophysical Research 82: 979-987.

Neville, R.A. & J.F.R. Gower, 1977. Passive remote sensing of phytoplankton via chlorophyll and fluorescence. J. Geophysical Res. 82: 3487-3493.

Oliver, B.M. & J.F.R. Gower, 1977. Use of an inertial navigation system for accurate track recovery and coastal oceanographic measurements. IN: Proceedings of the 11th Int. Symp. on Remote Sensing of Environment, Environmental Research Institute of Michigan, Ann Arbor, Michigan, April 25-29, 1977. pp. 1399-1413.

Thomson, R.E., J.F.R. Gower & N.W. Bowker, 1977. Vortex streets in the wake of the Aleutian Islands. Monthly Weather Review 105: 873-884.

7.3 REPORT OF THE FOREST MANAGEMENT INSTITUTE

7.3.1 Progress and Priorities

Forest Management Institute priorities shifted during 1977. Remote sensing became more firmly established in some applications-oriented programs such as the surveys in national parks and, in the case of large-scale aerial photography, in forest inventory. At the same time the remote sensing research program received a temporary setback through the resignation of two specialists. This weakness in the in-house program has been offset by progress of major contracts with Canadian industry.

The top priority of the remote sensing program has been the development of an interactive remote sensing interpretation system (ARIES) by Computing Devices Company. This installation is being completed under contract and is intended as an operational facility. As far as users are concerned, the system's outstanding features are high speed, versatility and a very well designed approach to interaction between operator and hardware.

Currently one of the top priorities at FMI is the improvement of national forestry statistics. This program will depend heavily on remote sensing for data input. It has also given new importance to earlier FMI monitoring experiments which will be revitalized during the coming year.

The application of large-scale aerial photography in forest inventory has been under development at FMI for about fifteen years. The method is now fully operational for Canadian conditions. During 1978, Dr. A.H. Aldred of FMI, will be seconded for six months to the Alberta forest inventory system. During 1977 and 1978, FMI has, in cooperation with Canadian industry, made further advances in the application of large-scale photography under tropical conditions. This work involved tests in Costa Rica which followed earlier trials in Surinam and Guatemala.

Another major contract managed by FMI dealt with the development of stereo orthophotography by Gestalt International. FMI coordinated the development of stereo orthophoto maps which demonstrated applications in forestry, glaciology, hydrography, and engineering.

In mid-1978, Mr. Kalensky will complete a two year secondment in Indonesia where he, as a remote sensing expert, participated in a large national resource inventory program. Another FMI scientist, Dr. G.M. Bonnor, returned from Malaysia after a one year assignment to help in the development of university courses relating to forest inventory. Dr. U.Nielsen took part in a series of seminars and workshops which were organized in Guatemala. Colombia and Chile under the auspices of EMR and PAIGH. FMI continues to be involved in the affairs of Commission VII, International Society for Photogrammetry and will contribute to the forthcoming symposium of that Commission. FMI will also continue to evaluate new space initiatives such as Landsats C and D, and Sursat.

7.3.2 Publications

The following publications have been issued since the 1976 report of CACRS was published:

Davis, W.A. and F.G. Peet. 1976. The identification and reclassification of small regions on digital thematic maps. FMR-X-91.

Kalensky, Z.D. and U.Nielsen. 1977. Resource mapping based on stereo orthophotographs Mande, France. September 1977.

Peet, F.J. 1977. A primer on the use of digital Landsat data. This primer is based upon a set of lecture notes prepared for the Alberta courses on remote sensing in 1974, 1975, 1976 and 1977.

Sayn-Wittgenstein, L. and A.H. Aldred. 1976. Environmental monitoring: the role of remote sensing. Paper presented at Commission VII, 13th Congress International Society for Photogrammetry, Helsinki, Finland, July 1976.

Sayn-Wittgenstein, L. 1977. Remote sensing and today's forestry issues. Invited paper presented at the Eleventh International Symposium on Remote Sensing, Ann Arbor, Michigan, April 1977.

Sayn-Wittgenstein, L. 1977. Resources for teaching remote sensing. Review paper for the IXth National Surveying Teachers' Conference, Fredericton, N.B. June 20-24, 1977.

7.4 Specialty Centre Report of the Lands Directorate, D.O.E.

7.4.1 Introduction

The evaluation of airborne and satellite techniques for ecological land classification, land use/cover mapping and land use monitoring continued as major Lands Directorate activities during 1977. The development of operational methods for land resource surveys and provision of advice and training to federal and provincial authorities is continuing. Remote sensing staff are centred in the Ecological Land Classification and Evaluation (ELCE) Division in Ottawa and in regional offices in Burlington, Quebec and Halifax.

7.4.2 Ecological Land Classification

Lands Directorate's ELCE Division since 1976 has acted as the secretariat to the Canada Committee on Ecological Land Classification. In this capacity, it is currently coordinating the preparation of remote sensing guidelines for land classification as well as monitoring current land classification research and field programs in Canada. Several in-house projects were undertaken during 1977.

The evaluation of LANDSAT data for operational ecological mapping in the Caribou Range was contracted to Dr. J.S. Rowe of the University of Saskatchewan. LANDSAT and panchromatic imagery formed the major data sources for an experimental ecoregion-district-system map of Northern Yukon prepared by the ELCE Division for Parks Canada. Visual analysis of these images have been shown to be highly practical data sources for reconnaissance mapping of land resources in both of these study areas. The Directorate has undertaken to prepare preliminary ecoregion and ecodistrict maps for all of Canada by 1979. For this purpose, a collection of 500 high quality LANDSAT colour transparencies is currently being purchased to act as a major data source.

The evaluation of LANDSAT digital data for ecological land classification continues by headquarters and regional staff. Supervised Image 100 classification at 1:250,000 scale for land classification in Northwestern Ontario has been shown to be effective in areas ravaged by fire and logging (C. Rubec). Digital satellite data is most useful for mapping wetland areas in the Hudson Bay Lowland coastal zone (G. Wickware). Coastal zone mapping in Nova Scotia with LANDSAT data continues to be pursued as well (N. Prout). In each of these cases the investigators have found current Image 100 services adequate but observed that considerable improvements would be required should any operational ecological mapping programs be initiated in the near future. Poor quality CCT's and extensive Image 100 downtime have caused surprising delays in project completions.

During the year staff scientists have been invited to offer advice to numerous provincial agencies for land classification projects as well as offering several remote sensing workshop sessions. J. Thie and D. Welch taught a one week course at the University of Manitoba outlining photo-interpretation and remote sensing techniques for terrain analysis.

7.4.3 Land Use Classification and Monitoring

Aerial photography formed the basis of continuing land use monitoring projects by Lands Directorate staff in 1977. A study of changes around Canada's 71 major urban centres was published (D. Gierman). Detailed studies of LANDSAT digital data for land use monitoring have also been completed. A review of the "state of the art" of remote sensing for land use studies is currently in progress in support of a proposed Canada Land Use Monitoring Program.

Registered supervised Image 100 classification of temporally separated LANDSAT data at 1:50,000 scale for land use change detection has been found to be unsatisfactory for land use studies. Extensive problems with scene registration, and non-unique spectral signatures make large scale monitoring inpractical at present. However, small scale mapping and monitoring appear to be practical and may form a major contribution to the national program proposal.

Several 1:250,000 experimental land-use systems maps have been prepared using LANDSAT data (C. Rubec, D. Welch) for interfacing with the Canada Geographic Information System data base at Lands Directorate. Such "land-use systems", if distinct ecologically, may have special relevance to land use planning.

Each unit has been delineated on the basis of land use/cover, soil parent material, drainage, and topography revealed from analysis of numerous LANDSAT scenes for the study regions in southern Manitoba.

7.4.5 Appendix I List of 1977 Remote Sensing Reports, Publications and Papers.

GIERMAN, D.M., 1977, Rural and Urban Land Conversion in Canada, Lands Directorate, Occasional Paper #19, Ottawa.

PROUT, N.A., 1977, Mapping of Ecological Land Units of Labrador Utilizing LANDSAT Imagery, Proc. 4th. Can. Sym. Remote Sensing, Quebec, Que., May 16-18, 1977.

SHUBERT, J.S., J. THIE and D. GIERMAN, 1977, Computer Processing of LANDSAT Data as a Means of Mapping Land Use for the Canada Land Inventory, Proc. 4th Can. Sym. Remote Sensing, Quebec, Que., May 16-18, 1977.

RUBEC, C.D.A., 1978, Land Use Change Detection Using LANDSAT Digital Data and the Canada Geographic Information System, Lands Directorate Interim Reports, Ottawa.

THIE, J. and D.M. WELCH, 1977, Remote Sensing for Ecological Land Classification: A Short Course, University of Manitoba, Dept. of Landscape Architecture, Oct. 17-21, 1977, Winnipeg.

8.1. INVITED REPORT
FACULTY OF FORESTRY,
U.B.C.
(Dept. Soil Science,
FACULTY OF AGRICULTURE)

Prepared by P.A. Murtha,
Associate Professor

8.1.1 Introduction

The remote sensing program of the Faculty of Forestry, in joint co-operation with the Department of Soil Sci., Faculty of Agriculture, is primarily responsible for teaching of undergraduates, teaching and research with graduate students, extension activities, and research into fundamental and applied problems. The goals are to produce qualified individuals capable of handling remote sensing at the highest professional capacity attainable; to apply knowledge in remote sensing to the specialized problems of British Columbia's people and resources, and to carry technology information transfer to people in government, industry and other sectors of the University. In 1977 the following activities were pursued, and accomplished:

8.1.2 AIRBORNE REMOTE SENSING

The Faculty of Forestry has no capability for obtaining it's own aerial photography by remote sensing data, and therefore must depend on obtaining services of the CCRS Airborne Unit or a private contractor. Air photography was obtained of two natural rangeland communities where a remote sensing rangeland classification was being developed and tested. Thermal line scanning was obtained on a round-the-clock basis for a study of the thermal inertia of the native rangelands in the central interior of British Columbia. Most of the airborne photography is used for damage detection and evaluation. CCRS obtained high altitude photography of two sites, and large-scale color-infrared photography obtained by Integrated Resource Photography with wing-tip cameras was used in the analyses of tree damages. All projects requested in 1977 were flown as specified, however, delays in obtaining the photo product preclude efficient use of good summer weather for ground-checking of interpretation. Therefore, in program planning, we must thoroughly anticipate the ground truth data that has to be collected at the time of the overflight.

8.1.3 SPACEBORNE REMOTE SENSING

The remote sensing program of the Faculty of Forestry makes extensive use of LANDSAT Imagery. It is employed primarily in the initial reconnaissance and stratification of "homogeneous units." However, we have found that items down to 'Level 3' can be interpreted via optical visual analysis (O.V.A.) techniques. It is our belief that the O.V.A. system must be used as a necessary precursor to the eventual computerized interpretation of the digital data. In one case, the philosophy of the Canadian Committee on Ecological (Biophysical) Classification was embodied in an interpretation system. Twenty-one satellite images were mosaicked together to provide a base map of the 80,000 sq. mile Indonesian Island of Sulawesi, and then at a scale of 1:500,000, the Land Systems were mapped (a land system is an area of land throughout which there is a recurring pattern of landforms, soils, vegetation chromosequences and water bodies). The map provided basic biophysical data to professionals working on a CIDA-sponsored U.B.C. contract concerned with the Sulawesi Regional Development Study in Indonesia. LANDSAT imagery was used to map the biogeoclimatic zones and subzones of the SKEENA public sustained yield unit (PSYU) for the B.C. Forest Service. Interpretation of the LANDSAT imagery has been vital in the development of the rangeland classification system, analysis of "snow" communities in Atlin Park (N.W. British Columbia), and in the monitoring of tree mortality caused by the Douglas-fir tussock moth. To accomplish the interpretation, we have an I^2S color-additive-viewer fitted with an automatic exposure control which facilitates the production of top quality Cibachrome prints. Information transfer is accomplished with the aid of a B&L stereo zoom transfer scope.

8.1.4 TECHNICAL DEVELOPMENTS

Most of our activities are application oriented, however, technical developments have involved thermal imagery and forest damage assessment. Substantial progress is being made towards software programming analysis of thermal-line scanner digital data supplemented with meteorological "ground-truth" data.

Analysis of tree damages on large-scale color infrared air photos has provided a formula whereby tree damages may be categorized, and a "plot-damage-value" calculated. The technique provides the capacity to establish a base-line value for tree damages, and sequential monitoring will indicate if damage is remaining static, increasing, or decreasing. The technique is especially useful in areas of chronic fume damage where industry

is under pressure to "clean up it's operation."

The final technical development was the formulation of a remote sensing rangeland classification that may be used during interpretation of satellite data, or walking on the ground.

8.1.5.1 EDUCATIONAL DEVELOPMENTS

After three years of teaching graduate and undergraduate students in remote sensing in the Faculty of Forestry, it became very evident that a need existed for an interdisciplinary program in remote sensing. A proposal was formulated, and after consultation with faculty members in the Department of Computer Science, Geography, and Civil Engineering, each of which on it's own represents a specialized aspect of remote sensing, a proposal was submitted to the Dean of Forestry for transferral to the University President for consideration of the establishment of an Interdisciplinary Program in Remote Sensing. The basic premises were the integration of individual programs, and more efficient use of current facilities for increased numbers of graduate students. Funds were requested for: (1) an image processing and display unit, (2) two technical assistants (one programmer and one photo-interpreter), (3) a new faculty member in Forestry as a specialist in quantitative remote sensing specifically assigned to the task of teaching of the remote sensing inventory systems for resource analysis. The funds for the program were approved by the U.B.C. Board of Governors on June 7, 1977.

The search was completed for the Faculty member, and a candidate is expected to be hired in the near future. The programmer has been hired, the photo interpreter's position is presently being advertised (and is expected to be filled by March 1st, 1978), and the image processing and display unit is being delivered. Increased communication among those concerned with remote sensing on the U.B.C. campus has occurred, research programs are being integrated, and specialty students are seeking information in other discipline fields. Other disciplines, including Astronomy and Geophysics are now involved.

The program is functioning well, and in 1977 over 100 full-time fourth year and graduate students involved themselves in the forestry remote sensing courses. The interest of the students has caused lineups for space to work in and equipment to work with. In a period of University budget cutbacks and restraint, the over-loaded space is a serious handicap to the potential of the remote sensing program. Consequently, there is a strong need for additional space.

8.1.5.2 AN EDUCATIONAL PROPOSAL

It also seems that the remote sensing program is filling a vacuum created by the lack of a B.C. Remote Sensing Centre. Since the U.B.C. program involves top level education at the graduate level, researches basic and applied problems, and provides a base for technology information transfer, a logical evolution of the program would be the establishment of a B.C. Institute of Remote Sensing housed in a home of it's own. Dr. L. Morley, in a letter (June 13, 1977) to the President of U.B.C., supported the idea of an institute. Administered as a U.B.C. function it would have it's goals: a) graduate student education, b) research--both basic and applied, and c) co-operative development with industry relative to remote sensing. The pursuit of the above goals could lead to: a) B.C. playing a more significant role in remote sensing activities, b) production of qualified professionals to meet future needs, and c) in certain areas lead to the establishment of new jobs because of research developments.

8.1.6 USER LIAISON AND TRAINING

User liaison and training are features of the continuing education and extension activities of the remote sensing program. In 1977 the following were conducted:

1) A presentation to a user group in Kamloops, organized by Agriculture Canada;
2) Two appearances on the "Bob Switzer" CBC-TV program to explain benefits of LANDSAT imagery. A record of one program was obtained on videotape;
3) The concept of the remote sensing rangeland classification was described to a special joint meeting of the Society of Range Management and the B.C. Soil Science Land Committee at Williams Lake, B.C.;
4) Special presentations were made to the:
   a. Sixty Soil Science Workshop (Vancouver),
   b. Symposium on Ecological Land Classification (Vancouver),
   c. Canadian Institute of Forestry Remote Sensing Working Group (Edmonton);
5) We represented U.B.C. Forestry Remote Sensing in the B.C.I.T. Hermes satellite "Learning at a Distance" education project;
6) Two continuing education courses were given:
   a. A fall evening course in photo interpretation,
   b. A week-long short course to 33 B.C. Forest Service Inventory Foresters on

remote sensing and photo interpretation.

Except for item 3) above, the activity was carried on by one individual. There is an intense need for year-round backup support for the single faculty member involved in qualitative photo interpretation, both in routine educational duties and in continuing education.

8.1.7 PROFESSIONAL LIAISON

During 1977, I served as President, Puget Sound Region, Americal Society of Photogrammetry, and was responsible for programming in 1976 and 1977. Several highly successful technical programs were held.

In 1977 I was officially appointed as North American Chairman in the Working Group on Remote Sensing for Vegetation Damage Assessment in Commission VII, I.S.P. As such, I was charged by the President, Commission VII to organize a meeting concerned with remote sensing and vegetation damage assessment. Consequently, on February 14, 15 and 16, 1978, a Symposium was held in Seattle, Washington to discuss the status of remote sensing for vegetation damage assessment.

8.1.8 CONCLUSIONS AND FORECAST

The remote sensing program of the Faculty of Forestry under the direction of Dr. P.A. Murtha is functioning as viably and efficiently as time, space, staff and funding permit. A large number of students elected to involve themselves in remote sensing courses, and on an average, their understanding of remote sensing ideas was very good. Research projects were completed, and others were initiated according to available research funds. New equipment was installed which permitted more efficient interpretation of remote sensing data. Professional and User Liaison is high and there is a demand for short courses.

Space and support staff are the critical problems, and in a time of University cutbacks and restraint, the Interdisciplinary Program in Remote Sensing received special support. But, this was not enough, for increased interest and numbers of students has placed many new demands of space and equipment. To have remote sensing used as the tool vital to the inventory, analysis and monitoring of natural and cultivated natural resources, education must be given top priority in remote sensing. The long-term outlook for remote sensing is good, if education plays it's appropriate role in the training of future professionals and citizens.

8.1.9 RECOMMENDATIONS

Whereas the Interdisciplinary Program in Remote Sensing (IPRS) received University support;

whereas a new Faculty is joining the program under funds provided by the University;

whereas the present facilities and staff are overloaded because of the educational needs of students, and continuing educational needs of professionals in resource management;

whereas research funds provided by the National Research Council are allocated through competition with all varieties of University research endeavours, and

whereas remote sensing research constitutes a special type of interdisciplinary activity,

the following recommendations are submitted:

1) that a B.C. Remote Sensing Institute be established and housed by a special grant provided by the people of Canada, for graduate student education, research, industry liaison and continuing education;
2) that the Canada Centre for Remote Sensing through all possible channels recommend to the Federal Cabinet and to the B.C. Ministry of Education that funds be made available for additional professional support staff at the professional and lecturer level, and for additional space;
3) that the Federal Government re-examine it's research funding policy, and make additional funds available for pure and applied research in Remote Sensing through the Canadian Corporation on University Space Science.

8.1.10 APPENDICES

8.1.10.1 Appendix I. Graduate Studies in Remote Sensing. Faculty of Forestry, U.B.C.

Remote sensing studies in the Faculty of Forestry, or in the Department of Soil Science are part of an interdisciplinary program in remote sensing in which the Departments of Computer Science, Geography and Civil Engineering also co-operate. Consequently, there are opportunities for the prospective student to enter through either Forestry or Soil Science and still be associated with the entire program.

Fields of remote sensing study in Forestry or Soil Science are either qualitative or quantitative or a combination of both. In the qualitative area the following

courses are offered:

Forestry 442: "Photo Interpretation of Forest Land". Emphasis of the course is on the photo interpretation of classical landforms.

Forestry 422 (or Soil Science 417): "Forest Land Classification". This spring term course takes the landform photo interpretation course to it's logical conclusions and builds remote sensing models for the different systems of land classification.

Forestry 443: "Remote Sensing in Forestry". This course runs concurrently with For. 442 and is designed to give students of Forestry and Agriculture the biological basis for interpretation of remote sensing data. The course also deals with film-filter relationships, qualitative image interpretation techniques, forest damage interpretation, and discussions of satellite, thermal infrared and SLAR data.

Forestry 543: "Selected Topics in Remote Sensing". A graduate level seminar course designed to look at special problems in remote sensing.

In the quantitative remote sensing area, the following courses are offered:

Forestry 435: "Remote Sensing Systems for Natural Resources Inventory". This course (introduction in September 1978) is designed to give the student a background in the recent developments in the various photo inventory systems, as well as an in-depth appreciation of satellite digital data.

Forestry 542: "Advanced Studies in Photogrammetry". A graduate level quantitative remote sensing course for the more mature student. Photogrammetry, mensuration, and computer programming for remote sensing data interpretation are subjects of study.

A complete list of courses in the remote sensing program is in Appendix II.

The graduate student has opportunities to use some of the most recent remote sensing data interpretation equipment located in the Faculty of Forestry. Equipment on hand includes:
- an I^2S color-additive-viewer fitted with an automatic exposure-control for production of hard-copy prints,
- a B&L stereo-zoom transfer scope,
- a B&L 240 zoom stereoscope,
- an interpreterscope,
- densitometer,

not to mention many varieties of stereoscopes. The remote sensing graduate students in Forestry or Soil Science also have priority access to a Comtal Image Processing and Display Computer (attached if necessary to the U.B.C. computer) located in the Department of Computer Science.

8.1.10.2 Appendix II. List of Courses Available in the Interdisciplinary Program in Remote Sensing.

Forestry		
422	(1½)	Forest Land Classification (cross-listed as Soil Sci. 417)
435	(1½)	Remote Sensing Resources Inventory Techniques (Introduced in Sept. 1978)
422	(1½)	Photo Interpretation of Forest Lands
433	(1½)	Remote Sensing in Forestry (Introduced in 1975)
542	(1-3)	Advanced Studies in Photogrammetry
543	(1)	Selected Topics in Remote Sensing (Introduced in 1975)
Geography		
370	(1½)	Air Photo Analysis
372	(1½)	Cartography
470	(1½)	Remote Sensing in Geographic Enquiry
Computer Science		
502	(1½)	Artificial Intelligence I
506	(1½)	Graphic Data Processing
522	(1½)	Artificial Intelligence II (Scene Analysis)
Civil Engineering		
453	(1½)	Elementary Photogrammetry
456	(1½)	Photogrammetric Surveying
576	(1½)	Civil Engineering Uses of Aerial Photographs.
Astronomy		
421	(1)	Astronomical and Astrophysical Measurements - Sensors & Principles
431	(1)	Astronomical Laboratory - Sensors & Principles

8.1.10.3 Appendix III. List of Faculty Members Involved in the Remote Sensing Program.

Dr. P.A. Murtha, Associate Professor, Faculties of Forestry and Agricultural Sciences;

Dr. A.K. Mackworth, Assistant Professor, Department of Computer Science;

Dr. A.L. Farley, Associate Professor, Department

of Geography.

Dr. G.H. Walker, Professor, Department of Geophysics and Astronomy;

Mr. H.R. Bell, Associate Professor, Department of Civil Engineering.

8.1.10.4 Appendix IV. Current Remote Sensing Projects in the Faculty of Forestry and Dept. Scoil Science.

a) Extravisual detection of vegetation damage. Funded by a three-year N.R.C. grant.
b) Analysis of Thermal Imagery of B.C. Rangelands. Funded in 1977 by U.B.C., now unfunded.
c) Remote Sensing of B.C. Rangelands: A Grasslands Photo Interpretation Manual. Funded by Agriculture Canada Contract.
d) Coastal Classification. Environment Canada, Lands Directorate Contract.
e) Biophysical mapping in Sulawesi from LANDSAT Imagery. CIDA & UBC Contract.
f) Biogeoclimatic Zones of the SKEENA PSYU from LANDSAT imagery. B.C. Forest Service Contract.
g) LANDSAT Rangeland Mapping. Contract from B.C. Select Committee on Agriculture.

8.1.10.5 Recent Publications (Since December 1976)

Murtha, P.A. 1976. Vegetation damage and remote sensing. Principal problems and some recommendations. Photogrammetric (1976): 147-156.

Murtha, P.A. & R. Trerise. 1977. Four years after: photo interpretation of the residual effects of SO_2 damage to conifers and hardwoods. Proc. 6th Biennial Works by Aerial Color Photography in the Plant Sciences. Amer. Soc. Photogramm. pp. 25-30.

Murtha, P.A. 1977. The power of remote sensing. Proc. 6th Soil Sci. Workshop. B.C. Ministry Agric. pp. 35-39.

Murtha, P.A. 1977. Remote sensing in ecological land classification. Proc. Symp. Ecological Land Class. in Canada. pp. 157-168.

Butterick, S. 1977. Alpine vegetation ecology and remote sensing of Terese Island, B.C. Unpublished Ph.D. Thesis, Vancouver.

Watson, E.K. 1977. A remote sensing-based multilevel rangeland classification for the Lac du Bois Rangelands, Kamloops, British Columbia. M.Sc. Thesis, Dept. of Soil Science, U.B.C., Vancouver.

Watson, E.K. & P.A. Murtha, A remote sensing rangeland classification for the Lac du Bois rangelands, Kamloops, British Columbia. Proc. 6th Workshop Air Color Photography in the Plant Sciences. Amer. Soc. Photogramm. pp. 100-110.

Special reports with restricted distribution:

Murtha, P.A. 1977. Air photo interpretation of tree damages, Kitimat, British Columbia. Special report to Surveillance Committee, Pollution Control Branch, Kitimat, B.C. 12 pp.

Murtha, P.A. 1977. LANDSAT Mapping of Sulaewsi. Special report to the Project Coordinator, Sulawesi Regional Development Study. 6 pp.

8.2 FOREST FIRE RESEARCH INSTITUTE

8.2.1 AIRBORNE REMOTE SENSING

The goal of this work is to develop a less expensive alternative to line scanning systems for mapping fire perimeters through thick smoke and for locating hidden fire sources that are encountered in the latter stages of suppression. To date two pyroelectric vidicons imaging in the 3-14 and 1-2 micron regions have been tested. The cost of these systems are about $15,000 and $2,000 respectively. Both systems have potential applications in fire control.

8.2.2 SPACEBORNE REMOTE SENSING 1016223

The goals of this project are to demonstrate the usefulness of LANDSAT digital methods and imagery to Canadian forest fire control agencies and to advance the technology in this field. The project is divided into two distinct parts. The first part deals with the production and operational use of map-like imagery showing major forest fire fuel classes. The second part is attempting to demonstrate that a Landsat digital, fuel type data base covering a large forest region is feasible to construct and use. This data base will supply near real-time fuel type, road and water information for initial attack dispatchers and will also provide the data needed for fire growth modeling. In addition, such a data base will provide information on major changes to the forest such as burns, roads, clearcuts and severe defoliation. Temporal overlaying combined with change detection methods will be researched once the data base is established.

8.2.2.1 APPLICATIONS

Progress to date in the production and application of imagery includes:

a) Production of 120 Taylor enhanced images[1/] covering the complete 8-million hectare area protected by the Société de Conservation de l'Outaouais (S.W. Québec). The area is spanned by 6 Landsat frames and the resulting map-like imagery was produced at a scale of about 1 inch =3.5 kilometers. The "map" has been successfully field tested during the last two fire seasons.

b) Production of a geometric corrected area to a U.T.M. coordinate base spanning 2 Landsat frames in the Outaouais area. A Taylor enhancement designed for forest access road detail was completed for one of these frames and tested in the field last season.

c) Production of a forest fire fuel map similar to the Outaouais map for a 3-million hectare area of northern New Brunswick at the request of the N.B. Forest Service.

d) Demonstration imagery for smaller areas using the Taylor enhancement method have been made for the Kelowna, B.C.; Hinton, Alta.; and Timmins, Red Lake, Dryden, Ont., areas. In some of these areas temporal overlays and change detection procedures were used.

Progress to date in the construction of Landsat data base include:

a) Conversion of the CCRS data management system UNIDISK and the accommpanying handlers to run on the Institute's PDP/11 T-34 minicomputer (RSX 11M operating system with standard FORTRAN IV). This will be used as the data management system for the large data base designed to cover the Outaouais forest fire control area at 1/2 hectare resolution.

b) Conversion of part of the CCRS UNIVID software package to run on the Institute's computer. This software provides the means to transport standard CCRS format output to the Institute's computer.

c) UTM correction and resampling to 1/2 hectare square resolution units of 2 Landsat frames in the Outaouais region. These frames are to be classified using CCRS's unsupervised histogram clustering algorithm to provide initial data for the Institute's data base.

8.2.2.2 1978 WORK PLAN

Efforts during 1978 will include:

a) Severe conifer defoliation mapping (for fire control purposes) using specialized temporal overlays combined with Taylor enhancement.

1/ Dr. M. M. Taylor, Defence and Civil Institute of Environmental Medicine, Dept. of National Defence, Downsview, Ontario.

b) Taylor enhanced mapping of a large area of the north central fire control region of the Ontario Ministry of Natural Resources (an area spanning parts of 4 Landsat frames). The output will consist of two series of 8 x 10 inch prints at a scale of about 1:50,000. The first "map" will show broad forest cover types, water and clearcut; the second series will be designed for road enhancement.

c) Continued work on the construction of the fuel type data base system.

d) Fuel type mapping of a small demonstration area for fire control purposes in northern Saskatchewan.

8.2.2.3 CONCLUSIONS

Landsat digital imagery has been shown to be a useful tool for forest fire control. Current efforts are aimed at demonstrating this tool to the various users across Canada. Future improvements in information content and image quality will come with the use of UTM geometrically corrected data, temporal overlaying, change detection methods and specialized enhancement (i.e., for roads). FFRI strongly supports CCRS in its efforts to:

a) To encourage development of a low cost image analysis and display system and/or remote terminal system suitable for provincial and industrial users across Canada.

b) To research, develop, document and maintain state-of-the-art software for digital processing and to make this software available for other Canadian imaging systems.

c) To continue investigating and testing of low cost alternatives for producing large quantities of hard copy output.

8.3 INTERTECH REMOTE SENSING LIMITED

8.3.1 Introduction

Intertech Remote Sensing Limited is a federally incorporated company jointly owned by Innotech Aviation Ltd. and Intera Environmental Consultants Ltd. Innotech and Intera have agreed that the managerial and technical direction required by Intertech will be provided by Intera.

Intertech has been organized to fill a gap in the Canadian Service Industry. It will be the first substantial Canadian commercial organization dedicated to the provision of services in environmental remote sensing. Intertech will not seek to acquire a share of markets already well serviced by Canadian enterprises (i.e. photogrammetry and geophysical surveys), but will focus its energies on the commercial application of new remote sensing technologies to renewable resource management.

These new remote sensing technologies have been pioneered in this country by the Canada Centre for Remote Sensing. Several years ago CCRS initiated a Transfer Plan with the ultimate purpose of transferring new technologies to Industry. Through involvement in CCRS activities by service contract, Innotech and Intera have been able to acquire the technology, operations experience, and market familiarity to launch this new venture.

8.3.2 Organization

Intertech will operate as a fully independent corporation with administrative and contractual responsibilities, having its own management and marketing staff much as defined in the Transfer Plan. Intertech has been organized with a Board of Directors, President and Vice President selected from the parent companies. Intertech will hire its own full time General Manager, Controller, Marketer, Secretary and Operations staff. These people will have the responsibility and authority to carry out those activities commonly found in commercial operations, such as administration, marketing, contract management, subcontracting, invoicing, business development, etc. It is expected that this staff will be fully organized and operational within the calendar year of 1978.

8.3.3 Data Acquisition Services

Intertech will operate aircraft equipped with a variety of remote sensing equipment with purposes of acquiring imagery and other data in the general categories described below:

(a) Colour and false colour 23 cm photography for biophysical surveys and environmental management studies using colour correction and filtering techniques developed by Fleming, Fretts et al.

(b) Thermal infrared data for fire mapping, energy management surveys and environmental impact studies.

(c) Multispectral photography for environmental impact monitoring and biophysical surveys.

(d) Radar surveys, specifically X-L Band Synthetic Aperture Radar for ice studies, geologic exploration and other environmental management purposes.

8.3.4 Data Analysis Services

Intertech will offer the services of professional remote sensing interpreters under contract for the purposes of undertaking data analysis in the following areas:

(a) Biophysical surveys and preparation of ecological habitat maps.

(b) Analysis of rangeland conditions for range management agencies.

(c) Analysis of vegetation stress and environmental impact from Industrial operations.

(d) Analysis and interpretation of ice type, character and surface conditions.

(e) Analysis of Landsat imagery by conventional or digital techniques as may be required.

The services listed above will be complemented by the preparation of technical reports and a variety of consulting services.

8.3.5 Staff

Intertech will begin with a nucleus of managerial and professional staff as described in an earlier paragraph. As sales volumes grow and operations of the company expand, Intertech will add applications scientists, technicians and pilots for execution of the work. It is anticipated that the operations staff will be derived in the first year or so through sub-contracts with the parent companies. However, as the business volume grows Intertech will require its own multi-disciplinary staff.

8.3.6 Facilities and Equipment

Intertech will operate initially out of two bases, Ottawa and Calgary. Intertech will operate its own aircraft, cameras, thermal scanner, and multispectral camera. Intertech will have access to the X-L Band Synthetic Aperture Radar under lease from the Environmental Research Institute of Michigan and will be able to offer surveys with that facility. Intertech will also have available to it all the interpretive systems and analysis equipment from its parent companies. The initial address for management staff is: Intertech Remote Sensing Limited, P.O. Box 507, RR5, Hunt Club Road, Ottawa, Ontario, K1G 3N3. Telephone: (613) 521-4073.

8.4 REPORT ON THE REMOTE SENSING TRAINING PROGRAM AT THE NOVA SCOTIA LAND SURVEY INSTITUTE

8.4.1 LOCATION AND HISTORY

The Nova Scotia Land Survey Institute (NSLSI) is located near the geographical center of the Annapolis Valley and operates as a Technical Institute under the Applied Arts and Technology Program of the Nova Scotia Department of Education. It was established in 1948 to provide training for surveyors, and in response to demands by the survey industry, gradually expanded its survey program and included separate programs in cartography and photogrammetry. Students have been drawn from every province in Canada and many other areas of the world; numerous senior survey and mapping officials in the provincial and federal governments, and leaders in industry are graduates of the Institute.

8.4.2 FACILITIES AND FACULTY

In 1975, a new 60,000 square foot facility was erected to house existing programs as well as new offerings in property mapping, community planning and, most recently, photo interpretation/remote sensing. The Institute holds a large inventory of the latest surveying, photogrammetric, cartographic, image interpretation, and data processing equipment. The faculty includes a total of sixteen earth science professionals in such fields as control surveys, photogrammetry, cartography, property mapping, regional and community planning, geography, geology, engineering, and remote sensing. Student enrolment is expected to approach 200 this year.

8.4.3 PROGRAM RESEARCH AND IMPLEMENTATION

NSLSI has for many years been involved in photo interpretation and remote sensing. Several members of the faculty were active in the interpretation of TIROS and supportive airborne imagery; several studies within the province have been undertaken using LANDSAT and airborne imagery. Photo interpretation/remote sensing has been taught as a major subject in each of the existing programs, and therefore, it was a natural progression to develop a specialized program in this field. Considerable support for the concept of a full-time training program in photo interpretation/remote sensing was given by the Nova Scotia Remote Sensing Committee and by CCRS. In 1976, with the assistance of CCRS, a questionnaire was distributed to many of the users of remotely sensed data in Canada. Results of the survey indicated strong approval for such a program and a continuing demand for graduates.

Approval for the implementation of the course was sought and received early in 1977. A class of 9 students was enrolled in October. These students have a wide variety of backgrounds including biology, geology, mathematics, oceanography, forestry, and cartography. They will graduate in May 1979. Enrolment for the class commencing in September 1978 is progressing, and the full establishment of 15 students has almost been reached.

8.4.4 PROGRAM CONCEPT

The general concept of this program is to provide the individual student with a veneer of technical expertise which he will use in the context of his prior education. If the individual comes to the program with a high school education, he will operate, upon graduation, as a technologist to assist the professional investigator in research and operational studies. Should the individual student have prior professional training, the addition of this diploma program will enable him to operate as a research scientist or independent investigator in studies related to his particular discipline. The first year is designed to provide the student with a basic knowledge of data acquisition platforms and systems, data handling procedures and analysis techniques, and permit the development of skills in the use of interpretation equipment. During the second year the student acquires a thorough knowledge of state-of-the-art non-imaging sensing devices, advanced platforms, and current data processing systems.

8.4.5 CURRICULUM

(1) First Year

Photography---------- 60 hours

Technical details of air cameras, film types and spectral response, filters and their use. Photographic processing and reproduction methods, sensitometry, and densitometry.

Data acquisition---------- 60 hours

Capabilities and limitations of satellite and airborne sensor platforms, mission planning, maps, charts, navigation, data handling, and reference sources.

Photo Interpretation----------120 hours

Interpretation equipment including folding, mirror and dual viewing stereoscopes; parallax-bar stereometers; wedges; scales; and grids. Measurements of areas, heights, and horizontal distances; construction of mosaics and radial line plots. Interpretation procedures and reporting.

Applications - Land----------310 hours

Photo geology and classification of various landforms. Analysis of rangeland and agricultural areas to determine soil types, acreage, possible yields, and crop disease. Forest cover, species determination, diseased and infested areas. Wild life habitant and counts. The determination of areas from which gravel or other construction materials may be obtained. Landform and material analysis as applicable to engineering requirements.

Applications - Water----------180 hours

Photohydrology and limnology including stream sources, drainage patterns, aquifers, and ground water tables. Pollution-thermal, natural and cultural in streams, lakes, ground water, and oceans. Submerged and emergent aquatic vegetation. Water currents; beach formation and erosion; the formation, dimensions, and behaviour of ice and glaciers.

Applications - Fieldwork----------150 hours

The care and use of basic ground survey equipment. Measuring horizontal and vertical distance; stream and landform gradients. The measurement of radiated and emitted energy using meters and radiometers. The identification of trees, crops, and grass. The preparation of test areas for remote sensing experiments.

Cartography---------- 90 hours

Lettering: Study of letters and lettering practice. Basic drafting. Care and use of instruments. Tracing in pencil and ink. Symbolization, graphic arts aids, layout, and design.

Technical Writing----------30 hours

Report layout, clarity, brevity; use of illustrations, maps, and charts; the executive summary, introduction, appendices, and glossary of remote sensing terms.

(2) Second Year

Advanced and Proposed Platforms------ 30 hours

Spectroscopy----------120 hours

Microwave Systems and Applications---120 hours

Optical Processing---------- 90 hours

Digital Processing----------150 hours

Data Transmission---------- 30 hours

Multi-spectral Systems---------- 90 hours

Major Project----------200 hours

Thesis Report----------170 hours

Note: Almost one-third of the second year will be devoted to the conduct of a major Remote Sensing Project culminating in a thesis type report. NSLSI has submitted a proposal to the SURSAT Project office for consideration, and it is planned to utilize this investigation as the students major project in the 1978-79 school year.

8.4.6 ADVISORY COMMITTEE

The curriculum summary, as outlined above, will be subjected to constant, critical analysis and revision to ensure the constantly changing requirements of the remote sensing community are met. To ensure the currency and validity of the program, an advisory committee has been appointed. Members are recognized experts in the application of remote sensing techniques within their particular field of endeavour; the first meeting is scheduled for 10 April 1978.

9.0 REPORT OF THE ACTION TAKEN BY CCRS AS A RESULT OF THE 1976 CACRS RECOMMENDATIONS

The following is a summary describing some of the action taken by CCRS to respond to the recommendations presented at the last CACRS meeting. The numbers cross-reference to the 1976 CACRS report.

3.10.1.1 A recommendation was passed to the National Research Council through IACRS with regard to recommending increased funding for research in areas of pattern recognition and image analysis. No response has been made by the National Research Council to this request. It is likely, therefore, that no increased funding has been approved for this research.

3.10.1.2 CCRS provides subsidies for the reception and data processing of LANDSAT imagery. The prices charged for image products cover the ISIS costs of reproduction and sales plus a royalty charge to offset the newly imposed NASA LANDSAT reception costs. Even so, the costs of products are below the EROS Data Centre charges for similar products.

3.10.1.3 CCRS has, in the past, responded to requests from the provinces to help them establish provincial centres and is still prepared to do so at any time. The specific request, however, must come from an interested provincial agency.

3.10.1.4 This is already happening and the APS-94D SLAR will soon be operational on the AES Electra aircraft for their ice reconnaissance program. DFE is also promoting the acquisition of a DASH-7R aircraft to be phased in to the ice reconnaissance program.

3.10.2.1 This recommendation has been referred to the Surveillance Satellite Project Office, but any possible action will probably have to be delayed until after 1979. Meanwhile, studies are continuing in cooperation with ESA as well as with NASA. Further studies will be undertaken in 1979 to provide the information necessary to recommend the most appropriate form of Canadian surveillance satellite systems in the 1980's.

The SURSAT office believes that initial technology development study contracts should be let for a space component of a Canadian surveillance satellite prior to 1979, taking into account such developments in NASA and ESA.

3.10.2.2 CCRS and other Federal departments have supported this type of endeavour through contract work in 1977. The Applicatons Development Section of CCRS is providing the scientific authority for the applications portion of this work.

3.10.2.3 CCRS is doing as much as it can with existing resources.

3.10.3.1 With regard to training courses, the Applications Division has sponsored a number of specialized workshops. In addition, CCRS has observed with pleasure a marked increase in the number of training courses organized by provincial centres, professional societies and industry. The formation of the CCRS marketing unit will assist CCRS to produce more PR information and lists of user-oriented applications and manuals on specific topics of user interest.

3.10.4.1 The SURSAT project, and in particular the SAR-580 component thereof, responds at least in part to these recommendations. Approximately 250 requests for SURSAT experiment proposals were distributed in early September 1977. As a result of this solicitation, 104 experiment proposals were received and are presently being evaluated. The SURSAT activity will greatly enhance user familiarization with aircraft and spaceborne imaging radars and complementary sensors. Further details are given in the SURSAT "User Handbook".

3.10.4.2 This is already being done. The system being developed will have a much higher spectral resolution than that of conventional multi-spectral scanners. Initial flight tests of a 2 channel prototype system have already taken place. CCRS would like to have more detailed feedback from the user community on the uses and potential users of this data.

3.10.4.3 Individual principal investigators should put their requests through CCRS for forwarding to NASA and ESA. Some have already been forwarded.

3.10.5.1 Dr. Morley presented a paper at CACRS 1978 on "Regional environmental information and co-ordination centres", in which he divided remote sensing activity into real-time monitoring and mapping. The term "database" probably applies more to the mapping activity than to the real-time monitoring or "now-casting".

3.10.5.2 The results of all the SEASAT experiments, including the SAR-580 and ground truth, will be discussed at a SEASAT conference and published along with the available SAR data.

3.10.5.3 This is the subject of a new initiative proposed by Dr. Morley at CACRS 1978, i.e., Ocean and Land information centres.

3.10.5.4 This is being done via the CCRS Newsletter. Preprints of foreign papers on remote sensing are entered into RESORS.

3.10.5.5 Prices for LANDSAT products are now reviewed annually in May. Adjustments are based on inflationary increases for materials and labour plus changes to the royalties after a review by Treasury Board of annual product sales.

3.10.5.6 Although this information is available commercially, the recommendation is a good idea and CCRS will attempt to implement it through the new Marketing and User Assistance Unit.

3.10.5.7 Le Centre canadien de télédétection produit actuellement toutes les images LANDSAT à Ottawa en utilisant un enregistreur cathodique (EBR). 1978 verra la production des négatives de première génération à Prince Albert à l'aide d'un enregistreur laser (LBIR). Les commandes pour les images en noir et blanc reçues par la station de Prince Albert seront satisfaites sur place and distribuées par ISIS dans les cinq jours. Les images en couleurs seront produites par les services de la Photothèque Nationale de L'Air (NAPL) à Ottawa dans un délai de trois semaines. Dans le futur, les images en couleurs seront aussi produites et distribuées par ISIS à Prince Albert. La façon de procéder pour commander une nouvelle image ou une reproduction sera envoyée par la poste avant que nous introduisions ce nouveau service à Prince Albert.

3.10.5.8 Les donneés et statistiques concernant les missions aéroportées sont transmises trimestriellement aux centres regionaux. Les programmes d'estimation des coûts sont maintenant accessibles par l'intermédiaire de l'ordinateur du CCT.

3.10.5.9 Le Centre fera tout son possible pour accélérer le travail de traduction.

3.10.6.1 This recommendation is unclear, and further clarification is requested from the working group.

3.10.6.2 CCRS is actively considering making the standard geometrically-corrected CCT product in the form of a sub-scene matching standard NTS 1:50,000, 1:125,000, or portions of 1:250, 000 UTM map sheets. It is expected that the cost of one geometrically corrected subscene would be similar to that of a full scene corrected for systematic errors (current product). There are no plans to produce system-corrected CCT subscenes.

3.10.7.1 CCRS encourages this, as far as it is considered feasible by working group chairmen.

3.10.7.2 Some working groups never met in 1976. In other cases, minutes were not distributed. Chairmen should send minutes to Mr. J. C. Henein at CCRS with a request to have them circulated. This will be one of the functions of the User Assistance and Marketing Unit, whose Chief is Mr. Henein.

3.10.7.3 This is happening as requested. A new Ocean Management chairman will be appointed.

3.10.7.4 This action may be taken by the Agriculture Working Group without reference to CACRS.

3.10.8.1 The CCRS Image Analysis System does provide first priority to users concerned with the development of operational applications of LANDSAT data from 1200 hours to 2200 hours, five days a week. During these times, a trained analyst is provided to work with the user in achieving the user's objectives. There are, however, fluctuations in demand for the CIAS during the year. If problems develop with respect to overloads, we will increase the user time to encompass a third shift for which we currently do not have staff.

3.10.9.1 CCRS is presently compiling a series of educational films and slide shows. These have been made available to educational institutions.

3.10.10.1 It is difficult to implement a vertical scale change varying with latitude in our basic production systems. We will implement the vertical setting that minimizes geometric error for Canadian latitudes. The digital correction system produces geometrically corrected images on a scene basis and will automatically take into account scale changes with latitude.

10.0 PARTICIPANTS IN CACRS MEETING

M. Hervé Audet
Provincial Representative
of Québec

Mr. Ralph C. Baker
Chief
Data Acquisition Division
CCRS

Mr. Robert Bone
Chief Administrative Officer
CCRS

Mr. Cal D Bricker
Provincial Representative
of Alberta

Mr. Leon Bronstein
Acting Chief
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CCRS

Dr. Ira C. Brown
Chairman
W.G. on Hydrology

Mr. Brian Bullock
Intertech Remote Sensing Ltd.

Mr. Donald Daw
National Aeronautical Establishment
National Research Council

Mr. Bob Douglas
for Provincial Representative
of Manitoba

Mr. Donald Fisher
Chairman
W.G. on Photo Reproduction and Marketing

Ms. Betty Fleming
for Chairman
W.G. on Cartography and Photogrammetry

Mr. E. A. Godby
Associate Director-General
CCRS

Dr. James F. R. Gower
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Mr. Jean-Claude Henein
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Program Planning and Evaluation Unit
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Mr. Donald Himelman
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Dr. Philip A. Howarth
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Dr. Peter Kourtz
Forest Fire Research Institute
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Dr. Jaan Kruus
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Dr. Philip A. Lapp
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Ms. Frances Macdonnell
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Mr. Sen Mathur
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Mr. Ernest J. McLaren
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Mr. Burtt Smith
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Mr. Jean Thie
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Dr. Roy VanKoughnett
Project Manager
Surveillance Satellite Project
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Mr. John Wightman
Provincial Representative
of Nova Scotia

Mr. Richard Worsfold
for Provincial Representative
of Newfoundland

Mr. Victor Zsilinszky
Provincial Representative
of Ontario

11.0 TABLE OF ACRONYMS USED IN THIS REPORT

AES	Atmospheric Environment Service, DFE
AIDJEX	Arctic Ice Dynamics Joint Experiment (U.S. - Canada)
AMOP	Arctic Marine Oilspills Program
AQT	Association québecoise de télédétection
ARIES	Interactive remote sensing interpretation systm (FMI)
CACRS	The Canadian Advisory Committee on Remote Sensing
C-CORE	Centre for Cold Ocean Research Engineering, Newfoundland
CCRS	Canada Centre for Remote Sensing
CCT	Computer Compatible Tape
CHS	Canadian Hydrographic Service, DFE
CIAS	CCRS Image Analysis System
CNES	Centre national d'études spatiales (France)
CSFR	Colour Strip Film Recorder
CWS	Canadian Wildlife Service, DFE
DCP	Data Collection Platform
DFE	Department of Fisheries and the Environment
DICS	Digital Image Correction System
DINA	Department of Indian and Northern Affairs
DND	Department of National Defence
DOC	Department of Communications
DOT	Department of Transport
DRE	Defense Research Establishment, DND
DSS	Department of Supply and Services
EDC	Eros Data Centre (US)
ELCE	Ecological Land Classification and Evaluation Division, DFE
EMR	Department of Energy, Mines and Resources
ERIM	Environmental Research Institute of Michigan
ERTS	Earth Resources Technology Satellite (U.S.) (Name changed to LANDSAT Jan/75)
ESMR	Electronically scanned microwave radiometry
FAX	Facsimile
FFRI	Forest Fire Research Institute, DFE
FFT	Fast Fourier Transform
FGGE	First GARP Global Experiment
FMI	Forest Management Institute, DFE
FMS	Fisheries and Marine Service, DFE
GEOS	Geodetic Satellite (NASA)
GOES	Geostationary Operational Environmental Satellites (2/5) SMS - Synchronous Meteorological Satellite
GSC	Geological Survey of Canada, EMR
IISS	Image Inventory Search and Summary (CCRS)
IMAGE -100	Interactive Multispectral Image Analysis System (CCRS)
INS	Inertial Navigation System
IPAS	Interprovincial Advisory Subcommittee (of CACRS)
ISIS	Integrated Satellite Imaging Systems Ltd.
ISISFICHE	Daily LANDSAT coverage of Canada produced on microfilm by ISIS
LLLTV	Low Light Level Television
LS-D	LANDSAT-D
MAD	Bendix Multispectral Analyzer Display
MEIS	Multispectral Electro-optical Imaging System (CCRS)

MIPS	Multi Image Processing System (PASS)
MOT	Ministry of Transport (see DOT)
MSD	Marine Sciences Directorate,DFE
MSS	Multispectral scanner
NAPL(RC)	National Air Photo Library (Reproduction Centre), EMR
NASA	National Aeronautics and Space Administration (U.S.)
NIMBUS	Weather and Earth Atmosphere Satellites (U.S.)
NOAA	National Oceanographic and Atmospheric Administration (U.S.).Also a series of environmental satellites operated for that administration.
NORDCO	Newfoundland Oceans Research and Development Corporation
NSLSI	Nova Scotia Land Survey Institute
NTS	National Topographic System
OAS	Ocean and Aquatic Sciences,DFE
OCRS	Ontario Centre for Remote Sensing
OMA	Optical Multichannel Analyser
OVA	Optical visual analysis
PAIGH	Pan-American Institute of Geography and History
PASS	Prince Albert Satellite Station (CCRS)
RBV	Return Beam Vidicon, a camera system on LANDSAT
RESORS	Remote Sensing On-Line Retrieval System, a document retrieval system at CCRS
SAR	Synthetic Aperture Radar
SCSS	Shoe Cove Satellite Station (CCRS)
SEASAT	Ocean parameter observing satellite due for lauch in 1978 (USA)
SKYLAB	Manned space station (U.S.)
SLAR	Side-Looking Airborne Radar
SMMR	Scanning Multifrequency Microwave Radiometer
SPOT	Satellite pour l'observation de la Terre (France)
SSC	Suspended sediment concentration
SURSAT	Surveillance Satellite Program (Canada)
TB	Treasury Board
TIROS-N	U.S. meteorological satellite
UAMU	User Assistance and Marketing Unit (CCRS)
UTM	Universal Transverse Mercator System
VHRR	Very High Resolution Radiometer (AES instrument)
VISSR	Visual Infrared Spin Scan Radiometer (a sensor on the GOES Satellite)

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