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THE CANADIAN ADVISORY COMMITTEE ON REMOTE SENSING

1978 REPORT

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

Dear Dr. Keys:

1978 was marked by a distinct jump in interest in operational remote sensing by the provinces. In operational remote sensing, it is ultimately the provinces which have the responsibility for resource and environmental management within their own boundaries. Six years of experimentation with Landsat 1, 2 and 3 data have demonstrated unquestionably that not only is satellite and airborne remote sensing useful for resource and environmental management but, for a country like Canada with its large and sparsely populated hinterland, it is essential.

The period of experimentation is past. Enough knowledge and support are now available in the provinces that the next six years should be marked by innovating this new technology into the provincial resource and environmental monitoring systems.

Yours sincerely,

L. W. Morley

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

28 June 1979.

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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, and thus ensures a broad representation of users, scientists and technologists. Annual meetings are held early in the calendar year 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

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 9-12, 1979

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. He also highlighted the fact that this was the first CACRS meeting at which simultaneous translation into both official languages was provided for the plenary sessions. (The workshop group representing the province of Québec also worked entirely in French.)

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. Victor Zsilinsky, the Ocean Management groups by Mr. Richard Worsfold, the Water Resources group by Dr. Ira Brown, the Land groups by Mr. Roy Slaney, the Vegetation groups by Dr. Alex Mack, the Technology groups by Mr. Sen Mathur, and the Specialty Groups by their representatives. 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 presentation by Dr. Phil Howarth of the report prepared by the ad-hoc committee on the rôle of education in the national program, which was established by the previous year's CACRS meeting. The report is attached as Section 8.1.

A presentation was made by Dr. Peter Kourtz entitled "An Insight Into the Problems of LANDSAT Technology in Forestry". This report is attached as Section 8.2.

2.4 STATEMENT OF THE THEME

The theme of the meeting was introduced on Tuesday afternoon by Dr. Larry Morley, who presented a statement of the problems involved in the development of regional environmental monitoring centres.

Subsequently, the first invited speaker, Mr. Angus Hamilton, Chairman, Survey Engineering Department, University of New Brunswick, presented a paper entitled "A Suggested Approach to the Development of Environmental Monitoring Centres", which is attached as Section 8.3.

The second invited speaker, M. Raymond Bergeron of the Société de développement de la Baie James, then spoke on the topic, "An Example of Resource Management in Canada - The James Bay Territory".

2.5 WORKSHOP GROUPS

Following these presentations, the conference broke into workshop groups consisting of representatives from five Canadian regions:

- the Atlantic provinces
- Québec
- Ontario
- the Prairies and the Northwest Territories
- British Columbia and the Yukon

The members of these groups spent a total of ten hours discussing the concept of the development of regional environmental monitoring centres. Each group prepared a list of conclusions and recommendations which are summarized in Section 3.

2.6 DISCUSSION OF RECOMMENDATIONS

On the final 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).

2.7 CONCLUSION

Dr. Morley closed the meeting at noon on Thursday, April 12, remarking on the amount that had been accomplished in three days, and looking forward to a successful year ahead.

He also thanked M. Guy Rochon, Président, Groupe de travail sur les écosystèmes terrestres, for his excellent work as General Chairman of the meeting. Next year's meeting will be chaired by Dr. Peter Kourtz, Forest Fire Research Institute.

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3.0 RECOMMENDATIONS

The members of the meeting were divided into five workshop groups (see 2.5) and the recommendations from each workshop are summarized below as 3.1 to 3.6. In each case, CCRS has added comments or action statements.

As well as this, each working group, province, and specialty group was invited to include recommendations in its annual report to CACRS. These recommendations are printed in each individual report but are also summarized below from 3.7 to 3.16.

The recommendations made by the ad-hoc committee on the role of education in the national program are also included as 3.17.

3.1 Recommendations from the British Columbia-Yukon Workshop

3.1.1 Whereas B.C. is already involved in a pilot project of integrated data base-lining and proposed monitoring activity on the Cranbrook test site, that CCRS pursue the idea of establishing under the B.C. Ministry of Forests, the demonstration of the advantages of the "distribute information network" that incorporates remote sensing data for the purpose of regional environmental monitoring.

- CCRS will initiate discussions with the B.C. Ministry of Forests on a joint project concerned with the role of remote sensing in regional environmental monitoring. The project would be conducted under the leadership of B.C. Ministry of Forests, would incorporate data base/information retrieval concepts, and would be supported by CCRS facilities and manpower as necessary.

3.1.2 That the chairman of CACRS pursue through the proper channels to the Canada Council of Resource Environment Ministers (CCREM) the recommendation that a study be done to define the existing land-based resource and environmental systems in Canada for the purpose of designing a resources and environmental monitoring system and to make recommendations on mechanisms for joint planning.

- This item will be discussed with IACRS in connection with the draft LANDSAT-D submission.

3.2 Recommendations from the Prairies & Northwest Territories Workshop

3.2.1 That provincial centres supported in part by the national program increase their thrust in environmental monitoring activities.

- CCRS supports this recommendation.

3.2.2 That provincial centres play a catalytic rôle in developing links between remote sensing information systems and disciplinary information systems, hence contributing to the development of an integrated resource management information system.

- CCRS supports this recommendation.

3.2.3 That numerous CACRS recommendations in the past have given strong support to the establishment of remote sensing centres in the Prairies and Northwest Territories. Centres are not yet functioning in Saskatchewan and the Northwest Territories. These recommendations, therefore, are still valid today. It is recommended that the important need for these centres be recognized.

- CCRS recognizes this need and encourages the governments of the provinces and territories to establish such centres. CCRS is prepared to assist through consultations and technical advice on request.

3.3 Recommendations from the Ontario Workshop

3.3.1 That CCRS establish a project to demonstrate the operational acquisition and analysis of remote sensing data for environmental monitoring at a suitable location or locations in Canada.

Members endorse the concept of environmental monitoring centres, but recommend caution against premature efforts to establish such centres. The first step is to demonstrate that remote sensing data can be acquired, be analyzed and be effectively combined with other data. This must be done on a timely and repetitive basis to provide information required by resource managers.

To aid CCRS in this endeavour, OCRS and other interest government agencies, OARS, universities and business enterprises would be willing to negotiate possible

test sites and offer expertise and cooperation.

- CCRS welcomes the concept of this recommendation and invites the province to propose a cooperative project in which CCRS will be happy to join as far as resources allow. See response to 3.1.1.

3.3.2 That CCRS carefully investigate both the current availability and the lack of data to meet needs at all levels of resource management in government and industry. The findings of this study should guide the implementation of the demonstration project.

- See response to 3.3.1.

3.4 Recommandations de l'atelier de Québec

3.4.1 Que le CCCT (CACRS) achemine la recommandation suivante aux IACRS, que soit créé un comité interministériel pour la gestion des informations sur l'environnement et les ressources naturelles avec le mandat suivant:

(1) d'harmoniser les modes d'acquisition et de stockage des informations sur l'environnement sous la responsabilité fédérale;

(2) de viser, dans cette opération, à répondre aux besoins d'information des organismes régionaux (fédéraux et provinciaux) de gestion des ressources naturelles.

- Le CCT le fera.

3.4.2 Que les coûts d'acquisition des données de satellite LANDSAT soient entièrement assumés par le gouvernement fédéral et que seuls les coûts de dissémination des données soient transférés aux utilisateurs.

- Le principe de cette recommandation est effectivement appliqué, à l'exception toutefois des redevances à la NASA, qui doivent être passées aux utilisateurs aussitôt que cela sera possible.

3.4.3 Que soit acheminée aux ministères québécois intéressés, la suggestion suivante:

que le gouvernement du Québec étudie la possibilité de créer un organisme québécois chargé de la gestion des informations sur l'environnement et les ressources naturelles de son territoire. Pour favoriser cette opération, il est suggéré qu'une expérience pilote soit tenée sur un territoire limité comme, par exemple, le territoire de la Baie James. Il est proposé que cet organisme normatif soit chargé de concevoir, réglementer, développer et surveiller la gestion de ces informations.

- Voir la réponse à la recommandation 3.1.1 et 3.3.1.

3.4.4 Dans le cas où le Québec développe un projet pilote de gestion des informations sur l'environnement où la télédétection y est intégrée, que le Centre canadien de télédétection apporte un soutien à ce projet en fournissant des ressources appropriés.

- Voir la réponse aux recommandations 3.1.1 et 3.3.1.

3.5 Recommendations from the Atlantic Provinces Workshop

3.5.1 That a "service facility" be established in association with existing facilities such as:

(a) Memorial University of Newfoundland
(b) Nova Scotia Land Survey Institute
(c) University of New Brunswick

Such an association has the following merits:

i) Permits the multi-purpose use of equipment and personnel
ii) Expedites technology transfer
iii) Facilitates related research and education
iv) Allows operation within a flexible institutional framework.

- CCRS encourages the establishment of such facilities, and is prepared to support them through consultations and technical advice on request.

3.5.2 In view of the emerging technology of the 1980's, it is now urgent that studies of regional requirements for land monitoring be carried out. It is recommended that CCRS provide "aid in

kind" to M.U.N., N.S.L.S.I., and U.N.B. to complete this cooperative study by the end of 1979.

- See 3.1.1, 3.3.1, & 3.5.1

3.6 Recommendations from IPTASC

3.6.1 Due to the inconsistent satellite image and data quality and poor service presently received, that CCRS permit separate contracts for PASS and SCSS when the present contract is renegotiated.

- This request will be considered by CCRS when contracts are renewed.

3.6.2 In view of the changing procedures in the airborne program for procuring flights and with regard to the end of the SURSAT Program in May 1979, that a clear statement of the new airborne policy, commonly referred to the "dry lease", be received before 1 June 1979.

- The CCRS Airborne policy is included in section 4 of this report. The "dry lease" concept has not yet obtained official approval.

3.6.3 Since the present arrangement for operational remote sensing airborne missions has proven to be unsatisfactory, that the restrictions on the use of CCRS aircraft be automatically lifted when commercial operations are unable to provide the services at the time specified by the client.

- Please see the airborne policy included in section 4.

3.6.4 As pleased as the provincial representatives are with the excellent reputation that CCRS has gained in the "developing nations", it is felt that its performance could be improved in the "developing provinces". It is, therefore, recommended that CCRS management, in consultation with the provincial representatives, develop specific "assistance in kind" programs to technologically under-developed provinces. This program should be implemented as soon as possible but no later than 1 September 1979.

- It should be noted that the main ingredient allowing some work in developing nations is CIDA funding. One equivalent source of funding for "developing provinces" is the Department of Regional Economic Expansion.

One of the principal requirements for CIDA funding of a project is that the interested country should consider it important enough to be placed high on the priority list in dealing with CIDA. The exact parallel for developing provinces is that they should carefully define the remote sensing projects that interest them, and place these projects high enough in their priority list in discussions with DREE or equivalent. CCRS will certainly respond with enthusiasm to such Province/DREE projects.

3.6.5 That CCRS Fact Sheets should be produced on a timely basis for:

(a) reviews of significant new publications and text books

(b) lists of newly released and available papers, reports and miscellaneous literature; both (a) and (b) demand a reporting procedure to be instituted amongst the remote sensing community.

- The CCRS Technical Information Service will compile and distribute remote sensing bibliographies on a regular basis (4 to 8 times a year). The bibliographies will be compiled from recent library acquisitions, will include books, reports, papers and miscellaneous literature, and will be distributed to individuals on the CCRS mailing list.

3.6.6 That a senior CCRS official submit a letter to the provincial representatives by 15 July 1979, outlining how and when the conclusions stated in Dr. Peter Kourtz's paper "An Insight into the Problems of LANDSAT Technology Transfer in Forestry" will be implemented.

- This letter is being prepared.

CONSOLIDATED RECOMMENDATIONS FROM THE REPORTS (Sections 5 to 8)

3.7 Organization

3.7.1 The development of Canadian space applications and technology is being increasingly hampered by the lack of

an effective, coordinated approach in Canada to space-related activities. This is especially serious in our dealings with the coordinated space activities of other countries. Therefore, the Data Handling and Satellite Technology Working Group supports, and recommends that CACRS strongly support, the development of a Canadian space agency and that it carry this recommendation to the ministerial heads of government.

- Data Handling

- A large number of people working in space in Canada believe that a Space Agency for Canada is long overdue, but Treasury Board and the Privy Council Office are not yet convinced. Ways and means of bringing this action about are being discussed at the Interdepartmental Committee on Space.

3.7.2 That encouragement, including funding, be given to the development of Regional Remote Sensing Centres and the use of these to transfer technology to the users by way of demonstration projects.

- Water Resources

- A Cabinet Submission now being prepared on LANDSAT-D includes assistance to provincial Remote Sensing Centres and to a technology transfer program.

3.7.3 That high priority be given to the establishment of a committee at the technical management level to provide a more effective link between federal user departments and CCRS. Such a committee should annually define federal departments' needs and priorities vis-à-vis remote sensing. This would allow CCRS to improve its awareness of the needs of other federal agencies by expanding its sources of information and cooperation.

- Lands Directorate

- This recommendation accurately defines the rôle of IACRS which has not met for two years, though a meeting is planned for late 1979. CCRS invites the user departments to express their needs actively through their representative on IACRS.

3.7.4 That a closer liaison should exist between the operational units of CCRS and the organizations in industry that are active in remote sensing.

- Photo Reproduction

- The UAMU is in the process of establishing formal liaison with industrial organizations engaged in remote sensing, through a planned series of personal visits to the head offices of these organizations. It is the intention of the UAMU to capitalize on marketing opportunities for remote sensing technology through ongoing dialogue with industrial organizations.

3.7.5 That CCRS be congratulated on the establishment of the User Assistance and Marketing Unit and that the Unit maintain close liaison and contact with marketing efforts of industrial organizations active in the field of remote sensing.

- Photo Reproduction

- See response to 3.7.4

3.7.6 Que le CCT prévoit dans son budget certaines disponibilités financières ou matérielles pour les groupes d'utilisateurs (Associations, centres régionaux, groupes disciplinaires, etc.) qui, par leurs activités, peuvent grandement favoriser le développement et le transfert des applications de la télédétection.

- Ecosystèmes terrestres

- Dans les limites de ses possibilités budgétaires, le CCT est toujours disposé à étudier la possibilité de projets conjoints avec un ou plusieurs organismes soumettant une proposition concrète et bien étudiée. En général, la participation du Centre se limitera à des ressources matérielles et non financières. Vu les restrictions budgétaires imposées au Centre, les organismes intéressés devront s'attendre à ce que les critères de jugement soient forcément sévères.

3.8 Future Program Planning and Development

3.8.1 In support of the resolution of Commission IV of the ISP, that CACRS support the idea of an operational satellite(s) based on current technology and receiving capabilities and having an extended life-span.

- Cartography

- CCRS supports this recommendation.

3.9 Analysis Systems

3.9.1 That the existing ad hoc Interdepartmental Working Group on Spatial Data Transfer Standards encourage CCRS to develop software to implement data transfer between the Canadian Image Analysis System at CCRS and the Canada Land Data System at DOE.

- Lands Directorate

3.9.2 That CCRS assign high priority to research and development work towards establishment of direct links between digital analysis and computer information systems.

- Lands Directorate

- The Canada Centre for Remote Sensing has assigned a high priority to research and development work towards the establishment of a direct link between digital analysis computer information systems. To this end a project has been started, called the Terra Observation Pattern Analysis System (TOPAS), which will lead to the development of the necessary algorithms; products, and links for effective and efficient transfers of information from remote sensing to the computer information systems. It should be noted that it is equally important to transfer data from the computer information systems to remote sensing analysis systems so that historical information may be combined with new information to improve the interpretations.

3.9.3 That CCRS maintain and expand when possible its support to the user, particularly in the development of photointerpretive instruments to aid in fast and objective analysis of imagery.

- Water Resources

- This is being done. The visual analysis laboratory is being maintained and updated to provide convenient and fast analysis of photographic products from all imaging sensors.

3.10 Sensors and Systems

3.10.1 That adequate funding be given to Canadian industries to design and produce an advanced imaging radar.

- Ice

- Development of SAR systems (Airborne) and SAR processing is a high priority item for CCRS. CCRS has completed arrangements with ERIM to keep the X-L Band SAR in the CV-580; plans are in hand (though not complete) to have it converted to C-Band in one channel, and discussions have started regarding the longer term development of a suitable light, (for small aircraft)high resolution SAR.

3.10.2 That access to orbital sensors with improved spatial resolution be available to the remote sensing community in Canada, especially the engineering users.

- Engineering

- Steps are being taken to request the additional funds required to enable CCRS to read-out, process and disseminate remote sensing data from the U.S. LANDSAT-D and French SPOT satellites, which have finer spatial resolution than the current LANDSAT series.

3.10.3 That present research and development of the use of field spectroscopy to evaluate various crop parameters relating to crop maturity and chemical composition be supported and continued; and that spectroscopy studies utilizing the visible and infrared spectral regions include a wide variety of fruit, vegetable and field crops as targets.

- Agriculture

- CCRS has developed a mobile spectroscopic laboratory which can make high resolution spectral measurements of field crops in the

wavelength region from 0.4 to 14 micrometres. Software has been developed to read the raw cassette tapes and crop ancillary data to the computer files, plot calibrated spectra, simulate any sensor band response, and correlate band reflectances with crop parameters. This facility is part of a comprehensive experiment in Saskatchewan (for the summer of 1979) to examine the spectral properties of rapeseed and rangeland species in order to develop operational systems to determine rangeland biomass in rapeseed acreage.

3.11 Applications Development

3.11.1 That adequate funding be provided in the future for support of surface ice measurements in conjunction with active and passive microwave measurements; in particular the signatures from brackish ice and icebergs need further elucidation.

- Ice

- The SURSAT Program includes surface ice measurements in conjunction with both active and passive microwave measurements for both brackish ice and icebergs.

3.11.2 That the application of satellite radar altimetry over land areas be explored.

- It is agreed that the application of satellite radar altimetry over land areas should be explored. Efforts are underway as part of the SURSAT Program to obtain SEASAT altimeter data of Canadian territory for purposes of this investigation.

3.11.3 That continued support be given to aerial hydrography.

- Water Resources

- This is certainly a priority area for CCRS, which is supporting the demonstration project being led by CHS, and research is continuing within CCRS on LASER techniques, more accurate navigation techniques and other supportive activities. CCRS has committed very large amounts of support to this project - for example, somewhat over 100 hours of PDP-10 computer time has been requested by the contractors working with CHS, and this has been committed by CCRS.

3.11.4 That CCRS maintain and expand where possible its support to the user, particularly in the area of determination of snow water equivalent.

- Water Resources

- CCRS plans to intensify its general user-support through activities of the User Assistance and Marketing Unit. A major goal will be to expand and facilitate user access to appropriate CCRS personnel and services. The Applications Division is increasing its encouragement of, and participation in, specialized workshops, and its efforts to develop user-oriented training aids. The facilities and expertise of the Centre will continue to be directed in support of user efforts toward the development of operational applications of remotely sensed data.

3.11.5 That basic research into the interactive mechanism of engineering materials be conducted to facilitate the interpretation of photography and imagery from photographic and non-photographic sensors.

- Engineering

- CCRS supports this recommendation.

3.11.6 To avoid the long delays that appear inevitable for processing CZCS data through NASA, that CCRS produce images from digital tapes using a variety of seston and chlorophyll concentration algorithms. This work would be in support of water colour experiments such as those listed above and would involve production of a reasonably large number of images (several hundred).

- Oceanography

- CCRS is already heavily committed to receiving LANDSAT and NOAA data, and processing MSS, RBV, AVHRR and SEASAT radar data. We decided not to receive or process HCMM or NIMBUS-G data because of our

resource limitations and the lack of a broad-base of users requesting these data.

3.11.7 Que le CCT accentue l'allocation de ses ressources humaines et financières au développement et au transfert des applications de la télédétection plutôt qu'au développement de nouvelles techniques de télédétection.

- Ecosystèmes terrestres

- Le CCT a redistribué ses ressources en vue d'accroître le développement et le transfert des applications de la télédétection. Nous ne pouvons pas réussir un tel transfert, qu'avec le support enthousiaste des institutions appropriées.

3.11.8 That a Canadian Crop Information System be developed through the efforts of Agriculture Canada, Canada Centre for Remote Sensing, Atmospheric Environment Service, and other interested federal, provincial and private sector groups; and that the Government of Canada provide the necessary financial and manpower resources for the development and implementation of this system.

- Agriculture

- CCRS alone cannot fund an operational Canadian Crop Information System. The Centre will, however, work towards assembling the main elements of a demonstration project, under the guidance of the major potential users in the agricultural field.

3.12 Data, Products and Production

3.12.1 That a direct link be established between satellite receiving stations and users. Direct data access is an alternative to quicklook imagery which should be considered, at least in principle, by CACRS.

- Ontario

- Direct data links between satellite receiving stations are vastly more expensive than our current distribution methods: facsimile and air-mail. CCRS would respond to requests for direct links where the value of the data would warrant the extra distribution costs.

3.12.2 Whereas resources at CCRS will not be adequate to record and process all LANDSAT-D data, that CACRS develop a rationale for deciding when LANDSAT-D Thematic Mapper data will be acquired, recorded, and processed.

- Data Handling

- CCRS plans to receive all LANDSAT-D Thematic Mapper data. In addition, CCRS Applications Division will cooperate with CACRS Working Groups on developing a coordinated approach to receiving and processing data from the SPOT satellite.

3.12.3 That CCRS provide, with each CCT distributed, a matching image reflecting the spatial extent of the data on the tape, with quality and annotation to allow a user to identify the line-number and pixel-number coordinates of a reference point to an accuracy of plus or minus one percent of full scale.

- Data Handling

- CCRS has recently established its major CCT production facility at Prince Albert and is improving its CCT production at Shoe Cove in order to deliver directly to users. Since we do not have the equipment to replay CCT's, at Prince Albert or Shoe Cove, we will arrange that a user may request that a CCT be shipped via Ottawa where a matching image will be produced.

3.12.4 That CCRS cooperate with user agencies in ensuring compatible high standards for DCP hardware, related sensors and data retrieval, archiving and publication.

The use of DCP's is expanding rapidly in numbers of platforms, in variety of parameters sensed and in variety of users. Standards are required to ensure the provision of good quality data in suitable format to meet the needs of the increasing variety of users. Due to this variety there is no logical lead agency; efforts should therefore be made to encourage a cooperative approach. The Water Resources Working Group has set up a small task force to look into the problem and suggest actions. The Quebec Meteorological Service organized a meeting of 35

agencies to look into the use of DCP's. Various government organizations are looking into the problem for their own requirements, and the question of the need for national working groups, as there are in the U.S., has been raised.

- Water Resources.

- CCRS has collaborated with Inland Waters of DFE to operate their facility at Prince Albert. The lead role for DCP usage in Canada should remain with that Agency.

3.12.5 That attention be directed towards the development of feasible photo interpretive techniques and products by CCRS and by means of financial support, through outside contractors, and that enhanced digital products be developed and the onsite capabilities of doing this work be accelerated at Prince Albert.

- Photo Reproduction

- CCRS is continuing to develop photo-interpretation techniques for various applications. A capability for making standard colour products is being developed at Prince Albert. When this facility is operational, the experimental methods developed for enhanced colour products will be considered for implementation.

3.12.6 As LANDSAT-D and other higher resolution satellites are vital to the meaningful interpretation of the more complex Maritime scene, that the priority for LANDSAT-D and SPOT image acquisition be given to the Atlantic region in particular and eastern Canada in general.

- Nova Scotia

- In the submission for funding to read-out LANDSAT-D and SPOT (see 3.10.2), CCRS proposes to upgrade both the Shoe Cove Satellite Station and PASS to ensure adequate coverage of the Eastern Canada, and in particular, the Atlantic region.

3.12.7 That the practice of archiving NOAA CCT's be continued at Shoe Cove and be instituted at PASS.

- Newfoundland

- Archiving LANDSAT data is a continuing financial burden on CCRS. We will not be able to archive NOAA CCT's at Shoe Cove or Prince Albert on an on-going basis.

3.12.8 That the users should be able to request special attention (without extra cost) to the detail of sea ice and ocean in the processing of northern and off-shore images at PASS.

- Newfoundland

- Image Processing at PASS is performed using standard procedures. Products requiring special processing necessarily incur extra costs which are usually passed on to the customer.

3.12.9 That CCRS ensure that the necessary system for the rapid production of timely, high quality LANDSAT Computer Compatible Tapes be now implemented to provide at least 24 LANDSAT CCT's per year to the agricultural remote sensing community.

- Agriculture

- The present capacity of the CCT production facility at PASS is 2 CCT's/day. Extra capacity exists at Ottawa if there is a special known requirement.

3.12.10 That CCRS recognize the importance of Canada-wide coverage of selected images from each of the main satellite imaging systems, MSS, LANDSAT 3, RBV and LANDSAT-D Thematic Mapper. Each image collection should be accompanied by published listings and index maps. Image sets should be distributed to the public by NAPL for purchase at prices comparable to those of air-photos.

- Geoscience

- CCRS recognizes the growing archive value of satellite imagery for Canada. Efforts will be made to maximize the utility of such imagery by ensuring high quality of photographic representation and reproduction; and to maximize availability to users through appropriate cost and distribution policies. The image set concept represents a very important option which will be given careful consideration in the immediate future.

3.13 Quality of products and services

3.13.1 That CCRS orient its resources and efforts towards improving the quality and usefulness of quicklook satellite information. The value of quicklook satellite information has great potential, particularly in areas such as environmental monitoring. This potential will not be fully realized until greater emphasis is placed in this area.

- Ontario

- The quicklook imagery at Prince Albert is now being produced using a high-resolution Laser Recorder. At both Prince Albert and Shoe Cove, photo-standards for these products have been introduced.

3.13.2 That CCRS maintain and expand when possible its support to the user, particularly in the continued improvement of all types of images, including hard copy from digital density slicing equipment.

- Water Resources

- CCRS is installing a video recorder with its density slicing equipment so that hard-copy colour products can be made.

3.13.3 As pleased as the members of this Committee are with the large variety of remote sensing products developed and provided by CCRS, our experience in requesting and purchasing the basic airborne and satellite products is that much greater emphasis needs to be given to their quality and consistency.

- Nova Scotia

- Quality standards have been established for satellite products and greater emphasis is being placed on quality control inspection. The same is true of airborne products.

Obviously there is undoubtedly room for improvement, and specific quality/consistency faults will be the subject of immediate investigation and change by CCRS.

3.14 Training and education

3.14.1 Dr. R. Protz of the University of Guelph suggests that a joint teaching program be set up by several Ontario universities.

- Ontario

- CCRS supports this recommendation.

3.14.2 That CCRS and ISIS support through a subsidy program the establishment of ISISFICHE in the post-secondary educational institutions having viable remote sensing programs for a one year trial period.

- Photo Reproduction

- See response to 3.17.3.

3.14.3 That CCRS establish a grants system to assist universities conducting remote sensing courses to purchase remote sensing satellite products similar to that in effect at NAPL for airborne products.

- Photo Reproduction

- See response to 3.17.3.

3.15 Information

3.15.1 As an aid to the remote sensing community, CCRS, NAPL, the SURSAT Office and Intera should establish a clearly defined and easy mechanism for cataloguing, displaying, and ordering thermal and radar imagery.

- Geography

- This recommendation has been referred to the Airborne Project Review Committee for action.

3.15.2 Methods should be developed for increasing the availability of information about ongoing and completed remote sensing projects in Canada. This, for example, might be achieved by the establishment of a data base complementary to the existing RESORS bibliographic system.

- Geography

- CCRS recognizes the usefulness of this recommendation and hopes to work with user engaged in such activities to achieve the desired results. CCRS is documenting selected operational systems through the publication of a series of application brochures.

3.15.3 (a) That CCRS maintain the Landsat catalogue and to ensure that this is updated, printed and published on a regular basis.
(b) That CCRS maintain IISS up to date as of now.

- Photo Reproduction

- Fluctuations in the production of Landsat imagery created inventory update backlogs that will be caught up this summer. Landsat catalogues are being maintained but cost of reproduction prevents frequent updating.

3.15.4 That the User Assistance and Marketing Unit concentrate on getting out the Landsat Data Users' Handbook.

- Photo Reproduction

- This will be done by the end of 1979.

3.15.5 Que le CCT publie une série de guides d'utilisation des données de télédétection pour des applications opérationnelles d'intérêt.

- Ecosystèmes terrestres

- Voir la réponse à la recommandation 3.15.2.

3.16 Cost of services

3.16.1 As airborne flights for operational remote sensing are no longer available from CCRS and as the cost of remote sensing flights in Nova Scotia will increase with respect to transit charges for commercial aircraft, that CCRS work actively to ensure that the total cost of airborne image acquisition be equal in all regions of Canada.

- Nova Scotia

- In the interest of developing commercial airborne capabilities, CCRS has absorbed all research and development costs and aircraft amortization costs. It is expected that this will result in reduced cost to the users. On the subject of transit costs to the user site, CCRS points out that careful co-ordination of flight requests by provincial centres can result in significant economies of scale.

3.17 Recommendations of the ad hoc committee on the role of education in the national remote sensing program.

3.17.1 It is recommended that the Chairman of CACRS write to the President of NSERC to
(a) emphasize the importance to the national remote sensing program of funded university research in remote sensing,
(b) ask for the establishment of an NSERC code category for remote sensing, and
(c) suggest that remote sensing investigations be included within the "Strategic Grants" category.

- This has been done.

3.17.2 It is recommended that the Chairman of CACRS actively encourage CCRS to continue and expand its support in kind of university research by
(a) ensuring that special pro-rated costs be implemented in the acquisition of airborne data for university research,
(b) maintaining the policy of free access to CCRS analysis equipment for use in projects approved by CCRS, and
(c) aiding in the support of university remote-sensing programs by all appropriate methods.

- (a) The CCRS airborne policy outlines the criteria for airborne research projects.
(b) CCRS will continue to provide free access to CCRS analysis equipment for approved research projects. Users should note, however, that cost-recovery policy is determined by the Treasury Board.

3.17.3 CCRS should act upon, and not just "consider" the recommendation of the April, 1978 CACRS meeting for "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", and have it implemented in the 1979-80 fiscal year. In addition, all post-secondary educational institutions should be included in this recommendation.

- This recommendation is noted. However, there are two obstacles to its implementation. One is legal, as CCRS does not at present have the authority to distribute grants; the second is financial, as CCRS cannot, particularly in a period of restraint, launch into a new, open-ended program. As noted in response to 3.14.2 and 3.14.3, CCRS will continue to seek ways to carry out the recommendation.

In the meanwhile, institutions should continue to include the purchase of educational material in their budget.

3.17.4 In view of the limited research funds at present available to remote sensing specialists, it is recommended that CCRS give "Announcements of Opportunities" on a regular basis (at least once a year), thereby permitting the university research community to act on these announcements. CACRS should also request specialty centres and other government agencies to take similar action, if possible.

- CCRS has no funds available specifically for university R & D grants. Most CCRS contracts for development of equipment and techniques are with Canadian companies, but whenever appropriate, CCRS does contract with universities for R & D work. Whenever such opportunities can be identified well in advance of the requirement, they will be published in the R & D bulletin.

3.17.5 In View of the costs of equipment, it is recommended that, whenever possible, the facilities of regional monitoring centres be used for the dual purposes of monitoring and training. The positioning of such centres in close proximity to existing educational institutions would be appropriate.

- CCRS supports this recommendation.

3.17.6 In view of their commitment to and expertise in teaching, is is recommended that university and college instructors be involved as much as possible in remote-sensing training courses and workshops for Canadian and overseas scientists.

- CCRS does look for the best available talent in remote sensing training courses. This talent often comes from universities, but can also be found in industry or within provincial or federal governments.

3.17.7 To provide on-going information to CACRS on matters related to education in the national remote sensing program, it is recommended that a CACRS Working Group on Education be established. The Working Group members should consist primarily of representatives from post-secondary institutions.

- This working group has been established under the chairmanship of Dr. Phil Howarth.

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4.0 REPORTS OF THE CANADA CENTRE FOR REMOTE SENSING

4.1 Historical Highlights

1968

May 23: Meeting of Interdepartmental Committe on Remote Sensing of Earth Resources from Aircraft Satellites convened by Dr. L.W. Morley to discuss advantages of joint programs in remote sensing.

1969

July 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.

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: 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

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 Center established in Edmonton.

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.

1978

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

March 5: Launch of LANDSAT-3.

April: Launch of HCMM

April 10-13: Seventh CACRS meeting, Arnprior.

June 27: Launch of SEASAT.

July: ERIM SAR installed and operational in the Convair 580 as part of the SURSAT program. Approximately 10,000 line km of data were acquired in 1978 as scheduled,

July 22: First analogue data acquired from SEASAT.

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

September 18: First digital data acquired from SEASAT.

October 10: Failure of SEASAT.

December 9: Signing of the Co-operative Agreement between the European Space Agency and Canada, to take effect January 1, 1979.

4.2 INTRODUCTION:

CCRS operates on a matrix project management system. The remote sensing activity is subdivided into 5 sub-activities: Applications Development; Data Acquisition; Processing and Dissemination; Applied Research; Scientific and Technical Support and Management and Administration. Under each sub-activity are all the projects of the centre. The sum of the project budget is the total budget of the centre.

A Long-Term Plan has been completed which gives financial expendature and major project milestones for the period FY 1978/79-1982/83. A Financial Management System is now in operation which gives up to date financial information to the responsibility centre managers on a project basis.

The following report is organized according to the sub-activity structure.

4.3 APPLICATIONS DEVELOPMENT

Research into the capabilities and limitations of aerial thermography for the detection of heat loss (residential and industrial) will be completed by the end of 1979. Applications Division scientists have offered two workshops on the use of aerial thermography in British Columbia. An airborne project concerning residential heat loss detection has been completed and documented in CCRS literature. A study of image ambiguities caused by water, snow and ice provided guidelines which improve the accuracy of heat loss interpretation for flat roof buildings. There has been a substantial transfer of technology and interpretation expertise to industry and in addition, Intertech Remote Sensing Limited is presently doing the majority of infrared data collection for heat loss analysis within Canada.

A technique for the measurement of suspended sediment concentration has been implemented on the CIAS. This procedure involves the analysis of the colour or chromaticity of LANDSAT/MSS digital data, and permits the extrapolation of "water truth" from one date to another. This removes the necessity for water sampling on all but one occasion. The system has had its first major practical application, providing sediment concentration maps for the Fundy Tidal Power Project. Speculations on the applicability of the chromaticity technique to agricultural topics has now initiated research into this very demanding field.

Every visible and infrared image is affected by the atmosphere. Therefore, for LANDSAT images, the Division has developed a technique for atmospheric correction known as the "clear lakes" method. Scenes which contain oligotrophic lakes can be corrected by estimating the path radiance over the lakes, inverting an atmospheric model to obtain the atmospheric corrections, and applying a two-dimensional correction function to the digital image. The software to carry out such corrections has been incorporated into the CIAS.

The development of a mobile ground-based spectroscopy laboratory will be completed this month (April/79) with the acquisition of a spectrometer sensitive to radiation from 0.3 to 14.0 um. Software has been developed to analyze and display data on PDP-11/10 minicomputers for research in support of image analysis and future satellite evaluation. An experiment this year will evaluate LANDSAT-D thematic mapping imagery for wheat production estimates.

AMOP (Arctic Marine Oil Spill Program)

This project is being conducted for the Environmental Protection Service of DFE by CCRS. Specifically CCRS is being funded 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 first in a series of operations was conducted in September 1978 off the Eastern Coast of Baffin Island to investigate the presence of a natural oil seep near Scott Inlet. This operation involved both the CCRS DC-3 aircraft with the fluorosensor, MSS, MEIS, and other sensors aboard and the CCRS Convair 580 with the ERIM synthetic aperture radar aboard. Following this program CCRS participated, in co-operation with ERIM and NASA, again using the same two aircraft in a planned oil spill program off the eastern coast of the U.S. This exercise, which was conducted in November 1978, provided an excellent opportunity to collect data under controlled conditions. Most recently CCRS, in support of AMOP activities, has participated, in March 1979, in oil spill monitoring related to the recent Kurdistan incident. This exercise, which was only mobilized at the last minute, only involved the use of the DC-3 aircraft with a combination of infrared scanning and low light level TV sensors in addition to photographic back-up.

As a result of very limited DFE funding in fiscal year 1979/80 the AMOP program will not be conducting any further experiments and will be submitting its final report early in the fiscal year. However, it is expected that CCRS will be participating in the fall of 1979 in a follow-up to the NASA planned oil spill program.

Aerial Hydrography

The aerial hydrography program, which is a co-operative effort between CCRS and the Canadian Hydrographic Service of DFE is currently entering a pilot demonstration phase of the program. As a result of an unsolicited proposal submitted by P.A. Lapp Ltd. a contract has been let by CHS to conduct a demonstration program involving direct comparison of aerial hydrographic and conventional surveys of the same shallow water area. This will permit a comparative analysis of the effectiveness of the aerial hydrography system when compared to conventional techniques.

During the past year considerable data acquisition activity has occurred using the

developmental photo hydrography system. As a result of data collected both in Arizona in the spring of 1978 and off Vancouver Island in the fall of 1979, the feasibility of the photo hydrography system has been demonstrated. In the integrated aerial hydrography system the photo system will be supported by measurements from a lidar bathymeter which will continuously measure water depths under the aircraft. It is expected that this measurement will then be used to improve the accuracy of the photo system as well as relaxing the overall system requirements. The pilot demonstration project which was begun in February 1979 will continue for a period of 18 months at the end of which it will be possible to determine the true commercial potential for the hydrography system.

4.4 DATA ACQUISITION, PROCESSING AND DISSEMINATION

Airborne Operations

The airborne program has taken steps in this past year to ensure a clearer delineation between operational projects on the one hand and research development and application development projects on the other hand. As a result of considerable discussion within the Airborne Projects Review Committee, Airborne Operations, and the CCRS Management Committee a new airborne operations policy has recently been developed in this regard. (See Appendix 1) This policy essentially states that projects which are within the capability of Canadian industry will be considered operational and therefore will not be accepted by CCRS as subsidized projects. Furthermore, all projects submitted to CCRS for airborne data acquisition will be scrutinized by the Airborne Projects Review Committee to ensure that they meet certain stipulated criteria including operational potential, applications benefits, etc. A more detailed description of the above policy including the criteria for acceptance of projects by CCRS is currently being distributed in the most recent CCRS Newsletter.

In line with the above and in order to enhance Canadian industry's capability to meet operational requirements in the remote sensing community, CCRS is currently proceeding with a Treasury Board submission to make its aircraft available to Canadian industry. Although this effort has been underway for a considerable amount of time we are now optimistic that all of the details have been worked out and that the aircraft will be available for the current operating season.

Involvement of Industry in the Airborne Program of CCRS

This program, which has been underway since 1975, has resulted in considerable Canadian industrial activity in airborne remote sensing. In addition to a broad involvement in the general area of infrared scanning, companies in Canada have become specifically involved in heat loss survey work and forest fire mapping activities. In addition, Intera Environmental Consultants, as a result of an unsolicited proposal submitted to DSS, has been successful in contracting for a program involving a comprehensive series of synthetic aperture radar experiments over both land and water. The results of these experiments will be used to support recommendations to be made with regard to future Canadian surveillance satellite requirements. As a result of this activity, Intera sees considerable potential business particularly in the support of northern oil exploration activities using the radar installations.

Shoe Cove Station

The Shoe Cove station has continued to receive and process Landsat and NOAA data this year. Shoe Cove has provided Landsat data received over Greenland and Iceland under an agreement consummated last summer. The data was archived and supplied to Danish and Icelandic users on request. The data recording over Greenland and Iceland was terminated in the fall of 1978 when the sun line moved south. It is expected that this coverage will be provided by the Swedish station in 1979.

The Shoe Cove station was modified and initiated tracking and recording of SEASAT Synthetic Aperture Radar data (SAR) on 15 July 1978 by use of a video tape recorder. By 1 September 1978 the station was routinely recording from SEASAT, the low rate telemetry data and the SAR data in three simultaneous modes: analogue recordings on the video tape, digital recording on the high density tape, and on optical signal film by the DREO-CRC optical recorders. The system also has playback capability from the analogue and digital recorders. Shoe Cove has received and recorded 38 orbits of SAR data through the short life of SEASAT. The SEASAT satellite died on 10 October 1978 from what appeared to be a massive power failure in the battery power system. CCRS has played back all of the recorded data onto signal film and ERIM has processed it into survey imagery.

The first digitally processed SEASAT image was produced by MDA Limited on 28 November 1978 from data recorded at Shoe Cove. The image is much superior to the optically processed images.

The Shoe Cove Station has also been modified to receive the TIROS-N satellite which was launched in August of 1978 and replaces the previous NOAA series. The station has been receiving and producing TIROS-N data since January 1979. TIROS-N has four digital channels of visible and IR data. Shoe Cove is capable of generating TIROS-N imagery one channel in real-time and the other channels, one at a time, in the playback mode. TIROS-N products which will be available from Shoe Cove are system corrected images, CCT's and photo and computer fax of selected scenes in near real-time. Landsat and TIROS-N data are presently being supplied to the Canadian Coast Guard and to Ice Central Ottawa on a routine basis via photo fax transmissions direct from Shoe Cove.

Satellite Program

Landsat

Landsat II and III are continuing to function well with the exception of Landsat III's thermal band, band 9. The MSS thermal channels, 25 and 26, on Landsat III developed a problem in July 1978 during the outgassing of the sensor. One channel has failed completely and the other is out of tolerance but still capable of producing data. NASA has informed CCRS that the thermal bands will not be turned on except as requested by users. CCRS has adapted the policy of not receiving, recording or processing the thermal data except for approved projects.

The RBV data from Landsat III has twice the resolution of previous RBV images. It has been received at Prince Albert since April 79 and recorded on the quick-look system. These QL images are currently available from ISIS Limited. The low cloud imagery will also be recorded on the electron beam recorder (EBR) system at Ottawa, which required modification to handle the new RBV data. The first EBR images are now becoming available from ISIS Limited as this facility starts production.

Landsat-D

A Cabinet submission for Landsat-D participation will be prepared by April 1979. It will request authorization to prepare Prince Albert and Shoe Cove for reception of the LS-D thematic mapper (TM) and multispectral scanner data and to develop facilities for providing TM images and CCT's to users.

Image Production Capability

The multi-image processing system (MIPS) installed in Prince Albert last year is routinely producing Landsat MSS 4-band master negatives in real time. The single band image capability has yet to be proven due to some optical problems with the laser beam recorder. Also there are production difficulties with CCT generation. The transfer of Landsat product generation from Ottawa to Prince Albert will be completed in 1979 when the single band image capability will allow colour products to be generated and the CCT generation problems are eliminated.

Ottawa will continue to supply RBV data and special products i.e. special enlargements, mosaics and fully corrected MSS CCT's through use of the Digital Image Correction System. These precision CCT's will become available in limited quantities from April 1979 as the DICS system goes through a 6-month pre-production phase.

Time Sharing System

The past year has seen the commencement of an upgrade program, to provide sufficient computing power to handle the continued growth in workload, and to replace obsolescent peripheral equipment.

In March 1978 we took delivery of a KL10 Central Processor and began a careful transition from the KI10 Processor. Despite holding the KL10 until October 1978, we have still been plagued with many hardware problems over the last few months. Currently the system is undergoing a "re-installation", a detailed and exhaustive check-out by Digital Equipment Corporation's top computer engineers. It is hoped that the system stability we used to enjoy will return shortly.

The remainder of the upgrades and replacements consists of:

- a doubling in main memory size which will have the effect of improving terminal response time, reducing the elapsed time large programs take to execute, and negating 'lost' time which is caused by and imbalance between the KL10 processor and the present memory configuration;
- a replacement of the obsolete communications linescanner with a PDP11/40 - based communications processor; the pot-

ential for expansion in the number of terminals supported and the ability to support high transmission rates is assured;

- replacement of obsolete tape drives; we will have a complement of two 800 BPI/ 1600 BPI and four 1600 BPI/6250 BPI high -performance drives;

- replacement of obsolescent line printer with a high-speed upper/lower case line printer;

- replacement high-speed, high resolution electrostatic printer/plotter;

- increased disc space, both in public and private; with a rearrangement of public file structures we will support a total of six private disc spindles, and increase of 50%;

- replacement of 'MAD' color display, high resolution monitor, theme tracks, zoom capability, look-up-tables and readback of processed image to computer memory.

The new equipment will be phased-in gradually over the spring and summer of 1979 to assure customer confidence and minimize downtime. It is hoped that there will be a big improvement in service as a result of these changes.

Precision Processed Landsat MSS CCT

Since April 1979, CCRS is offering the remote sensing community precision processed Landsat multispectral scanner MSS imagery on CCT's using the Digital Image Correction System, (DICS). The DICS product consists of Landsat subscenes which are compatible with the Canadian National Topographic System map series. Each NTS-compatible Landsat imagery CCT contains a 4-band MSS subscene which is aligned on the metric grid of the UTM projection. Lines of image data are parallel to the Easting direction. The DICS subscene product corresponds to one quarter of a 1:250,000 scale map and has the following dimensions: 0.5 degree latitude by 1.0 degree longitude. In the Northing direction this corresponds to 56 kilometres and in the Easting direction it varies from 85 kilometres for Southern Canada to 20 kilometres for 80° North. The imagery is resampled to a square pixel of 50 accuracy of 50 metres.

The user can choose between two radiometric transformations and various interpolation algorithms. Recorded in the universal imagery format, each CCT contains three files: the universal header file, the subscene header file and the imagery file. These files are similar in format to the Canadian Landsat MSS System Corrected CCT offered by CCRS. The CCT contains ancillary information in order to translate line and pixel numbers into Northing and Easting co-ordinates.

High Resolution Film Imagery Product

A new high resolution film product for Landsat multispectral scanner imagery will be offered to the remote sensing user community starting late 1979. The data will be recorded on 187 x 230 mm films using the CCRS Optronics scanning microdensitometer. The primary product will consist of imagery which has been geometrically corrected on DICS in the UTM projection and which is compatible with the Canadian National Topographic system. The user will have the option of ordering the imagery at various map scales and will have the choice between various radiometric transformations. The image will be fully annotated including cartographic, histogram distribution and grey scale information. This new product will be particularly suitable for map overlay and multitemporal applications.

Color Image Recorder

The Color Image Recorder (CIR) is a minicomputer based CCT to 240 mm file recording system that was delivered to CCRS in late 1978. The recorder will image Landsat MSS resolution data, with high radiometric and geometric accuracy, directly upon color film. The software development and hardware checkout is proceeding to a scheduled image production capability by October 1979.

4.5 APPLIED RESEARCH

Microwave Program

The Airborne Program of CCRS is currently entering a new phase in the development of all-weather remote sensing techniques. As a first step in this program CCRS has arranged for the purchase of the Environmental Research Institute of Michigan's synthetic aperture radar currently installed in the CCRS Convair 580 for use in the SURSAT program. In addition to using this X/L band SAR for a variety of application-oriented experiments, it is proposed to enhance capability of this equipment by adding a C-band capability to it. This will permit application development work in the C-band frequencies, a frequency currently proposed for a number of surveillance satellites but for which to date very little data is known of its applicability.

CIAS

The redesigned CCRS Image Analysis System (CIAS) will be completed shortly and studies are beginning on future analysis requirements. Two additional hardware devices are being added: an Image Analysis Processor (IAP) to increase classification scope and spread, and an APPLICON ink-jet plotter for improved colour hard copy output. Over the past year the CIAS capability to process synthetic aperture radar (SAR) imagery has been greatly enhanced with the addition of geometric and radiometric correction software.

4.6 SCIENTIFIC AND TECHNICAL SUPPORT

Substantial emphasis was placed on the transferring of information on remote sensing applications to the user community as well as the general public. These include the CCRS Newsletter, "Remote Sensing in Canada", with a selected global circulation of 2,500; Newsbriefs, designed to inform on specific remote sensing applications and current interest, Factsheets, a ready reference material for users; surveys of remote sensing data users in forestry, wildlife, biophysical mapping and related areas. Remote sensing also received broad popular exposure on more than a dozen occasions through CCRS press releases and interviews through the major media.

In addition to these liaison and dissemination functions, division scientists have been involved in a number of efforts in close co-operation with outside parties. Projects on forestry, water resources, agriculture, energy conservation, etc. have been undertaken. Future activities will ensure that the benefits of such research are made more broadly available through technology transfer programs.

Image Analysis via ANIK B

The image analysis facilities of the CIAS will soon be available to distant users without the current necessity of travelling to Ottawa to use them. A pilot project proposed by CCRS and supported by the Alberta Remote Sensing Center and Memorial University of Newfoundland has been accepted by DOC for inclusion in the ANIK B experimental program.

In an effort to make more widely available the use of our image analysis system, thereby stimulating the use of remote sensing data, and to demonstrate the feasibility of remote access, a link will be set up via ANIK B between Belfast Road and one of the cooperating agencies. From October to next May a remote analysis centre at ARSC in Edmonton will have access to the CIAS for up to 8 hours scheduled each week. Then following a preliminary evaluation of the service, a remote analysis centre in MUN at St. John's, Newfoundland will be linked instead and will provide remote image analysis for a year.

The ANIK B system will provide a one way video channel for viewing the I100 output, a one-way data channel for monitoring the image processing activities with a slaved terminal, and a two-way telephone link so that the required processing can be achieved through the CIAS analyst.

Image analysis experiments suitable for remote access will be selected several months in advance and through the life of the experiment. Interested participants are invited to contact Carolyn Goodfellow at Belfast Road.

Technical Information Service

The technical information service is an ongoing program to collect, catalogue and make available every remote sensing publication of research quality published anywhere in the world. These are made freely available for the advancement of Canadian science and technology through a computerized catalogue; the Remote Sensing On-line Retrieval System (RESORS), is now being directly accessed from St. John's to Victoria. Research reports from the Centre are also published and disseminated to major libraries, information centres and individuals (4000/yr) and requests are answered for conference papers, technical articles, etc. (6000/yr).

Spectroscopy Laboratory

The development of a mobile ground-based spectroscopy laboratory will be completed this month (April/79) with the acquisition of a spectrometer sensitive to radiation from 0.3 to 14.0 mm. Software has been developed to analyze and display data on PDP-11/10 mini-computers for research in support of image analysis and future satellite evaluation. An experiment this year will evaluate LANDSAT-D thematic mapping imagery for wheat production estimates.

4.7 MANAGEMENT AND ADMINISTRATION

A User Assistance and Marketing Unit was formed under the Program Planning and Evaluation Unit as a direct result of a CACRS recommendation. Its purpose is to provide better marketing services for CCRS products and services and to provide a common inter-

face between the Centre and the user community. Mr. Paul Hession was appointed head of the unit early in 1979.

Liaison

An ESA/Canada Cooperative Agreement was signed in Montreal on 9 December 1978. The agreement came into effect on 1 January 1979, and provides for Canada's involvement in the long term planning activities of the agency, by participating in ESA's General Studies Program.

Two proposed ESA satellites of interest to Canada are LASS (Land Applications Satellite System) and COMSS (Coastal Ocean Monitoring Satellite System). Both satellites will carry a SAR and an optical scanner. CCRS is now reassessing its liaison role with ESA. More involvement in ESA affairs will be required should Canada decide to participate in the above satellites.

Surveillance Satellite Project

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.

Seasat Data Status

Data from the Seasat satellite was recorded at the Shoe Cove Satellite Station from July 1978 until the satellite suffered total failure on October 10, 1978. Data from 40 passes of the satellite were recorded at Shoe Cove. In addition, approximately 100 passes containing data of Canadian territory were recorded by NASA receiving stations. The failure of the satellite had a significant impact on the Sursat project. It was decided, however, to continue the project to the maximum extent possible within the original financial and schedule constraints since a large amount of data was recorded prior to failure of the satellite and since airborne data can be used to partially infer the capabilities of satellite-borne sensors.

Seasat SAR data recorded at the Shoe Cove receiving station was first available in optically processed form in October 1978 and in digitally processed form in December 1978. A limited quantity of such data has been disseminated to experimenters. The bulk of the Seasat SAR data processing task will be completed during the March - July 1979 time period. Canada achieved the distinction of producing the world's first digitally processed Seasat SAR image. The quality of digitally processed data significantly exceeds that currently available by optical processing means used elsewhere.

Seasat data for sensors other than the SAR has largely been obtained through NASA.

Airborne Data Status

Mobilization of the CCRS Convair 580 aircraft equipped with the ERIM X-L SAR was completed in July 1978. During the period July - October 1978, two sorties to the west coast of Canada, one to the east coast, and one to the Arctic were completed. In total, 10,000 line kilometers of SAR data were collected, processed, and distributed to investigators by the end of December, 1978. Performance of the facility has largely exceeded expectations despite a few instances in which full image quality was not obtained.

In 1979, four sorties will take place (east coast, western Arctic, eastern Arctic, and Newfoundland). The aircraft will be equipped for all 1979 sorties with a calibration facility as well as means to record raw SAR data in digital form and to digitally process one channel of the SAR data in real time. Data collection for purposes of Sursat experiments will terminate in May 1979.

Experiment Status

In response to the Sursat solicitation of experiments, over 100 experiment proposals were received. Many proposals were combined to result in a set of approximately 40 experiments divided into Human Activities, Weather and Ocean, Floating Ice, Land, and SAR Engineering categories. The experiments are described in the documents "Sursat Experiment Plan" which are available from the Sursat Project Office, 580 Booth Street, Ottawa, K1A 0Y7.

In some instance, complete data sets are in the hands of experimenters. In the maj-

ority of cases, partial data sets have been delivered. With the conclusion of airborne experiments in May 1979 and the production of Seasat SAR data in significant quantities which is presently commencing, most experimenters should receive complete data sets by mid-summer 1979.

Production of the Sursat Project Office final report will commence in October 1979, and be completed by the end of December 1979.

APPENDIX 1

CANADA CENTRE FOR REMOTE SENSING

Policy on the Future Mode of Operation of the Airborne Program

The Canada Centre for Remote Sensing is dedicated to the development of new technology to collect, disseminate and analyse remote sensing data, in order to help improve the management of Canada's natural resources and environment. CCRS has, therefore, organized its remote sensing program to ensure the provision of timely and useful remote sensing data to users across Canada.

Recognizing that in the early stages of research into a new technology, there are few guaranteed benefits to pioneering users, CCRS has provided data at a subsidized rate for the first few years of operation of the Airborne Program. These rates were increased gradually to allow the users time to build up their budgets to the point where they would be able to pay commercial rates for airborne remote sensing services which had reached the operational stage, and could be provided by private industry.

As a final stage in the involvement of industry in the Airborne Program of CCRS, approval is now being sought for an arrangement whereby the CCRS aircraft can be made available on a full cost recovery basis to Canadian industry for the provision of remote sensing services.

Thus, in future, all the services available to the user in the past will still be available but some of these services will no longer be available at a subsidized rate directly from CCRS.

In general, CCRS will, in cooperation with industry, be concentrating its efforts on the development of new sensors and systems and proving out the application of their sensor systems in cooperation with the users. Developed sensors such as photographic cameras and I.R. linescanners will still be maintained and used but mainly in support of the development activities mentioned above. Projects involving any available sensor will of course be accepted under very special circumstances such as national emergencies in which industry is unable to respond.

It is hoped that this new direction of the CCRS Remote Sensing Program incorporating an innovative government-industry relationship, will result in the continued stable development of a vigorous and effective Canadian Airborne Remote Sensing Program.

Starting with the 1979 flying season, therefore, CCRS will only provide remote sensing services at the $18.50 sensor line mile rate, (rate effective for Fiscal Year 1978/79), for projects which meet the criteria attached. For projects not meeting these criteria, commercial remote sensing and survey companies would have to be used.

Criteria for Acceptance of Airborne Project by CCRS

(1) The project must be experimental or research oriented;

(2) The requestor must provide the airborne operations office with background information and an assessment of the benefits* to be expected from the project;

(3) The project must not be within the capabilities of industry to accomplish. Normally this will eliminate projects which use photographic cameras and infrared linescanners as the primary sensor;

(4) The requestor must have the capability to use and analyse the data and must agree to supply a report on the results of the experiment.

* will contribute significantly to a research project or has a good probability of becoming a commercially viable operation.

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5.1 REPORT OF THE WORKING GROUP ON AGRICULTURE

5.1.1 AIRBORNE REMOTE SENSING

Experimental requirements for airborne photographic and thermal imagery remained similar during 1978 as in 1977 as shown by the number of projects requested and successfully completed (31 projects vs 26 in 1977). However, the requirements were associated more with studies for selected experimental areas than for block coverage (operational studies) as indicated by line mileage reduction from 2667 to 1394 nm. In general, the quality of the color infra-red photography has become much more consistent than in previous years since adoption of the Fleming procedure for correcting the color balance of the dye layers prior to flight. Only two projects were lost in 1978 due to poor color quality and scheduling constraints. Some improvement has been noted in the Industrial survey sector to provide quality color IR.

Aerial color IR photography continued to be used for a wide range of applications involving assessment of vegetative conditions. The photography, in association with Landsat data, was used for assessment of rangeland productivity (21, 24), crop acreage (20,22) growing conditions of wheat and seed crops (8, 17), winter-kill of crops (1) and crop losses (23), mining operations (potash coal), land-use (19), farm management operations (14), and vegetation mapping (12,6,22, 24). Thermal data was used in a few locations in relation to soil moisture (2).

The acquisition of a 4-Band microwave imaging system by the Sursat Project Office was of particular interest in 1978 (13). The Sursat Project Office screened and accepted proposals for acquiring radar imagery under a contractual arrangement with Innotec Consultants, and ERIM, Michigan. Four-band imagery was obtained for twelve areas representing different major soil-climatic and crop growing regions of Canada. Growing conditions and crop data were recorded at all sites. Preliminary investigations indicate the system was sensitive to a wide range of crops and crop conditions with remarkably good resolution for identifying field boundaries and various structural features (3).

5.1.2 SPACEBORNE REMOTE SENSING

Development of procedures for determining crop growing conditions from Landsat data for winter wheat regions received the primary emphasis during 1978 (8). Crop data from Kansas was used to represent a major winter wheat region in North America suited for developing, evaluating and verifying procedures. Assessment of rapeseed crop acreage was carried out for a major crop district in Saskatchewan within a spring-wheat cropping system. Establishment of the Homogeneous Land System concept was developed, and maps were prepared for Saskatchewan. The concept is being studied for its suitability as a reference base for resource and meteorological satellite data. Utilization of satellite data to complement aircraft data for assessing Rangeland productivity continued to be carried out in Alberta and British Columbia (21, 24). Landsat data for pasture management studies under CIDA programs are being employed (6). Studies with satellite data for evaluating the mapping of ecological areas in several regions were conducted (19). The capability to produce geometrically corrected Landsat imagery compactible with topographics Survey Maps and other commonly used thematic maps had greatly increased the usefulness of Landsat imagery (9). The high cost and time required for the preprocessing of satellite data and availability of adequate hardware still greatly restricts its widespread use. However, the greatest deterrent to use of Landsat imagery is the relative unavailability of current imagery from Canadian sources.

Satellite radar-imagery from Seasat (L-Band) was obtained for a few selected agricultural test areas of Canada through the Canadian Sursat Project Office and Jet Propulsion Laboratory, California. Imagery for two of the Spring Wheat sites in Western Canada was obtained. Through the CCRS Receiving Station, Shoe Cove, imagery was acquired for parts of Quebec and the Maritime provinces during July and August prior to the failure of the satellite system. Processed imagery of these areas is expected to be available in 1979 for interpretation. Its evaluation will be carried out in association with the imagery from the Sursat Airborne program (4-Band ERIM Radar) (13). The specific sites selected for radar study were: Grand Falls, N.B., Sherbrooke and Ste. Hyacinthe, Qué., Simcoe, Guelph and Ottawa, Ontario, and Raymond (Alta), Melfort and Swift Current, Saskatchewan. The areas suitable for land resource studies were established also in the prairies, Ontario and Maritime provinces.

5.1.3 TECHNICAL AND SCIENTIFIC DEVELOPMENT

The availability of suitable procedures in 1978 for improving the geometrical and radiometric aspects of Landsat imagery was of particular values for agricultural applications (9,22). The procedures developed for correcting the uneven dye-layer sensitivity of color IR-film and for determining the exposure setting has greatly improved the reliability of aeroborne color plotography. Progress was made in developing procedures for reducing the uneven huminosity of airborne color photography. Several of the factors responsible were identified through a research program (4) in cooperation with NRC (10,11). Research on spectroscopic properties (15,18) of crops under small plot and field conditions has now increased considerably with the successful operation of the Field Spectrometer Unit of CCRS and the preposed formation of the Field Spectroscopic unit at the University of Manitoba. Research on the basic electrical properties of a soil system was continued (5) and on the fluorescent aspects of peat soils (16).

5.1.4/5.1.5 APPLICATIONS AND BENEFIT ANALYSIS

5.1.6/5.1.7 USER LIAISON AND TRAINING

The Agriculture Working Group of CACRS held its annual meeting at Houston Texas, October, 1978. The meeting was held to coincide with the Symposium on the Review of LACIE at the Johnstone Space Center, NASA, Houston, October 23-26. This provided an opportunity to become familiar with some of the aspects of the LACIE program which involved NASA, USDA and NOAA. The LACIE follow-on programs are now being developed for continued joint studies at the JSC/NASA complex and for operations within the USDA. A number of papers and several displays were presented at the Fifth Canadian, Symposium of Remote Sensing, Victoria B.C., August 28-31, 1979. A bibliography was prepared on the papers published during 1977 relevent to agricultural remote sensing applications (7).

5.1.8 CONCLUSIONS AND FORECAST

5.1.9 RECOMMENDATIONS

I. Whereas the economic interest of Canadian agriculture would be well served by timely and accurate national and international crop information; and

Whereas the acquisition of such crop information relies on the maintenance of a high level of Canadian remote sensing expertise; and

Whereas the Large Area Crop Inventory Experiment has identified both successful techniques and pr lem areas in the acquisition of crop information;

The Agriculture Working Group recommends that

a) a Canadian Crop Information System be developed through the efforts of Agriculture Canada, Canada Center for Remote Sensing, Atmospheric Environment Service, and other interested federal, provincial and private sector groups;

b) the Government of Canada provide the necessary financial and manpower resources for the development and implementation of a Canadian Crop Information System.

2. Whereas the agricultural remote sensing community has a requirement for at least 24 LANDSAT Computer Compatable Tapes per year; and

Whereas the development of a crop information system would require an even greater number of LANDSAT CCT's per year; and

Whereas the current production of LANDSAT CCT's of acceptable high quality has failed to meet the needs of the user community in terms of both the number of tapes being produced and the quality and turn-around time of tapes that are produced,

The Agriculture Working Group recommends that the Canada Centre for Remote Sensing ensures that the necessary system for the rapid production of timely, high quality LANDSAT Computer Compatable Tapes be now implemented to provide at least 24 LANDSAT CCT's per year to the agricultural remote sensing community.

3. Whereas the Agriculture Working Group recognizes the great potential value of field spectroscopy as a practical tool for remote sensing for agricultural crop information, especially spectroscopy utilizing the visible and infrared spectral regions,

The Agricultural Working Group recommends that

a) present research and development of the use of field spectroscopy to evaluate various crop parameters relating to crop maturity and chemical composition be supported and continued;

b) spectroscopy studies utilizing the visible and infrared spectral regions include a wide variety of fruit, vegetable and field crops as targets.

5.1.10 APPENDICES

5.1.10.1 Appendix I: Current Airborne Projects

Project Number	Requesting Agency	Principal Investigator	Geographic Area	Alt. ASL (ft)	Camera Format	Lens (inch)	Film type	Dates flown 1978	Line Miles (nm)
78-12	Alta Environment	Woolnough, D.	Vegreville, Alta (Falcon)	8,000 15,000	9x9 70MM 70MM 70MM 70MM	6.0 3.0 3.0 3.0 3.0	2443 2405 2405 2424 2445	July 8 Oct. 5	46
-15	City of Winnipeg	Letinsky, E.	Winnipeg, Man. (Falcon)	37,000	9x9 70MM 70MM 70MM IRLS	3.5 3.0 3.0 3.0 -	2443 2405 2424 2445	Aug. 5	24
-17	Alta Rem. & Center, Edmonton	Bricker, C.	Grand Prairie Calgary (Falcon)	12,000 36,000	9x9 70MM 70MM 70MM 70MM IRLS	3.5 3.0 3.0 3.0 3.0 -	2443 2405 2405 2424 2445	Aug. 2 Aug. 3 Aug. 28	115
-19	Agric. Canada Ottawa	Mack, A.	Stoney Mountain, Man. Star Buck, Man. Altona, Man.	32,000	9x9 9x9 IRLS	6.0 6.0 -	2443 2445	July 25	34
-20	Agric. Canada	Mack, A.	Melfort, Sask. Delisle, Sask. Swift Current, Sask. Torquay, Sask.	32,000	9x9 9x9 IRLS	6.0 6.0 -	2443 2445	July 13 July 14	50
-21	Agric. Canada Ottawa	Mack, A.	Fort Saskatchewan Olds, Alta. Raymond Alta	32,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	July 13 July 26	38
-22	Agric. Canada.	Mack, A.	Dawson Creek, B.C. (Falcon)	32,000	9x9 9x9 IRLS	6.0 6.0 -	2443 2445	Aug. 2 Aug. 3	12

78-22	B.C. Min. Environ.	Bennett, R.	Alta: Peace River (Falcon)	9,000 13,500	9x9 9x9 IRLS	6.0 6.0	2443 2445	May 18	224
-31	CCRS/EMR Ottawa	Goodenough, D.	N.B.: Grand Falls (C47-RSB)	11,000	9x9 9x9	6.0 6.0	2443 2445	Aug 14 Aug 16	35
-34	Laval University Ste. Foy, Quebec	Paquin, R. Res. Stn. Agric. Canada	Que.: Eastern Townships (C47-RSB)	5,000	9x9 IRLS PRT5	6.0	2443	May 29 June 16	26
-35	Sask. Res. Council Saskatoon, Sask.	Taylor, W.	Sask.: Potash Sites, (Falcon)	14,000 23,000	9x9 9x9 IRLS	3.5 6.0	2443 2445	July 7,10,14 Aug 4 Oct 7	322
-36	Sherbrooke Univ. Sherbrooke, Que.	Bonn, F.J.	Que.: Sherbrooke (C47-RSB)	2,600 11,000	70MM 70MM 70MM 70MM IRLS PRT5	1.5 1.5 1.5 1.5 --	2405 2405 2424 2424	May 23	54
-38	CCRS/EMR Ottawa	Brown, R.	Ont.: (C47-RSB)	1,500	9x9	3.5	2443	July 13 July 24	6
-39	Sherbrooke Univ. Sherbrooke, Que.	Bonn, F.J.	Falcon	11,000 26,000	IRLS PRT5	--	--	May 24 Nov. 9	104
-46	Agriculture Canada Ottawa, Ontario	King, G.	Simcoe/Norfolk Co. (C47-RSB)	9,750	9x9 9x9 70 70 70 70 IRLS	6.0 6.0 3.0 3.0 3.0 3.0	2443 2445 2402 2402 2402 2402	June 20 July 12	51 CANC
-48	Univ. of B.C. Vancouver, B.C.	Watson, K.	Kamloops/Vernon/ Pritchard (Falcon)	7,500 8,000 32,000	9x9 9x9 IRLS	6.0 6.0	2443 2445	June 17 June 20 July 29/30	55
-49	Fisheries/Envi- ronment Saskatoon, Sask.	Adams, D.	Humboldt (CV-580)	23,000	SAR		4-band	Aug 1	50
-50	Agric. Canada Ottawa	Mack, A.	Raymond, Alta. Melfort, Swift Current (CV-580) Sask.	23,000	SAR		4-band	July 31 Aug 1	130

78-51	D.O.E. (Lands Direct.) Ottawa	Rubec, C.	Neepawa, Man. (CV-580)	23,000	SAR		4-band	July 25 Aug. 1	103
-52	Univ. of Guelph Guelph, Ont.	Protz, R.	Guelph Test site (CV-580)	23,000	SAR		4-band	Aug. 2 Sept 28	104
-55	Agric. Canada Ottawa, Ont.	Mack, A.	Ottawa Test site (CV-580)	23,000	SAR		4-band	July 25 Aug. 1 Sept. 28 Nov. 9	57
-56	Agric. Canada Ottawa, Ont.	King, G.	Simcoe, Ont. (CV-580)	23,000	SAR		4-band	Aug 2	32
-67	Agric. Canada Ottawa, Ont.	Mack A.	Ottawa Test site	1,250	9x9	6.0	2443	June 14/15 July 25 Aug 10/21 Sept. 19	4
-73	University of Laval	Lacoucer, G.	St. Hyacinthe (C47-RSB)	5,500	9x9	6.0	2443 IRLS	Aug 11	8
-75	CCRS/EMR Ottawa	Goodenough, D.	Grand Falls, N.B. (CV-580)	23,000	SAR		4-band	Aug. 15 Aug. 17	93
-76	Sherbrooke Univ. Sherbrooke, Que.	Bonn, F.	Sherbrooke Univ. (CV-580) Que.	13,000 23,000	SAR		4-band	Aug. 15/19 Nov. 8	51
-81	Agriculture Can.	Paquin, R.	St. Hyacinthe (CV-580) Que.	10,000 23,000	SAR		4-band	Aug. 19	24
-82	N.S. Land Survey Inst. Lawrencetown, N.S.	McLaren, E.J.	Annapolis Valley CV-580 N.S.	23,000	SAR		4-band	Aug. 15/18	218
-83	Guelph University Guelph, Ont.	Protz, R.	Guelph Test area (C47-RSB) Ont.	8,250	9x9	3.5	2445	Oct 2/10 Oct. 30	53
-86	Alberta Environment	Woolnough, D.	Red Deer, Alta. (Falcon)	5,600	9x9 IRLS	6.0	2424	Oct. 6	128
-119	Intera Consultants Calgary, Alta.	Upton, L.	Stavely, Alta. (CV-580)	3,000 10,000	9x9	3.5	2405	Mar 20/21 (1979)	14
-120	Intera Consultants Calgary, Alta.	Upton, L.	Lethbridge, Alta. (CV-580)	3,000 10,000	SAR		4-band	Mar 20/21 (1979)	14
-123	Intera Consultants	Upton, L.	Neepawa, Man. (CV-580)	3,000 10,000	SAR		4-band	Mar 21 (1979)	23

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REPORT OF THE WORKING GROUP ON CARTOGRAPHY AND PHOTOGRAMMETRY

5.2 Cartography and Photogrammetry

For several years Landsat images have been used operationally in Canada for topographic map revisions and positioning off-shore features, albeit on a relatively small scale. In addition to conventional mapping applications, satellite imagery has made possible the dynamic mapping of ice movements in the navigable waters of Canada at Ice Central, DOE. Imagery continues to be used by Canadian contractors working overseas as base maps in poorly mapped areas.

Some experimental treatment of the imagery is continuing in search of other cartographic applications and these activities are outlined below.

5.2.1 Mapping Intermittent Ponds

On behalf of the Surveys and Mapping Branch, EMR, Geostudio Consultants have embarked on the development of a methodology for mapping intermittent ponds and lakes using repetitive Landsat scenes, since mapping based on aerial photography taken at one water level state cannot accurately depict the distribution of surficial water in areas characterized by large seasonal variations in water distribution. Digital techniques will be used to analyse the imagery and computer programs developed to depict the boundary lines of permanent and intermittent waters using automated cartographic techniques.

5.2.2 Change Detection

Gregory Geoscience Ltd. are working on the development of inexpensive techniques for detecting and mapping change relevant to the updating of topographic maps for the Surveys and Mapping Branch. If change can be reliably detected in wilderness areas on the basis of satellite imagery, routine re-photography can be rationally directed to those areas most in need of map revision. The detection and extent to which actual revision information can be extracted from Landsat images will be tested in a block of maps currently scheduled for re-photography and revision.

5.2.3 Photomaps

Methods of refining the Landsat data to produce more useful products for mapping are being investigated. The Geoscience Working Group in cooperation with CCRS has initiated the "Geo-image" project. Its goal is to define and produce a demonstration set of high quality Landsat imagery which is digitally enhanced for visual interpretation. Experimental colour photomaps have been produced which are radiometrically and spatially enhanced as well as cartographically corrected to the standard U.T.M. coordinate system of N.T.S. maps.

5.2.4 Extension of Control

Work continued at Laval University to determine the role that space photography could have in extending or improving control networks in those areas of the world where such information is sparse or only available from 1:1 000 000 maps. By doing aerial triangulation with SKYLAB photography, the accuracy for ground control is significantly improved when the coordinates are rounded to higher values (100,200...1000m). For example, when ground coordinates were rounded to 1000m the bundle adjustment used for an Ontario model improved the accuracy by more than 500 per cent.

Several recommendations were made by Ali and Brandenberger as a result of this study:

i) The bundle adjustment technique should be used for the aerial triangulation of space photography and the orbit parameters should be utilized for the adjustment of the photogrammetric systems.

ii) All available control points, associated with their weights, must be used even if they are of inferior quality.

iii) An efficient way must be found to mark all control and pass points before the photomissions especially in areas with few or no suitable natural objects such as roads or highways.

5.2.5 Synthetic Aperture Radar (SURSAT Project)

Experiment proposals for cartographic studies of synthetic aperture radar imagery, both airborne (SAR-580) and satellite (SEASAT-SAR) were made by the Surveys and Mapping Branch, EMR and the

University of New Brunswick, to the SURSAT Project. These proposals have been supported by the Project Office and sample imagery is being made available. The proposals center on studying the geometric accuracy of the imagery and the development of analytical restitution or plotting methods for the reduction of system distortions. The imagery is to be evaluated for accuracy and content relative to standard map accuracy criteria. The airborne SAR imagery is now in the hands of the investigators and this aspect of the project is proceeding.

5.2.6 European Space Agency (ESA) Metric Camera Experiment

One of the remote sensing experiments to be flown on the first ESA Spacelab flight of the Space Shuttle Orbiter is the Metric Camera experiment using a Zeiss RMKA 30/23 aerial mapping camera. The focal length of 305 mm and the orbital altitude of 250 km yields an image scale of 1:820 000 giving a ground coverage of approximately 190 x 190 km^2. A total of 1650 exposures on three different film types are proposed.

Calls for experiment proposals have resulted in a number of Canadian submissions. The main objectives of the experiments are to test the use of metric cameras in space for

- revision of existing maps
- generation of new or improved maps in areas where the existing map base is unsatisfactory.

Unfortunately, the limited northerly extent of the orbit (57°) and the dependence on a summertime launch for adequate solar altitude could considerably limit the acquisition of photography over Canada. The Director, Topographical Survey, will act as coordinator for cartographic studies of any photography over Canada obtained from this mission.

5.2.7 Large Format Camera For Shuttle

NASA is building a high-performance cartographic camera with a 30.5 cm focal length and 23 x 46 cm format which will initially be carried in the cargo bay of early Shuttle flights. The orbits of these flights will be limited to 28.5° latitude N-S. Canadian coverage cannot be expected before later missions with higher orbital inclinations or after the camera is mounted in the Multimission Modular Spacecraft (MMS). Polar orbit capability should be available in 1983. Using analytical plotters it is expected that the photography will be adequate for map compilation at scale 1:50 000 according to National Map Accuracy Standards and compiling contours at 30 m vertical interval.

5.2.8 SPOT

Under the responsibility of the French Space Agency (CNES) this satellite, to be launched in 1983, carries a push-broom type scanner. This scanner, since it is pointable, has the capability of producing stereo-image pairs with a one-day time interval and a base-height ratio of (0.6) or a larger B/H /1.2) on a longer time interval. The satellite will be capable of systematic coverage of the earth every 26 days with a swath width of 115 km. Simulations have indicated that the imagery will meet 1:500 000 map standards.

5.2.9 Satellite Radar Altimetry

The radar altimeters of GEOS III and SEASAT were conceived for ocean studies, however recent investigations of altimetric records over the Greenland Ice Cap and the San Joaquin Valley, California have resulted in unexpected successes in earth terrain contouring.

Agreement to within a few metres of known ground values have been reported. These results perhaps indicate that a future satellite altimeter could be designed to provide terrain elevations which would be particularly useful in areas where access is difficult and expensive such as the arctic ice-caps. Currently an effort is being made by the Surveys and Mapping Branch, EMR to acquire space satellite altimetric data over a suitable Canadian test site to evaluate this potential.

5.2.10 ISP Working Group 4 "Mapping from Space-borne Photographic and Non-Photographic Imaging Systems: Resolution"

At the ISP International Symposium on "New Technology for Mapping", Working Group 4 of Commission IV received unanimous support for the following resolution relative to operational space-forms, earth-sensing systems:

CONSIDERING -

That there is an urgent world-wide carto -

graphic need to support resource management and environmental understanding, and that the need cannot be met at the required rate by existing conventional systems,

AND RECOGNIZING

that experimental earth resource satellite programs have demonstrated the capability for meeting this need, and

that several organizations and countries are taking steps to further improve space-borne earth sensing systems of cartographic potential, with a variety of sensors,

BE IT RESOLVED

that the participants at the symposium of Commission IV, held in Ottawa, Canada, October 2-6, 1978 recommend to the Council that the society urges member countries and international organizations to introduce at the earliest possible date, operational cartographically sound earth-sensing systems for the benefit of mankind."

5.2.11 Conclusion

Because new mapping in Canada is being carried out at scales of 1:50 000 or larger, satellite imagery has had very little impact on the program. Partial revision of small scale maps and the establishment of the areas in need of map revision are probably the most profitable applications to be foreseen for imagery currently available and for that proposed for the near future.

Development of small-scale mapping techniques using space-borne imagery has value for the less well mapped portions of the world and can be used by Canada in its overseas assistance programs. For this reason research will continue in these fields.

5.2.12 Recommendations

i) In support of the resolution of Commission IV of the ISP, the Working Group on Cartography and Photogrammetry recommends that CACRS support the idea of an operational satellite(s) based on current technology and receiving capabilities and having an extended life-span.

ii) That the application of satellite radar altimetry over land areas be explored.

5.2.13 Appendices

5.2.3.1 Appendix I - Current Bibliography

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REPORT OF THE WORKING GROUP ON DATA HANDLING AND SATELLITE TECHNOLOGY

5.3.1 INTRODUCTION

The Working Group met four times since the last CACRS meeting, but because of the "volunteer" nature of the group, it is generally not practical for it to undertake ambitious, time consuming studies. Hence the group's prime roles are those of providing an external review of CCRS technological projects, and informing CCRS of new recording and processing techniques. Considerable time was spent reviewing CCRS plans for Landsat-D, SPOT and SURSAT. The group also studied a number of technological developments in the area of advanced data recording techniques. The most advanced of these is the Plessey System for optical recording, which shows considerable promise for the permanent storage of digital data at a much higher packing density than has been possible in the past. In addition the sub-working groups on CCT's, Future Remote Sensing Satellite Programs and Image Analysis met 6 times during the year.

As a result of the inspiring remarks given by Mr. H.W. Thiessen, Deputy Minister of Environment for the Alberta government, the group decided to hold the majority of its 1979 meetings as joint meetings with the discipline-oriented working groups in order to enable the remote sensing technologists to obtain a better understanding of the problems facing the user community. The first of these joint meetings was held with the Working Group on Forestry, Wildlife, and Wetlands in Winnipeg on February 26th, 1979.

Two of the meetings included tours of provincial remote sensing organization facilities (Alberta and Manitoba) while one included a tour of the PASS facilities.

The Sub-Working Groups may at times undertake some in-depth studies or projects. For example, the Sub-Working Group on the Remote Sensing Satellite Program is investigating some aspects of a possible Canadian surveillance satellite. The CCT Sub-Working Group has made important suggestions regarding the new format being developed by the Landsat Ground Station Operators Working Group.

5.3.2 ADVANCES IN DIGITAL RECORDING TECHNIQUES

When the Working Group on Data Handling, under the Program Planning Office (1969-1972) began planning for Canada's participation in the ERTS (now Landsat) program, many new forms of digital storage seemed to be on the brink of commercial availability. Fortunately, it was decided that the new methods involved too much risk for use at that time. During the past year, a few very large scale memory systems have finally been announced commercially, and working demonstration models now exist. Production is scheduled for some systems this year.

Plessey in the U.K. has developed an optical system with a recording density of ten million bits/cm^2. The system uses a holographic approach, and two media are available: one for permanent recording and a second which is erasable, hence reusable.

System Development Corporation in the U.S.A. has developed an on-line memory system, TBMII, with a maximum capacity of 2.8×10^{12} bits of storage which is more than one thousand Landsat-D scenes. The system consists of a number of high speed, high density magnetic tape drives using video, helical scan recording techniques. Recording density is much lower than that of the Plessey system, about 100,000 bits/cm^2. The tape is about 5cm wide. To minimize error, 100% redundancy is employed in writing, with the redundant data widely separated on the tape. Sustained data rate for a single unit is 5.5 million bits/second.

5.3.3 COMPUTER COMPATIBLE TAPES

This sub-working group had its initial meeting in January 1978, and held two further meetings during the year. In its terms of reference, the group decided to establish itself for an initial two year period and review the need for continuation after that time. It agreed to provide advice on CCT format changes, distribution procedures and quality control; to report on novel applications, user experience, current and proposed usage, and the availability of input/output software for digital image analysis systems. The group wishes to promote the wider usage of digital analysis of remotely sensed data and compatibility between systems and data types.

During the year a number of documents pertaining to the proposed new universal format for CCT's were reviewed by the group, and a number of useful comments and suggestions were made. It is hoped that an improved format will result, and that it will indeed be universally adopted.

Members of the group reported a number of problems experienced with CCT's both from EROS and CCRS. The majority of problems referred to CCRS were resolved in conjunction with the phaseover of production to the receiving stations. Improvements are being made in quality control procedures for the production of ISISFICHE. Problems with EROS tapes must be reported directly to the EROS Data Center.

The group members reported a number of interesting and novel uses of Landsat and other remote sensing data. Some of these may be reported on to a wider audience through the CCRS Newsletter.

5.3.4 FUTURE REMOTE SENSING SATELLITE PROGRAMS

The sub-working group on Future Remote Sensing Satellite Programs, consisting of eight members, began a series of meetings in 1978 to examine the future satellite program options for Canada. These meetings, held every two months, are continuing into 1979 and will result in publication of a report by the fall of 1979.

The sub-working group is reviewing program plans of other nations as well as examining the options for a Canadian remote sensing satellite program. The final report will address many issues of concern including the potential for foreign programs to meet Canadian requirements, modes of possible international cooperation and Canadian capabilities for program implementation.

5.3.5 IMAGE ANALYSIS

There are now at least five Canadian companies with expertise in the manufacture of image analysis systems. These include Computing Devices of Canada, NORPAK, OVAAC-8, MDA and DIPIX. Computing Devices built the first commercial system in Canada, ARIES, for the Department of Fisheries and Environment. DIPIX is a new company made up of the Computing Devices staff previously involved in the ARIES project. NORPAK builds colour displays suitable for use in any image analysis system. In addition, they have developed a powerful digital image enhancement system for DCIEM in Toronto. The federal government has funded OVAAC-8 to develop a line of image analysis systems ranging from elementary, low-cost systems (LOCAS - less than $100,000) to a highly sophisticated facility which includes special hardware processors to increase the speed of image analysis and to perform efficient geometric correction. The MDA system was originally designed to augment the ground stations marketed by MDA. It is noteworthy that the MDA development received no direct funding from the federal government. MDA has sold three analysis systems which are used for METEOSAT, LANDSAT, TIROS-H, and SEASAT image processing, geometric correction, and interpretation.

In addition to these commercial systems, many laboratories are now putting together their own facilities for digital analysis of remote sensing data. CCRS has developed its own system using a General Electric Image-100, a PDS scanning densitometer, an Applicon colour ink-jet plotter, two minicomputers and special purpose array processor designed and built by Computing Devices and DIPIX. The Ontario Remote Sensing Centre is developing, with DIPIX, a system based upon a PDP-11 minicomputer, a NORPAK display and ARIES software. AES has an image analysis system for meteorological analysis configured around an Interdata 8/32 minicomputer and a NORPAK display.

A number of groups are now using the CCRS developed UNIDSK file management software, including FFRI, PFRC, OVAAC-8, and Laval University. Most systems are based upon the PDP-11 family of computers, while the MDA system uses Interdata. Hewlett-Packard Computers are used in some U.S. systems.

In the Landsat-D era, higher resolution will mean that more data will have to be processed, and spatial features, such as texture, will increase in importance, adding further to the computational loads of analysis systems. It will become more important to effectively integrate information from sources other than the imaging sensors, and to produce output information more easily used by the resource manager.

5.3.6 RECOMMENDATIONS

5.3.6.1

The development of Canadian space applications and technology is being increasingly hampered by the lack of an effective, especially serious in our dealings with the coordinated space activities of

other countries. Therefore, the Data Handling and Satellite Technology Working Group supports, and recommends that CACRS strongly support, the development of a Canadian space agency and that it carry this recommendation to the ministerial heads of government.

5.3.6.2

Whereas resources at CCRS will not be adequate to record and process all LANDSAT D data, the Data Handling and Satellite Technology Working Group recommends that CACRS develop a rationale for deciding when LANDSAT-D Thematic Mapper data will be acquired recorded, and processed.

5.3.6.3

CCRS should provide, with each CCT distributed, a matching image reflecting the spatial extent of the data on the tape, with quality and annotation to allow a user to identify the line-number and pixel-number coordinates of a reference point to an accuracy of plus or minus one percent of full scale.

5.3.7

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5.4 REPORT OF THE WORKING GROUP ON ENGINEERING APPLICATIONS

5.4.1 INTRODUCTION

The Working Group had two meetings in 1978. It met for the first time in February and once since the CACRS Annual Meeting.

Activities of the group have concentrated on establishing a framework for its future activities. So far, the goals and objectives have been identified, subcommittees have been formed and steps were taken to enlarge the membership to include representation from the East and West Coast.

The Working Group considers that in an area such as engineering applications, it is important that

(a) its activities should represent a consensus of the users and should serve as many as possible,
(b) the users should be fully aware of the capabilities, costs and benefits of feasible remote sensing systems and procedures.

Accordingly, plans are underway to organize, in 1979, a national workshop on the Engineering Applications of Remote Sensing and to prepare a user's manual.

In addition, work began on the identification of limitations in sensor and application technology which would restrict their use.

5.4.2 SUBCOMMITTEES

The Working Group decided to focus its efforts at present on 4 areas of engineering applications. Subcommittees have been formed to perform tasks in these areas.

Subcommittee on	Chaired by
Pipeline	Dr. J.D. Mollard
Highway	Mr. B. Sen Mathur
Land Development	Mr. S.J.G. Bird
Energy Conservation	Dr. P. Lapp

5.4.3 RECOMMENDATIONS

5.4.3.1 Access to orbital sensors with improved spatial resolution be available to the remote sensing community in Canada, especially the engineering users.

5.4.3.2 Basic research into the interactive mechanism of engineering materials should be conducted to facilitate the interpretation of photography and imagery from photographic and non-photographic sensors.

5.4.4 Appendix 1

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5.5 RAPPORT DU GROUPE DE TRAVAIL SUR LES ÉCOSYSTÈMES TERRESTRES

5.5.1 ACTIVITÉS DU GROUPE DE TRAVAIL

Le groupe de travail sur les écosystèmes terrestres a réalisé la première étape de son programme d'actions, soit l'inventaire des projets "opérationnels" de télédétection reliés à la végétation naturelle et à la faune sauvage.

Nous avons maintenant un portrait beaucoup plus fidèle des applications réelles de la télédétection dans ces domaines, comme des caractéristiques connexes des utilisateurs de données de télédétection au Canada. Notre prochaine étape consistera à diffuser autant que possible l'information recueillie, que nous tiendrons à jour de façon continue, par des publications et des séminaires régionaux. Enfin, dans la mesure des disponibilités des membres du groupe de travail, une certaine forme de coordination des activités dans ce secteur sera tentée cette année en aidant à la création ou à la structuration de groupes d'utilisateurs ayant des affinités communes.

5.5.2 ACTIVITÉS DE TÉLÉDÉTECTION AU CANADA

Outre les activités importantes de l'Institut d'aménagement forestier, de l'Institut de protection contre les feux de forêt et de la Direction générale des terres du Ministère de l'Environnement, l'enquête mentionnée plus haut a permis de dénombrer quelques 320 projets jugés opérationnels par les répondants d'un questionnaire transmis massivement à tous les utilisateurs canadiens de données de télédétection.

Il est intéressant de noter, par exemple, que plus la technique de télédétection mentionnée apparaît complexe, moins celle-ci est utilisée couramment. Ainsi la photographie panchromatique est-elle mentionnée, dans ces projets, deux fois plus souvent que la photographie couleur infrarouge, et six fois plus souvent que les images numériques Landsat.

Les applications les plus courantessont la cartographie biophysique (300), les applications à la foresterie (234) et l'étude de la faune sauvage (220). Les applications à l'étude des territoires sauvages n'étaient signalées que dans cent vingt-neuf cas. Enfin l'utilisation de la télédétection varie considérablement d'une région à une autre du Canada. L'Ontario vient en tête du nombre de projets, suivie des Prairies (l'Alberta surtout), des Maritimes, du Québec, de la Colombie britannique, et des territoires du nord-ouest.

En résumé cette enquête a permis de constater qu'il existe d'une part un bon nombre d'organismes au Canada qui ont intégré la télédétection dans leurs activités normales, mais que la technologie utilisée est en général loin derrière les capacités réelles des systèmes actuels. D'autre part, même pour des domaines d'application où la télédétection a fait ses preuves depuis longtemps, on constate également que beaucoup d'organismes sont demeurés imperméables au potentiel de la télédétection. De façon globale on peut affirmer que le transfert des technologies nouvelles est à peine amorcé, qu'il est lent à se faire et qu'il s'opère différemment d'une région à l'autre du Canada.

En répétant périodiquement ce type d'enquête nous espérons ainsi pouvoir évaluer de façon continue l'évolution de la télédétection au Canada, l'impact des politiques et actions d'organismes oeuvrant dans le domaine de la télédétection et les modestes interventions de notre propre groupe de travail.

5.5.3 RECOMMANDATIONS

Le groupe de travail sur les écosystèmes terrestres recommande:

(1) que le Centre canadien de télédétection accentue l'allocation de ses ressources humaines et financières au développement et au transfert des applications de la télédétection plutôt qu'au développement de nouvelles techniques de télédétection.

(2) que le Centre canadien de télédétection prévoit dans son budget certaines disponibilités financières ou matérielles pour les groupes d'utilisateurs (Associations, centres régionaux, groupes disciplinaires, etc) qui, par leurs activités, peuvent grandement favoriser le développement et le transfert des applications de la télédétection.

(3) que le Centre canadien de télédétection publie une série de guides d'utilisation des données de télédétection pour des applications opérationnelles d'intérêt.

Enfin le groupe de travail appuie la recommandation de la Direction générale des terres du Ministère de l'Environnement concernant l'intégration des résultats d'analyse numérique des données de télédétection à des banques d'information sur le territoire.

5.5.4 RÉFÉRENCES

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5.6 REPORT OF THE GEOGRAPHY WORKING GROUP

5.6.1 Airborne Remote Sensing

An analysis of airborne projects was undertaken by a member of the Working Group. Of the total of 88 applications projects flown under the auspices of CCRS in 1978, 29 of them were classified as being geography related. They covered a wide range of topics including ecological mapping, impact studies, coastal investigations, meteorology, ground water studies and land use. Eight of the projects involved the acquisition of SAR data; the other projects required data collection by various combinations of sensors.

It was reported to the Working Group that aerial photography is still the major data source for ecological and land-use mapping. Geographers have made use of multidate photography in a variety of studies from park evaluations to detecting the movement of large boulders by ice on tidal flats. Various types of airborne data have been used for terrain mapping and trafficability studies. Supplementary hand-held aerial photography from light-aircraft becomes a more popular method of data collection as the costs of acquiring vertical photography increase.

The purchase of thermal imagery through CCRS/NAPL is still difficult as the original tapes have to be run each time imagery is required. It is appreciated that in comparison with other types of data, thermal imagery is more problem-specific; for example, processing can be done to emphasise information for either land or water on the same image. It is suggested, however, that negatives be produced from good quality thermal data. The locations of the imagery can be catalogued and recorded on flight line diagrams at NAPL and prints be made available for reviewing. A similar policy should be instituted for radar imagery. In this way, both thermal and radar imagery can be made readily available to the remote-sensing community.

5.6.2 Spaceborne Remote Sensing

Visual Landsat imagery continues to be used by geographers for small-scale ecoregion and terrain mapping in various parts of the country. Use of the data for studying seasonal ice cover and for climatological studies related to albedo measurements were also reported.

Geographers continue to be active users of digital analysis systems. It was reported that in 1978 a total of 28 geography-related projects were undertaken on the CCRS Image Analysis System (CIAS). Of these, 10 studies involved biophysical/habitat mapping, 10 were directed towards land use/land cover mapping, while 8 projects were grouped as hydrology and coastal region studies. Users are from industry, federal and provincial government agencies, as well as universities. The emphasis in many of the studies is on operational mapping.

5.6.3 Project Information

For both airborne and spaceborne remote-sensing programs, members of the Working Group have found it difficult to know what proportion of geography projects come to their attention. With incomplete information, it is obviously difficult to make a valid assessment of current remote-sensing projects.

In the CACRS 1977 Annual Report there was no consolidated listing of airborne projects. In addition, there has never been a comprehensive listing of projects being undertaken on the CIAS and other digital analysis systems. There is thus a need for a centralized system for recording project information and making it readily available to interested persons.

The recent publication of the CCRS Airborne Program Assessment is an indication of the type of information that could be made available on a regular basis. In addition, members of the Working Group have found the recent listing of projects prepared by the Working Group on Forestry, Wildlands and Wildlife to be a valuable source of information. Publication of the document has already led to interchange of information between persons with projects included on the list. In particular, it has brought attention to reports that have only a limited circulation. An extension of the work undertaken by the Forestry, Wildlands and Wildlife Working Group so that other disciplines could be included in a general listing would be valuable.

For the task to be undertaken most effectively, a computer-based information system for projects would be the logical approach to use. A system similar to the very efficient RESORS bibliographic listing should be developed.

5.6.4 Technical Developments

It was reported to the Working Group that the colour balance in the processing of colour infrared film now achieved by CCRS and NAPL has been of great assistance to interpreters.

5.6.5 Applications

In the early stages of Landsat analysis, many geographers were involved with mapping projects. Although mapping is still being undertaken, emphasis at present is changing towards the development of monitoring techniques.

There are three main emphases that can be identified in this work. First is the development of methodology for using digital Landsat data to identify areas of change. Although some land-use changes can be detected, a lot of work remains to be done in the practical aspects of recording, measuring and displaying the changes. A second emphasis involves the incorporation of Landsat data and aerial photography into one monitoring system. Finally, investigations are underway on methods for incorporating remote-sensing data into geographic information systems for monitoring purposes. This is an area where developments are likely over the next few years.

The Geography Working Group was recently asked to review two "Companion Maps" and make suggestions for a possible user survey to identify potential applications and users. Initial ideas on this topic have been forwarded to CCRS.

5.6.6 Benefit Analysis

A major study on the benefits of airborne remote sensing was begun in late 1978 by the CCRS representative on the Working Group.

5.6.7 User Liaison and Training

Members of the Working Group noticed the increased information distributed by CCRS in 1978. The Fact Sheets, in particular, were seen as a useful addition to the items made available.

The major liaison and training effort of the Working Group in 1978 was the organization of a workshop in conjunction with the Annual Meeting of the Canadian Association of Geographers. Held at the University of Western Ontario in London, the workshop was entitled "Remote Sensing of the S.W. Ontario Landscape". Its aim was to give participants with little or no experience in remote sensing an introduction to the visual analysis of imagery. Following a brief introduction, emphasis was on guided practical work studying colour, colour infrared, Landsat, thermal and radar imagery from the local region. An encouraging response from the 15 participants suggests that a similar venture be undertaken upon a future occasion, although no workshop is planned for 1979.

The Working Group, however, does plan to continue its liaison activity. Early in 1979, the Group will sponsor a one-day session in Calgary in conjunction with its regular meeting. The title for the session is "Remote Sensing of Prairie and Arctic Environments - Present Programs and Future Needs".

5.6.8 Conclusions and Forecast

It was noted by members of the Working Group that 1978 was a year of consolidation. Although there were no major new developments, there was a general strengthening and extension of existing programs. This was noted particularly in the areas of ecological mapping from remote-sensing data and in environmental impact studies. The availability of good quality colour infrared photography was seen as an important element in furthering these areas of study.

The coming year will see increased availability of radar imagery and assessment of the value of such data for geographical investigations. In addition, there will be increased emphasis on the development of methods for monitoring change in the environment from remote sensing data.

5.6.9 Recommendations

The Geography Working Group submits the following recommendations to CACRS:

5.6.9.1 As an aid to the remote-sensing community, CCRS, NAPL, the SURSAT Project Office and Intera should establish a clearly defined and easy mechanism for cataloguing, displaying and ordering thermal and radar imagery.

5.6.9.2 Methods should be developed for increasing the availability of information about ongoing and completed remote-sensing projects in Canada. This, for example, might be achieved by the establishment of a data base complementary to the existing RESORS bibliographic system.

5.6.10 Appendix I

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5.7 REPORT OF THE GEOSCIENCE WORKING GROUP

The Working Group met twice during the year; at Victoria, following the 5th Canadian Symposium on Remote Sensing, and at Yellowknife, N.W.T. at the start of Geoscience Forum. The group also hosted a meeting of the International Geological Correlation Programme, Project 143 (Remote Sensing and Mineral Exploration) in Ottawa. Regular contact is also maintained with the Geosat Committee through three members of the group. It has been a quiet year for remote sensing consultants, overseas work leading Canadian remote sensing projects in importance. Gregory Geoscience reports a marked shift from government contracts to industry contracts, accompanied by a shift from research to application type projects.

5.7.1 AIRBORNE REMOTE SENSING

Airphotos are still the most widely used data source in remote sensing. The Surficial Geology and Wetlands Mapping Project undertaken by the O.C.R.S. is especially noteworthy because of the very size (150,000 km^2) of the area. MSS images are being used to support the airphoto studies.

INCO staff Geologist J.A.E. Allum described several case histories involving both airphotos and SLAR imagery in the search for base metal deposits at a talk given to the Prospectors and Developers Convention in Toronto.

The ongoing airborne SAR programme sponsored by the SURSAT Office is assisting geologists in Nova Scotia, Quebec, Ontario and the Northwest Territories in structural and surficial mapping projects. Reports on progress are expected during the summer.

At the Geological Survey of Canada, multispectral techniques have been applied to airborne gamma-ray data from the Hearne Lake area near Yellowknife, N.W.T. A supervised classification technique was used, the classes were recognized with 80% success within the training data set.

5.7.2 SPACEBORNE REMOTE SENSING

Despite the breakdown of Seasat, enough imagery was recovered for a reasonable evaluation of the SAR imagery. Geological analyses will be carried out on images from most of the provinces. The SAR responds very well to topography, to surface roughness and to moisture changes which would indicate potential value in structural studies, surficial mapping and landuse mapping. Gregory Geoscience cautions that the single look direction of SEASAT-SAR may introduce a bias into studies of linear trends comparable to the bias found in studies of Landsat MSS imagery. This problem may be minimized by using SAR imagery from ascending and descending passes.

For more than a year the Working Group have argued the need for specially preprocessed MSS colour composites. A research project sponsored by the Group has investigated haze removal, band stretching and edge enhancement techniques on the CCRS Image 100, as well as methods of transferring data from tape to film.

The effects of concentrations of base metals in soils on vegetation growth has been investigated by Gregory Geoscience using MSS images.

5.7.3 Technical Developments

The first computer controlled Applicon Colour-Jet Plotter in Canada was acquired by the Geological Survey of Canada for off-line production of coloured airborne magnetic and radiometric maps as well as Landsat scenes.

Gregory Geoscience reports proposals for a simple, inexpensive image analysis system which uses projection techniques for combining multispectral images and for detecting changes in imagery acquired at different times.

5.7.4 Training

A half-day workshop involving 5 speakers and a poster display formed part of Geoscience Forum, an annual event held in Yellowknife, N.W.T.

A speaker was also sent to a workshop on remote sensing held at the Bedford Institute of Oceanography.

5.7.5 Conclusion and Forecast

A policy change by the CCRS is needed to give priority to the preparation of Canada-wide collections of high quality, specially processed imagery not only of Landsat MSS but also near-future imaging systems, in particular, Landsat 3-RBV and Landsat D-Thematic Mapper.

The imaging systems which appear most promising to geologists are the Landsat 3-RBV, and the large format cameras proposed for the space shuttle. Stereo-photography from space is now only a few years away.

5.7.6 Recommendations

The Geoscience Working Group recommends that CCRS recognize the importance of Canada-wide coverage of selected images from each of the main satellite imaging systems, MSS, Landsat 3-RBV, and Landsat D-Thematic Mapper. Each image collection should be accompanied by published listings and index maps. Image sets should be distributed to the public by NAPL for purchase at prices comparable to those of airphotos.

5.7.7 Appendices

5.7.7.1 Appendix I - Current Bibliography

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Newton, A.R. and Slaney, V.R. (1978): Geological interpretation of an airborne gamma-ray spectrometer survey of the Hearne Lake Area, N.W.T.; Geological Survey of Canada, Paper 77-32.

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Strome, W.M., Fleming, E.A., Bruce, W.P. and Slaney, V.R. (1978): Landsat imagery - a cartographic reference base; Proc. I.S.P. Commission IV, Symposium on New Techology for Mapping, Ottawa, Oct. 1978.

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5.8 REPORT OF THE WORKING GROUP ON ICE

5.8.1 AIRBORNE REMOTE SENSING

Over the past year the A.E.S. ice patrol aircraft has been contracted by various oil and gas exploration companies to undertake remote sensing missions with S.L.A.R., laser, I.R. and B.W. photographic imagery obtained on a number of missions. These included ice type and motion studies in the Sverdrup Basin (Petro-Canada Exploration Inc.), and ice data base information for the Arctic Pilot Project (Melville Shipping Co.) through Baffin Bay and Peary Channel.

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

Photography off the Labrador coast is being used to generate statistics on multi-year ice frequency, while in the Beaufort Sea the emphasis has been on deriving pressure ridge statistics.

On March 12th, 1978 a NASA Lewis C-130 aircraft equipped with laser, radar altimeter, scatterometer and cameras overflew target areas in the Mackenzie Delta region of the Beaufort Sea. Targets were set up and ground truth information were collected by personnel from Canmar Exploration and Imperial Oil

The NASA Ames Convair 990 flew a route across the Canadian Arctic in November 1978, overflying target areas at Pond Inlet and the Beaufort Sea.

The remote sensing component of the Arctic Marine Oil Program involved detection and tracking of oil slicks in ice-infested waters. Sensor requirements were tested using the CCRS Convair 580; in addition, the SAR on board was used for iceberg identification against different sea states.

Norcor Engineering and Research Ltd. performed a survey of icebergs in Baffin Bay, using a Britt Northern Islander. The sensor complement includes search radar, low light level TV, thermovision, forward video, Hasselblad photography, airborne radiation thermometer and comprehensive data recording system.

With the demise of SEASAT-A, the SURSAT ice experiments will consist of extensive airborne programs and surface measurements. Planning was initiated in 1978 for 1) Gulf of St. Lawrence, late February '79, 2) Beaufort Sea, March '79, 3) East Coast, early April '79, and Grand Banks, early May '79, Sorties by the CCRS Convair 580 equipped with ERIM SAR. Accompanying flights will utilize a gamut of sensors: AES Electra, oil industry Twin Otters, NASA Lewis C-131, NASA JSC C-130, NASA Wallops P-3, helicopters, Danish C-130, U.S.C.G. C-130, etc.

5.8.2 SPACEBORNE REMOTE SENSING

Landsat and NOAA imagery is being used by various companies to monitor overall ice conditions in the Canadian Arctic, the two main uses of the imagery being to expand the historical ice data base and aid in tactical operational planning.

Digital Landsat data has been used in the field of glacier inventories, by the University of Nebraska at Omaha, especially for areas with no, or poor, maps, such as the Hindu Kosh, Nepal areas. A test correlation was performed for the Dorjet area, Yukon, when compared to the Canadian Glacier Inventory. Good results were achieved for ice areas, less correlation for glacier debris and ice cored moraines, but Landsat-3 should provide better resolution.

Ice validation experiments for SEASAT-A for the Beaufort and Labrador Sea were submitted by Canmar/Esso Resources/Dome Petroleum to the Sursat Project Office and N.A.S.A. These plans cover examining data from all the sensors. As well as the detection of ice, companies are interested in the validation of the sensors for collecting oceanographic and meteorological information.

Even with the demise of the satellite the interested companies are actively pursuing ways of fulfilling the goals set out in the plans. While operating, SEASAT-A provided good amounts of ice data in the

Beaufort Sea, and coincident data sets exist from the AES SLAR-equipped aircraft and industry ground truth and photographic flights.

The NIMBUS-7 spacecraft, carrying a SMMR (scanning multichannel microwave radiometer) for ice information was launched on October 24, 1978. The satellite is operating well, and the SMMR is turned on every other day, (even Julien days), yielding total coverage of the ice covered areas. It is expected that these data products will be available in the near future from NASA Goddard.

5.8.3 SURFACE REMOTE SENSING

Three shore-based radars have been operated during 1978, two from the north coast of Bylot Island, and one at Hope Monument overlooking Lancaster Sound. An X-band, (ship) radar was set up by Steltner Development and Manufacturing Co. At a lower elevation (often obscured in cloud) Petro-Canada have set up a radar for iceberg tracking (and winter ridges, spring breakup) with weather stations at the site and 2000 feet below.

A Canadian Coast Guard ship was used as a platform for a cooperative experiment with C-Core's impulse radar and the University of British Columbia, Department of Geophysics and Astronomy, glacier sounding radar, to measure the sub-surface geometry of several small bergs off Labrador. The U.B.C. 840 MHz radar system was slightly more successful, owing to its manouver beamwidth. Data were sampled and recorded on magnetic tape for subsequent replay and computer enhancement.

5.8.4 TECHNICAL DEVELOPMENTS

Advances are occurring in the field of impulse radars for ice thickness measurements. The C-Core radar has undergone improvements and can now be considered "airborne", with detailed testing due March 1979 in the Sursat Beaufort Sea Ice Experiment together with the NRC prototype 10 MHz impulse radar system. The MPB Technologies (Montreal) system is still being put together and will be tested during 1979, with TDC funding support.

5.8.5 APPLICATIONS

Landsat and NOAA imagery were received at Shoe Cove station, processed and relayed to Environment Canada and Coast Guard vessels in a timely manner, i.e. within 2 - 2 1/2 hours, in a CCRS funded demonstration with C-Core.

Another NIMBUS-5 ESMR time lapse movie has been made by Crawley Films, Ottawa, showing ice areas of the Northern Hemisphere, while three more for different areas are in production. The first movie, lasting 12 minutes, showing Canadian ice areas (Beaufort Sea, Arctic Islands, East Coast and Hudson Bay) is available from Crawley at $80.00 per copy, or on loan from René O. Ramseier, OAS, Ottawa.

5.8.6 USER LIAISON

The Working Group held meetings at Dartmouth, N.S. and Ministère de L'Industrie et du Commerce, Quebec City, P.Q. during the year. Invitations are extended to potentially interested personnel in the environs, but usually do not result in wider response.

A sub-group has been initiated to make proposals for "Ice Parameters to be Sensed Remotely for Ice Reconnaissance", and held its first meeting at Quebec City in November.

5.8.7 TRAINING

AES Ice Branch, Downsview, has continued its routine remote sensing workshops for ice observers from AES and Canadian Coast Guard personnel.

5.8.8 FORECAST

A Centre for Remote Sensing of Sea Ice in Navigable Waters is to be established in Burlington, Ontario, as part of Ocean and Aquatic Science, D.F.E., sometime in 1979.

A preliminary study at NASA Goddard has been made on an Ice Processes Satellite, a definition study will be completed in mid 1979 and, if approved, will lead to a satellite with target launch date of 1985.

5.8.9 RECOMMENDATIONS

The Working Group on Ice recommends that:

5.8.9.1 adequate funding be given to Canadian industries to design and produce an advanced imaging radar.

5.8.9.2 adequate funding is provided in the future for support of surface ice measure-

ments in conjunction with active and passive microwave measurements; in particular the signatures from brackish ice and icebergs need further elucidation.

5.8.10 APPENDICES

5.8.10.1 Appendix I - Current Projects

"Ice", Nos 56 and 57, 1978, the news bulletin of the International Glaciological Society, contains a comprehensive summary of Canadian ice activities, submitted annually by Simon Ommanney.

5.8.10.2 Appendix II - Current Bibliography

Bibliography of 1976 publications is now ready, prepared by Glaciology Division, DOE, Ottawa.

5.8.10.3 Appendix III - List of Group Members

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5.9 Report of Oceanography Working Group

5.9.1 The working group did not meet during 1978. The SURSAT project and the launch of SEASAT-A led to experiments in aircraft and satellite oceanography and to planning meetings that covered many of the interests of the working group. The IUCRM meeting on Passive Radiometry of the Ocean in June 1978 discussed optical (water colour), infrared (water temperature), and microwave (salinity temperature and wind speed) remote sensing. Reports and recommendations from the three working groups formed under these headings at the meeting are now available.

Relevant Canadian projects of which the chairman has details, continuing in 1978 are as follows:

GOASEX (NOAA, NASA, SURSAT, OAS, AES) SEASAT 1, sensor validation experiment in the Gulf of Alaska, Sept. 1978. A continuing series of workshops are being held for data intercomparison of all Seasat sensors with ship, aircraft and meteorological model ground truth.

The Grand Banks Experiment (LaViolette and Gower), Detection and Mapping of Ocean Current Boundaries using satellite and airborne SAR. Tail of Grand Banks of Newfoundland June 1978, Sept. 1978, May 1979.

Seasat Internal Wave Experiment (Gower and Hughes) surface roughness measurements over internal wave pockets and comparison with satellite and airborne SAR imagery Canadian west coast, July 1978.

Canada/France Ocean Optics Experiment (Gower and Morel) water colour measurements and their interpretation for chlorophyll and seston mapping. Aircraft, ship and Nimbus 7 CZCS Ligurean Sea, March 1979. Canadian west coast, July 1979, Lancaster Sound, August 1979.

Canada/German Experiment on remote sensing of water quality. (AMOS Doerffer, Amann and Haberaecker) ship, aircraft, Nimbus 7 and Landsat study in the Elbe River estuary and Bay of Fundy, March 1979 to April 1982.

5.9.2 Recommendation

To avoid the long delays that appear inevitable for processing CZCS data through NASA, CCRS should produce images from digital tapes using a variety of seston and chlorophyll concentration algorithms. This work would be in support of water colour experiments such as those listed above and would involve production of a reasonably large number of images (several hundred).

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5.10 MEETING OF THE WORKING GROUP ON DATA REPRODUCTION AND MARKETING

February 20, 1979 at Ottawa

PRESENT: B.L.Bullock,President,INTERTECH
J.P.Hession,UAMU/CCRS
G.Nitchsky,Chief,NAPL/RC
D.Ross, President,Photo-Optical Consultant
A.Gregory, President,Gregory Geoscience
Don Fisher, President, ISIS
K.Slidders,Executive, Powell & French Advertising Agency
P.A.Murtha, Associate Professor UBC
E.Shaw, Chief, DPD/CCRS

5.10.1 Don Fisher acted as Chairman. The members of the Committee were introduced. B.L. Bullock was asked to act as Secretary for the Meeting. Minutes of the meetings of last year were tabled and discussed. A booklet describing the best way to search for and order Landsat data, which was recommended last year, is now under preparation at CCRS. Peter Murtha suggested that the formats of Remote Sensing Data Products should be better defined to avoid jargon. George Nitchsky suggested that a simple statement definition be printed on the back of the order form.

5.10.2 Quality Control Standards: There have been many difficulties; standards were established but then Kodak discontinued production of film. The new film is very difficult to handle. Don Fisher tabled standards that were produced by ISIS for processing and reproduction.

5.10.3 Special Processing and Special Handling Options available: No work has been done at ISIS but CCRS has done some thinking about it. ICAS did some work, reprocessing airborne FCIR to enhance the final product. Custom processing is now available from ISIS for the Color Additive Viewers, if a request is made to ISIS. U.S.G.S. is now experimenting with Band ratioing, and such special handling may be required in the future.

5.10.4 Potential Delays in Delivery of Data: This area remains a problem because the Landsat archive is a mixed bag of products. Part of the archive is stored in Ottawa and part in Prince Albert. There were also gaps in contracts and color work at CCRS almost stopped in the last year. P. Murtha indicated that UBC has had some excellent delivery of Black and White Landsat imagery lately.

Delivery from EROS is much slower, 8-12 weeks. There was a problem with customs concerning Landsat data out of the U.S. Gregory Geoscience Ltd. succeeded in obtaining a customs ruling. A copy of the ruling is included in the minutes.

Data Delivery Option - Couriers, Air Express, now available out of Prince Albert. Real-time data has been a key element of the ISIS service. P. Murtha feels that there are more people who could be users of real-time data.

5.10.4 1977 Recommendations: Dr. Morley sent a letter in May 1978 replying to the recommendations made to CACRS.

A contract will soon be let to prepare a manual on case histories of successful applications of Remote Sensing technology. With regard to cost recovery, P. Murtha indicated that several U.S. court cases have held that Landsat data is public data and admissible as evidence. Thus Landsat data belongs in the Public Domain.

A Landsat Catalogue was prepared but was only accurate to March 31, 1978. The problem with catalogues are that they are out of date when published. A more useful method is a computer search.

CCRS has not maintained IISS in the last year for Landsat-C.

CCRS is considering a grant system to provide Remote Sensing data products to assist in University Courses.

CCRS has set up a Marketing and User Assistance group. Paul Hession has studied the use of Landsat data and feels that government agencies have been well penetrated. He says, however, that industry has only about a 30%

penetration. He will recommend to CCRS that large companies should be contacted on a personal basis. The key element in all of the marketing and publication of remote sensing is successful case histories.

Ed Shaw said that not much work on enhanced digital products is being done at the receiving sites but some work is being done on the Image-100 with direct orientation to geology. Enhanced products from Tiros-N will be available from Shoe Cove in the future.

Geometric transformation is being done for enhanced CCT products whereby the data is aligned to Eastings and Northings on the UTM grid to a resolution of 50 m.

Don Fisher tabled copies of the Terms of Reference of the Working Group. Recommended changes are noted on the enclosed terms of reference.

5.10.5 Submission of Production Sales and Statistics.

5.10.5.1 NAPL - George Nitchsky distributed a list of airborne and Landsat products sold.

5.10.5.2 Verbal summary of Intertech sales presented by B.L.Bullock.

5.10.5.3 ISIS Report tabled by Don Fisher - copy included in the minutes. Don indicated that they had hoped for a marketing push this year but were unable to carry it out because of technical problems.

Comments by Ed Shaw; Chief, DPD/CCRS:

While there have been difficulties with the commissioning of MIPS it has not been as difficult as the EBIR system was. Furthermore, MIPS has introduced a new standard of consistency and data quality. The new standards have complicated the start up of MIPS.

Real Time CCT production was premature. However, the CCT tapes are now a superior product to the products of a year ago.

Color on Demand products from CCRS have taken some time but we are now at a stage where all orders have been filled and the oldest order currently on the books was placed in February 1979.

Ed felt that the ISIS report was overly negative and that the installation of MIPS was a very positive forward step. Some of the positive aspects such as production of high quality B&W prints from MIPS should be given a higher visibility in the report.

5.10.5.4 Don Fisher says that his frustration and negative feelings arise from the delays in production as they have influenced marketing efforts. In terms of actual production, the statistics show a very close relation to production forecast. Al Gregory noted that both Canadian and U.S. total sales of LANDSAT images peaked in 74-75 and then dropped off to approximately 50% of the peak. Don Fisher indicated that sales are very close to forecast and that sales are generally increasing by 5 to 10%. The use of RBV data was discussed. A. Gregory said that they will be using RBV data for all mapping jobs to obtain positional accuracy.

5.10.6 Future Production and Marketing Objectives

CCRS: Paul has formulated plans but not yet achieved management approval. He will be pushing the contract for production of the case histories.

NAPL: NAPL is not actively displaying or advertising its products. George suggested that their major emphasis in the next year will be to continue to support and work with ISIS. Particular emphasis will be placed on improving quality and service. Utilization of colour images is increasing.

INTERTECH: A marketing report was tabled by B.L. Bullock. Major growth is expected in thermal and radar.

ISIS: The marketing effort was held up by lack of consistent production capacity. In the coming year ISIS intends to begin a public advertising program. The loss of NOAA data will leave a hole in the production program at ISIS.

5.10.7 RECOMMENDATIONS

5.10.7.1 That CCRS and ISIS support through a subsidy program the establishment of ISISFICHE in the educational institutions having viable remote sensing programs for a one year trial period.

5.10.7.2 That CCRS establish a grants system similar to that in effect at NAPL for airborne products, to assist educational institutions conducting remote sensing courses to purchase remote sensing satellite products.

5.10.7.3 (a) That CCRS maintain the Landsat catalogue and ensure that this is updated, printed and published on a regular basis.

(b) That CCRS maintain IISS up to date as of now.

5.10.7.4 That the User Assistance and Marketing Unit concentrate on getting out the Landsat Data Users Handbook.

5.10.7.5 That a closer liaison exist between the operational units of CCRS and the organizations in industry that are active in remote sensing.

5.10.7.6 (a) That attention be directed towards the development of feasible photo interpretive techniques and products by CCRS and, by means of financial support, through outside contractors.

(b) That enhanced digital products be developed and that the on-site capabilities of doing this work be accelerated at Prince Albert.

5.10.7.7 The Working Group congratulates CCRS on the establishment of the User Assistance and Marketing Unit and recommends that the Unit maintain close liaison and contact with marketing efforts of industrial organizations active in the field of remote sensing.

APPENDIX I:

DRAFT TERMS OF REFERENCE WORKING GROUP ON DATA REPRODUCTION AND MARKETING

The Working Group on Data Reproduction and Marketing reports to the Canadian Advisory Committee on Remote Sensing (CACRS) which is responsible to the Deputy Minister, E.M.R. for advising on equipment, methods, and procedures required to carry out the National Program of Remote Sensing of Resources and the surface environment.

The terms of reference of the Working Group include:

1. To determine the path of Satellite and airborne remote sensing (ARS) data from acquisition through all processing, electronic and photographic, to determine the elements which limit the data quantity, quality and turn-around time, and to make recommendations towards improving the system.

2. To recommend a marketing scheme for satellite and ARS data, bearing in mind Treasury Board guidelines.

3. To recommend procedures for cataloging and archiving Satellite and ARS data.

4. To establish and maintain liaison with users of Satellite and ARS data.

5. To examine and make recommendations on new forms of data of potential interest to users.

The frequency of meetings is to be determined by the Working Group Chairman.

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5.11 REPORT OF THE WATER RESOURCES WORKING GROUP

5.11.1 AIRBORNE REMOTE SENSING

Flights were made in the spring of 1978 for the Gamma-ray Snow Survey Project in the Lake Superior Basin, being conducted for Inland Waters Directorate. There have been difficulties in the upgrading of quality and presentation of results and the final report should be available early in 1979.

The Atmospheric Environment Service is conducting an evaluation of X and L Band SAR for the discrimination of snow conditions and for eventual assessment of SURSAT data. Flights are being undertaken over a test area at Crystal Beach near Ottawa.

The Saskatchewan Research Council used airborne IR over potash mine areas and tailing ponds to document changes and the information is used quantitatively to analyse the inflow of ground water into several potash ponds. The University of Saskatchewan investigated the possibility of photographically detecting feedlot pollution in the Pheasant Creek area.

Infra-red scanning was used in Manitoba to study sediment plumes.

The Ontario Ministry of the Environment used infra-red scanning to study the thermal plumes from the Bruce and Pickering Nuclear Generating Plants and for the detection of groundwater discharges in the Maitland Valley area. Low level multispectral photography was used to delineate cladophora at a test site near Oshawa as a part of the Ministry's surveyance program in the Great Lakes. Monthly flights were also undertaken to study the aerial distribution and concentration of aquatic bio-mass in shallow streams.

Infra-red scanning was used in Quebec to study pollution in the Lac St. Jean area. Both thermography and aerial photography were used to track down sources of pollution and study the dynamics of the waters of the Magog and St. François Rivers by the University of Sherbrooke.

5.11.2 SPACEBORNE REMOTE SENSING

The Atmospheric Environment Service is evaluating SEASAT-A data for determination of wind and wave data, particularly over northern waters and under a variety of conditions.

The National Water Research Institute at CCIW continues its studies of the use of remote sensing for determining water quality, physical and biological aspects, of inland lakes using LANDSAT imagery and in situ measurements. Gregory Geosciences have developed a technique for mapping and monitoring Baffin Bay ice with NOAA-VHRR and LANDSAT imagery. This technique might also be applicable to large lakes.

LANDSAT imagery has been used in the Bay of Fundy area to study sediment movement. Nimbus imagery is also available in the Bay of Fundy area approximately 1/2 hour later than the LANDSAT passes. It was indicated that bottom effects can bias the interpretation; therefore the image is only useful for sediment movement if the bed of the water body cannot be visually delineated. SAR imagery from the SEASAT program will be used to delineate and classify wet lands in Saskatchewan and Manitoba and tidal zones in the Bay of Fundy and Minas Basin.

LANDSAT imagery is being used at Marmot Creek and in the Pacific northwest for studies designed to indicate the area of snow that is melting in mountainous areas.

In Saskatchewan studies are being made to test the feasibility of using infra-red to predict watershed yield and heat capacity for agricultural yield in the prairies. This work has been done with NOAA-5 digital tape and will be used to determine the applicability of GOES-2 and TIROS-N for hydrological and agricultural purposes.

Laval University continued the inventory of the characteristics of the lakes of New Quebec at the request of Quebec Hydro using LANDSAT imagery. They also continued development of a model converting radiances into reflectances to aid in the study of water quality. A study of the dynamics of transport of sediments in Rupert Bay confirmed the results obtained by circulation models.

INRS-EAU studies of the Lac St. Jean area comparing the spatial variation of suspended solids and the depths determined by secchi disc with Band 5 data from LANDSAT confirmed that large stretches of water could be studied by LANDSAT images alone. They also compared the progressive recession of the snow cover with that simu-

lated by the Cequeau Hydrologic Model using ESSA-8 images as a part of a large project for Hydro Quebec on the basins of the Great and Little Whale Rivers. A similar study is underway using LANDSAT images for the Eaton River, a tributary to the St. François.

5.11.3 TECHNICAL DEVELOPMENTS

The Atmospheric Environment Service is evaluating X and L band SAR at Crystal Beach and in the Larose Forest, near Ottawa, to discriminate snow under different land uses. AES data reception of GOES-east imagery is quasi-operational. Imagery will be supplied initially to Toronto and then to Winnipeg, Toronto and Halifax. Plans are being made to receive GOES data at Vancouver as part of the program for replacing weather ship Papa. Toronto is in the process of changing equipment for reception of TIROS-N instead of NOAA-5. Edmonton has made the change.

Gregory Geoscience Limited developed a technique for mapping and monitoring Baffin Bay ice with NOAA-VHRR and LANDSAT ISISFICHE which are projected to get ice floe size statistics. Such techniques might also be applicable to lake ice on large lakes.

Rather than a technical development a technical lack is noted by B.C. Hydro whose operational application of NOAA-VHRR imagery to obtain snow cover for operational modeling is hampered by the lack of suitable hardware for manual analysis. It was noted in discussing this point that CCRS is preparing a catalogue of available hardware.

The Saskatchewan Research Council is investigating the possibility of using mini-computers as an interface between major satellite reception agencies (such as ISIS and AES) and user agencies.

While not directly remote sensing, an automatic thermometric apparatus for removing hoarfrost is being tested in connection with a GOES platform at the foot of Mount Valin, Quebec.

5.11.4 APPLICATIONS

For the purposes of the Water Resources Working Group some uses of radar are considered to be remote sensing.

A project jointly funded by the Universities of McGill and Wisconsin has been initiated to determine the use of radar in delineating aerial extent of rainfall for use in short term precipitation forecasts and the same project is serving as ground truth for satellite experiments. It is expected that the research experiment will be transferred to the Woodbridge Research Station and tied into the GOES satellite to be used in Malton weather forecasts in the Toronto area.

The Alberta Research Council is using radar operationally to provide mean basin precipitation to the Alberta River Forecast Center. The main problem is the massive amounts of data which have to be analyzed. Currently less than 6 hours of data is analyzed daily.

It is reported that weather radar now covers the Ontario-Quebec corridor and the Edmonton-Vancouver area. However, it appears that these data, because of their abundance, are used only for subjective forecasting. During discussion of this subject it was pointed out that high intensity rainfalls can interfere with microwave (weather radar and data transmission) signals and that this might be used as a measure of precipitation intensity. It was suggested that research should be undertaken in this area.

The need for archiving and publishing of retransmitted data was raised in terms of providing standards for information. A policy is being formulated by the Atmospheric Environment Service and will be reported in future meetings of the working group. A task force of 3 were appointed to look into the question of data retransmission platforms in terms of data generation and archiving. Members come from Alberta, Quebec and AES.

The Atmospheric Environment Service has proposed supplying regular maps of snow cover using NOAA-5 and GOES data, to the St. John River Basin Flood Forecasting Center. Snowcover information will be supplied approximately once a week during spring when cloud cover permits. Both visible and IR imagery is used and the operator divides the intensities into ranges, assigning different colours to each range in order to separate snow covered terrain from snow free ground. The thermal IR imagery has proved particularly useful in this regard and imagery for the 1978 season agreed well with the snowcover maps produced by NESS. While this system is semi-automated there is still a large subjective input to the procedure and this requires considerable consultation by

the analyst with current expertise snow cover analysis by satellite.

Lake temperature determinations from NOAA-5 and TIROS-N IR data have been taken of Lake Winnipeg for the period June 1 - September 15, 1978. The maps are provided to AES central region for use in cooperative studies with provincial agencies. It is planned to provide bi-weekly maps of Great Lakes surface temperatures when TIROS-N data are received operationally. Present studies indicate that satellite retrieved temperatures are within 1.5K of ART and Buoy measurements. ART flights are still the only means of obtaining surface temperatures under persistent overcast conditions.

Gregory Geoscience reports that NORTHWATCH was discontinued in its 4th year of operation because of insufficient funding. The snowmelt forecasting model developed using data for heating/melting degree days and snow thickness in meteorological stations was found able to predict with an accuracy of plus or minus 2 days in general. A paper containing the snowmelt forecasting model and 3 years of snowline migration in the Yukon and the Northwest Territories has been accepted for publication by Polar Record. Another paper dealing with sea ice will be published by the Arctic and Alpine Research. Studies are continuing on new techniques for application of remote sensing to the study of snow and ice. Several papers on snow, river ice, sea ice and summer weather and open water have been published or are in press.

B.C. Hydro reports that snow cover data is being obtained by remote sensing methods and used as direct input to operational runoff models. Ground truth is provided by snow line elevation flights and this data together with that obtained from NOAA-VHRR imagery are being used though the operational application has been hampered by a lack of suitable hardware. Limited use is being made of data transmission by satellite with 3 DCP's in operation in B.C. measuring streamflow. An additional DCP was added in the Bridge River Drainage area this year to measure glacier runoff as well as air temperature and a precipitation sensor will be added next year. Another DCP transmitting precipitation, temperature, snow pack water equivalents and groundwater levels is in operation in the Okanagan Drainage.

Saskatchewan Department of Agriculture is actively pushing for a Remote Sensing Center in Saskatchewan. Included would be a black box reception of either GOES or TIROS-N for real time operations.

In Quebec there are 35 DCP's for hydrometric and meteorological data collection. It is anticipated that this will increase to 75 in 1979 and to 135 in 1982. The Quebec Meteorological Service further reports on the instrumentation that will be hooked into DCP's. Two gamma-ray automatic snow measuring devices will be operating from Duchesnay; Alcan will utilize 11 GOES platforms for water levels in rivers and reservoirs and proposes to place about 20 supplementary platforms in the same basin to obtain data on temperature and precipitation in real time; Ministry of Lands and Forests tested three meteorological stations measuring temperature, humidity, precipitation and wind.

5.11.5 BENEFIT ANALYSIS

Snow cover mapping by satellite in the St. John River Basin started as a WMO project and its continuation on a regular basis with a large input by government organizations indicates that even in these times of austerity there must be a valuable benefit.

While no figures have been presented, it is obvious from the rapid increase in use of DCP's in Quebec and elsewhere that they are considered to provide a cost benefit.

B.C. Hydro estimates the annual value of runoff forecasts for its present system at about 5 million dollars (at 7 mills per kWh). For drainages with mainly snowmelt runoff current forecasting methods will increase usable water supply by 2% and in basins of mainly rain runoff by 5%. The value of short term runoff forecasts is estimated to be twice that of seasonal runoff forecasts. This is considering the value of water for hydroelectric generation only and other benefits such as flood control, irrigation, etc. are not included. It is difficult to determine the extent to which remote sensing might improve efficient water management; an improvement of only 1% would result in an annual benefit of $50,000.

5.11.6 USER LIAISON

One meeting a year of the Water Resources Working Group is devoted largely to user liaison in that it is an open meeting at which there is exchange of information between members of the working

group and anyone within reach of the meeting who wishes to come. The 1978 liaison meeting was held in Edmonton at the Alberta Remote Sensing Center.

As various public and private agencies expand their use of DCP's there will be an ever increasing need for some standardization so that the data can be exchanged and also published in suitable format. The Quebec meeting at the Choiniere Dam, near Granby, September 8, 1978, emphasized the necessity of liaison with the users in this area. A task force set up by the Water Resources Working Group may be the start in a continuing dialogue with the users of DCP's.

5.11.7 TRAINING

The University of Laval is engaged in a CIDA project of transfer of technology in collaboration with the remote sensing center of Ouagadougou, Haute-Volta. This is to determine what parameters can be obtained by remote sensing with relation to space and time variations of groundwater. The project also is to train African participants to use these techniques themselves.

5.11.8 CONCLUSION AND FORECAST

Visual analysis continues to be the most widely used method of interpretation in the water resources field and consequently there is a continuing need for the best possible imagery (and for more cloud free days).

Remote sensing and the use of satellites are providing water resources information mostly in the field of snow cover and to provide real time data through the use of DCP's to relay hydrometeorological and other data from areas of difficult access. The use of remote sensing and water quality and pollution studies in monitoring is increasing and in some areas is used operationally.

The working group emphasized that while the assistance to users provided by CCRS and Provincial Remote Sensing Centers is of great value there is still a pressing need for more regional centers which users can reach quickly and cheaply. Users feel that there is more to be gained by frequent short visits than by infrequent though longer visits to far away centers. It is a question of finances in that most users cannot afford to buy the more sophisticated instruments needed at times even for visual analysis nor can they afford the cost of frequent long trips to go to the instruments.

The use of remote sensing in the water resources field is healthy and growing slowly even under present financial constraints and it will continue this way until the purse strings are loosened and more finances are available for transferring technology to the user.

5.11.9 RECOMMENDATIONS

The Water Resources Working Group recommends that:

(i) CCRS cooperate with user agencies in ensuring compatible high standards for DCP hardware, related sensors and data retrieval, archiving and publication.

The use of DCP's is expanding rapidly in numbers of platforms, in variety of parameters sensed and in variety of users. Standards are required to ensure the provision of good quality data in suitable format to meet the needs of the increasing variety of users. Due to this variety there is no logical lead agency; therefore efforts should be made to encourage a cooperative approach. The Water Resources Working Group has set up a small task force to look into the problem and suggest actions. The Quebec Meteorological Service organized a meeting of 35 agencies to look into the use of DCP's. Various government organizations are looking into the problem for their own requirements and the question of the need for national working groups, as there are in the U.S., has been raised.

(ii) CCRS maintain and expand when possible its support to the user, particularly in the following areas:
- Continued improvement of all types of images, including hard copy from digital density slicing equipment.
- Development of photointerpretive instruments to aid in fast and objective analysis of imagery.
- Continued support for aerial hydrography.
- Encouragement, including funding, for the development of Regional Remote Sensing Centers and the use of these to transfer technology to the users by way of demonstration projects.
- Determination of snow water equivalent.

5.11.10 APPENDICES

5.11.10.1 APPENDIX 1 - CURRENT BIBLIOGRAPHY

The following are items submitted by working group members in their reports and do not constitute a complete bibliography for the current year.

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5.11.10.2 APPENDIX 2 - LIST OF GROUP MEMBERS

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6.0 1978 PROGRESS REPORT ON THE ESTABLISHMENT OF AN INTERPROVINCIAL/TERRITORIAL ADVISORY SUB-COMMITTEE TO CACRS (IPTASC)

At the CACRS meeting for 1977, Dr. L. Morley, Director-General of CCRS, invited Victor Zsilinszky, the Ontario representative, to organize the representatives from all provinces and territories into an advisory sub-committee to CACRS.

An exchange of views by correspondence was conducted among the members throughout the year on the organization of the sub-committee and also on the subjects of the increase in the price of CCT's and the CCRS software distribution policy. On both these issues, Victor Zsilinszky fulfilled the function of acting Chairman by consolidating the comments of members and submitting them to CCRS.

A meeting of those representatives who were able to attend the Fifth Canadian Symposium was organized by Ms. Mary Redmond in Victoria; unfortunately, very few could be present. On December 14 and 15, 1978, the members gathered for a planning meeting at the OCRS in Toronto. At this point, membership had been finalized at 11, including a representative from the Northwest Territories. The following were adopted as the terms of reference of IPTASC:

INTERPROVINCIAL/TERRITORIAL ADVISORY SUB-COMMITTEE TO CACRS

TERMS OF REFERENCE

This is a body of representatives appointed by CACRS on the recommendation of the respective provinces and territories.

Objectives

1. To ensure that remote sensing technology, data resources and developments in methodologies of application, are made available to resource managers and scientific investigators in all Provinces and Territories of Canada.

2. To ensure that the needs of regional users of remote sensing are reflected in the national program.

Functions

1. To facilitate an exchange of information originating in international, federal and provincial/territorial remote sensing programs, among the provincial/territorial remote sensing representatives.

2. To facilitate the mutual assistance of provinces and territories regarding the technical and organizational problems of their respective remote sensing programs.

3. To encourage the efficient co-operation between federal and provincial/territorial efforts to better serve regional remote sensing practitioners and potential users.

4. To facilitate the process of providing the federal remote sensing program with information as to use made regionally of remote sensing resources and the benefit derived from such use.

5. To make recommendations regarding proposals for current and future changes in or additions to the federal remote sensing program.

6. To prepare and present a report, that includes recommendations, to each CACRS meeting without prejudice to each provincial or territorial report to CACRS.

7. To review the above Terms of Reference annually.

It was voted that Victor Zsilinszky continue to act as chairman until IPTASC could meet again just before the CACRS meeting, at which time the first chairman of IPTASC would be elected for a two-year term. It was decided that a vice-chairman would also be elected, who would become chairman automatically at the end of the two years. If the present representative finds it desirable, a second representative is to be chosen to act as alternate. In addition, the membership found it preferable for each representative to nominate an official observer to accompany him to the annual CACRS meeting.

The conclusion of the meeting was that IPTASC would come into official existence in April, 1979.

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6.1 REPORT OF THE ALBERTA REPRESENTATIVE

6.1.1 Airborne Remote Sensing

In 1978, ten requests for airborne remote sensing flights in Alberta were submitted to Airborne Operations, Canada Centre for Remote Sensing. Ten flights of 2,066 nautical miles were completed.

The 1978 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 has proven advantageous to all agencies concerned.

6.1.2 Spaceborne Remote Sensing

During 1978 extensive use was made of the Alberta Remote Sensing Center's Landsat facilities which provides for mail, telephone and in-person assistance in viewing, selecting and ordering of imagery. Canadian scenes from each satellite were viewed and selected from Integrated Satellite Information Services (ISIS) ISISFICHE that the Center receives daily. Selection of Landsat scenes was also made from the Center's terminal and dedicated line to the Canada Centre for Remote Sensing's (CCRS) Remote Sensing On-Line Retrieval System (RESORS). An Alberta Landsat Prime Scene listing and Alberta Landsat Index Map was distributed throughout the province to assist requestors. There has been a large increase in the use of Landsat imagery in 70mm, four waveband, transparency strips. This type of imagery is used routinely in the Center's multispectral viewer for analysis and production of hard copy imagery.

The Center's Landsat Imagery Library of black and white and color scenes of Alberta was enlarged to provide a more complete service to users. Transparencies continue to be phased in as they provide a more interpretive product.

At the paid request of the Alberta Remote Sensing Center, the National Air Photo Library constructed, and is offering for sale, a Landsat Color Mosaic of Alberta.

The number of out-of-Alberta requestors for Landsat and other data from the Center continued to increase in number.

6.1.3 Alberta Remote Sensing Center

The Alberta Remote Sensing Center, Alberta Environment, 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. Its facilities are available free of charge to Albertans.

6.1.4 Training

The Alberta Remote Sensing Center in cooperation with the Faculty of Extension, University of Alberta, conducted the Seventh 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.

Two thermography workshops, sponsored by the Alberta Remote Sensing Center and conducted by CCRS, were held in Edmonton for participants from throughout the province.

The Alberta Center hosted two CACRS Working Group Meetings - Data Handling and Satellite Technology and Water Resources. The latter meeting was coincident with a city flood. Which may have been carrying western hospitality a bit far.

6.1.5 Special Projects

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

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

6.1.6 Conclusions

Remote Sensing is alive and well in Sunny Alberta.

6.1.7 Appendix I

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6.2 REPORT OF THE BRITISH COLUMBIA REPRESENTATIVE

6.2.1 Airborne Remote Sensing

Very few airborne projects were requested from CCRS in British Columbia in 1978, but several projects involving colour infra-red and thermal imagery, which are considered as operational now, were flown by other agencies. The weather was such that the provincial air photo section had average success flying conventional B&W air photos with lenses varying from 85 mm to 610 mm focal length.

6.2.2 Spaceborne Remote Sensing

There has been an increase in the number of enquiries about satellite imagery this year which may in part be due to the fact that provincial representatives have advertised in the CCRS brochure and Newsletter. Some ISIS-Fiche is now available for view in my office.

6.2.3 Technical Developments

MDA in Vancouver have continued to develop their hard and software. The BC Ministry of Forests in combination with the federal Forest Management Institute are working on a system to update forest inventory maps using Landsat imagery in digital form.

6.2.4 User Liaison

User Liaison remains minimal pending the report of the provincial Task Force on Remote Sensing within government which is due soon.

6.2.5 Training

The University of BC has developed an Interdisciplinary Programme in Remote Sensing which is attracting both post and under-graduate students to its courses. The course 'Remote Sensing for Resource Managers' is timed so that it is possible to commute from Victoria to take the course. An evening course which is an introduction to remote sensing is also being offered in Victoria.

6.2.6 Conclusion and Forecast

There has been more activity within this province regarding remote sensing during 1978 but it is still piecemeal. There is no remote sensing society because that gap is filled by the active Puget Sound Chapter of the American Society of Photogrammetry which also covers Washington State.

In spite of a national air strike the Fifth Canadian Remote Sensing Symposium was successfully held in Victoria last August.

There is still a very definite need for a full time remote sensing co-ordinator and centre in B.C.

6.2.7

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6.3 REPORT OF THE MANITOBA REMOTE SENSING CENTRE

6.3.1 AIRBORNE REMOTE SENSING

During 1978 there were three requests submitted through the Manitoba Remote Sensing Centre for airborne remote sensing projects. The total nautical line miles was 57. Success was realized on two projects with a final total of 34 nautical line miles. One project was cancelled due to the time-bounded nature of the image requirements.

The two projects completed are as follows:

1. To determine the usefulness of small-scale multispectral imagery for land use planning of the city of Winnipeg.

2. To investigate the use of multispectral imagery for the detection of radiation damage in the experimental area at Lac Du Bonnet. This was the fifth year for this study.

The Centre's 70 mm camera system was used throughout the year to acquire 4,070 line miles of aerial photography. The main users were municipal planners, surveyors for identifying field control stations, foresters for mapping burn and cut-over areas, land inspectors for assessment work and geologists for sand and gravel mapping.

Responsibility for the Provincial Air Photo Library has been combined with the Remote Sensing Centre. We are presently working on an update program to acquire complete information on all aerial photography coverage for the entire province. The present information coverage ranges from 1923 to 1978. The system under development will have microfilm records of the flight indices, cassettes containing 16 mm records of each photographic image and a computer program to assist in searching available coverage for specific geographic areas.

6.3.2 SPACEBORNE REMOTE SENSING

The Centre continued to provide a service on LANDSAT coverage through a subscription to Isisfiche and a terminal for access to the CCRS's RESORS information source. We also provided an ordering service for anyone wishing to purchase imagery or tapes. There was a slight increase in the number of people using this facility over 1977.

Manitoba now has a colour LANDSAT mosaic of the Province. The construction work was done by the National Air Photo Library on a request by the Manitoba Remote Sensing Centre.

6.3.3 TECHNICAL DEVELOPMENTS AND NEW EQUIPMENT

This year the Manitoba Centre acquired a "Silent 700" portable terminal for accessing directly to the RESORS computer at CCRS. Since installation of this terminal, there has been a 150% increase in the Technical Information Service offered by the Centre.

In order to increase the usefulness of our density slicer, a Vivatar 50 mm macro-lens was purchased. It is presently in use after considerable difficulty clearing customs.

6.3.4 USER LIAISON

The Manitoba Remote Sensing Centre continued to maintain its existing interpretation equipment and provide information services to anyone wishing to avail themselves of the facilities. There is no charge for the use of the equipment or services with the exception of the 70 mm camera system. This system is operated as a service to other government departments on a cost-recovery basis.

There was a small increase in the number of people using the services of the Centre in 1978, with the total being close to 1,300. Requests ranged from aerial photography coverage information to project assistance. During the year, the staff of the Centre co-authored three articles on remote sensing with users wishing assistance.

6.3.5 TRAINING

During the year, assistance was given and instructors provided for courses and seminars at the University of Winnipeg and the University of Manitoba. On a continuing basis, instruction is provided and short courses are given to interested groups at the Centre. With the facilities available, we like to limit the group size to fifteen people. This limitation has the advantage of being able to give closer attention to each person taking a course.

Staff at the Centre provided supervision to four Honours students from the University of Winnipeg who were doing their theses on various aspects of remote sensing.

6.3.6 CONCLUSION AND FORECAST

There is a continuing interest in remote sensing as evidenced in the slight increase in use of facilities the Manitoba Remote Sensing Centre has to offer. Through more activity and development of operational techniques on a regional basis, much greater use can be made of remote sensing.

6.4 REPORT OF THE NEW BRUNSWICK PROVINCIAL REPRESENTATIVE

6.4.1 Airborne Remote Sensing

Imagery was provided by the CCRS airborne unit for two requests from the N. B. Department of Agriculture in their continuing study of the potato industry. Both flights were successful, with the interpretation and analysis of the results being done at the present time.

6.4.2 Spaceborne Remote Sensing

The N. B. Department of Environment is continuing work on a flood plain mapping project and is attempting to develop techniques to use satellite imagery. To date there have been difficulties with the problem of geographic corrections in matching the imagery to existing maps.

The snow cover mapping project for spring run off and flood forecasting is operational through co-operation with NESS. During the 1979 season the project will be done in parallel with the A.E.S. digital system in an attempt to get the results on a more real time basis.

6.4.4 Applications

The interpretation of conventional aerial photos and preparation of forest type maps at a scale of 1:20 000 have been completed for the whole province. The joint federal-provincial project to provide ortho-photo map coverage at a scale of 1:10 000 is progressing; maps covering most of the settled area in the south and east of the province have been completed.

Work is continuing on refinements of the two projects of snow cover mapping for run off and flood forecasting, and the assessment of the potato industry.

6.4.6 User Liaison

There has been a continuing interest in LANDSAT imagery and its uses; several inquiries for information have been processed during the year.

6.5 REPORT OF THE PROVINCE OF NEWFOUNDLAND AND LABRADOR, 1978

6.5.1 Airborne Remote Sensing

During 1978 the Department of Forestry and Agriculture, Lands Branch, flew 7272 line miles of colour photographs at 1:12,500 and 2000 line miles of colour infrared at 1:40,000. Detailed indexes are available, if required, at the Map Library, Howley Building, Higgins Line, St. John's.

The Centre for Cold Ocean Resources Engineering (C-CORE) carried on its active program of using airborne platforms for testing sensors. The work is presently centered on determining the parameters for flight testing their GSSI Impulse Radar.

6.5.2 Spaceborne Remote Sensing

Newfoundland Ocean Research and Development Corporation (NORDCO) continues to operate the Shoe Cove Satellite Receiving Station. LANDSAT and NOAA images were collected on an operational basis during 1978. SEASAT I data was collected at the station during the lifetime of the satellite and data playback and re-recording using various systems is being carried out on a routine basis.

C-CORE completed its Satellite Ocean Related Imagery Applications Program in October 1978. The program dealt with potential usage of the Shoe Cove imagery for sea surface temperature, sea ice distribution and iceberg/ocean vessel detection applications.

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

6.5.3 Technical Developments

The Department of Forestry and Agriculture photographic facility is operational and providing black and white and colour photographic service for all photos in their files as well as aiding the local community in processing film that cannot be processed elsewhere in the Province. Prices are comparable to the National Air Photo Library.

C-CORE is continuing to develop its impulse radar for airborne use for the measurement of sea ice properties.

NORDCO has developed a commercial weather prediction system for commercial use that utilizes AES satellite data.

REMOTEC Applications Inc. has been involved in establishing a site location with the potential for making infrared transmission measurements over an ocean path. The first stage is complete and potential sites have been chosen.

6.5.4 Application and Benefit Analysis

A brief summary of 1978 projects carried out by various groups follows:

6.5.4.1 Newfoundland Forest Research Centre

This agency has been making use of the high level colour and colour infrared photographs obtained by CCRS in 1972 and 1973. They have been used to delineate the major peatland regions of Newfoundland. Where further subdivision was necessary, 1:12,500 colour and 1:50,000 black and white photos have been used.

The 1:12,500 colour photos were used to estimate the degree of budworm infestation at Lake Bond in Central Newfoundland, as well as other areas.

Existing 1:50,000 black and white and 1:12,500 colour photos were used to interpret biophysical units at the land type level for Unit 14.

6.5.4.2 Wildlife Division, Department of Tourism

Routine use of aerial photographs for vegetation and habitat typing and for selecting various sample plots is made. A project to use LANDSAT images for snow accumulation/melt studies in important

caribou winter ranges was not successful due to the scarcity of suitable images during the critical spring and fall months.

6.5.4.3 Department of Mines and Energy

Limited use has been made of LANDSAT imagery to delineate structural lineaments in bedrock mapping programs and for cursory examination of glacial flow features on a regional scale.

Extensive use of air photos (1:15,840 to 1:140,000) has been made in connection with all department mapping programs in either black and white, colour, or colour-infrared formats depending upon availability.

In the future, surficial and glacial mapping programs may make more extensive use of LANDSAT imagery and as well, the Inventory of Aggregate Resources program is assessing the use of LANDSAT to monitor this development of pits and quarries throughout the Province.

6.5.4.4 Memorial University

6.5.4.4.1 Faculty of Engineering and Applied Science

Further work has been carried out on the "Water Fowl Census Program". The computer techniques are being refined and test counting has been carried out.

6.5.4.4.2 Geography Department

Research is being carried out concerning the co-relations between sensed phenomena and the fisheries, ie. co-relations between fog and the fishery, ice and the fishery, and sediment types and the fishery. Interest in co-relating plankton density and distribution with spatial realities but research is hindered by lack of empirical and theoretical "control" situations needed for quantitative analysis.

6.5.4.5 REMOTEC Applications Inc.

Work being carried out to determine radar backscatter of mixed crops in a test area in Southwestern Ontario.

LANDSAT imagery being used in site evaluation studies for over ocean infrared transmission paths.

Use of NOAA IR band for sea surface temperature mapping limited because of lack of historical data on CCT.

Use of GEOS-3 radar altimeter data for prediction of extreme weather events has been successfully carried out.

6.5.5 Training

The regular remote sensing course is being offered by the Engineering Department of Memorial University.

6.5.6 Conclusions and Forecasts

The remote sensing activity in Newfoundland and Labrador is continuing to increase. This increase is mainly due to the offshore exploration programs now commencing. Thus, increasing importance will place demands on the Shoe Cove Satellite Receiving Station. The data requirements from this station will increase,and as new satellites are launched, this data must be available for utilization in ocean monitoring systems. Consideration must be given for the development of data products and receipt of data from follow-on satellites for GEOS-3 and SEASAT. Because of the marine environment, microwave sensors must be given the first consideration for further installation at Shoe Cove.

6.5.7 Recommendations

The following recommendations are submitted to CACRS from the Province of Newfoundland and Labrador:

1) Historical NOAA CCT's of the Arctic were requested by REMOTEC to carry out a study for a major company. The tapes were not available as they had been recorded at Prince Albert and were erased after two weeks storage. Presently Shoe Cove archives these tapes but there are rumours that this practice may be discontinued. It is recommended that:

a) This practice continue at Shoe Cove

b) This practice is instituted at Prince Albert.

Valuable historical data is presently being lost and is not recoverable. More will be lost if this practise of not archiving CCT's is continued.

2) Imagery from the Shoe Cove Station is processed to reflect the requirements of imaging the sea ice and ocean. As Prince Albert also records sea ice in the Arctic areas and as historical sea ice data is archived, efforts should be taken to ensure that when imagery of this type is requested, special processing should be carried out to insure ice detailed in the imagery. This special processing should not increase the cost as it only requires the processors to pay attention to their task. A user should be able to request this special processing on his request form. This recommendation is based on inconsistent imagery received from Prince Albert for areas offshore Labrador and the ice cover on Lake Melville.

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6.6 REPORT OF THE NOVA SCOTIA COMMITTEE ON REMOTE SENSING

6.6.1 General Activities

Remote sensing activity has shown a marked increase over last year. The Sursat Project provided the means for a number of investigators to participate in meaningful experiments. The development and equipping of the Remote Sensing training program at the Nova Scotia Land Survey Institute has made much more sophisticated equipment available to users. The establishment of a Remote Sensing Center has provided a greatly increased flow of information and technical assistance to individuals, industry and government departments.

6.6.2 Sursat Project

The projected benefits from this project have not been realized. This has been mainly due to technical problems or equipment failure. Some imagery was obtained; however, the quality for the most part was not sufficient to meet experiment objectives. It is sincerely hoped that top quality data can be obtained in future to supplement the heavy investment of time, materials and money by local investigators.

6.6.3 Nova Scotia Remote Sensing Center

Funding was received under a Canada Works grant to operate a Remote Sensing Center for a twelve month period ending in late September 1979. A staff of ten provides information and technical services to individual users, a large number of government departments and agencies as well as to private industry. The laboratory facilities and specialized remote sensing equipment at the Nova Scotia Land Survey Institute are readily available on a part time basis as both operations are located in the same building. Other sources of funding to carry on the work of the Center are being actively investigated.

6.6.4 Airborne Remote Sensing

Other than airborne imagery obtained for the Sursat experiments only one experimental project was reported using CCRS aircraft. This imagery was obtained by the Department of Lands and Forests to investigate various sensor, film, filter combinations in evaluating forest damage/disaster monitoring techniques. Some operational heat loss flights were flown for DND.

The loss of the traditional CCRS airborne program could not have happened at a worse time for the development of remote sensing in Nova Scotia. The effectiveness of the Nova Scotia Remote Sensing Center has been greatly reduced. A large number of projects which would have been flown under the previous policy cannot now be attempted. A flexible policy which recognizes regional differences in the level of remote sensing development would be more equable.

A number of projects using small format cameras in light aircraft were flown by the Nova Scotia Remote Sensing Center.

Operational flights using conventional film were flown for a number of provincial government departments as part of their regular programs.

6.6.5 Spaceborne Remote Sensing

The failure of the Seasat satellite was a major disappointment to the remote sensing community in Nova Scotia. Only a limited part of the province was covered. This was in the Halifax area; however, the image has not yet been released.

Landsat imagery is being used by a number of agencies using both CCT's on CCRS equipment and photographic interpretation on in-house or NSLSI equipment. Progress on suspended sediment studies has been realized by the Bedford Institute of Oceanography. The Department of Lands and Forests in conjunction with Nova Scotia Forest Industries Limited are using digital analysis to update forest cutovers and road construction as well as various experimental applications of forest parameter measurement. The federal Department of Fisheries and Environment (Lands Directorate) is involved in the digital analysis of the Nova Scotia coastal zone. Another project deals with the visual interpretation of Landsat images for the spatial distribution of ice in the Bay of Fundy.

6.6.6 Training

The remote sensing training program at the Nova Scotia Land Survey Institute will graduate its first class in May 1979. Job prospects are excellent and all students should have employment by graduation. It is expected that they will have a very positive impact on remote sensing activity in the

Maritimes as well as nationally.

The NSRS Center is offering a one evening a week course in photo interpretation and remote sensing for agricultural and forestry applications. A class of 28 has registered for this ten week program. Several one and two day workshops are planned for late spring.

6.6.7 Conclusion and Forecast

The decision to hold the 6th Canadian Symposium on Remote Sensing in Nova Scotia in 1980 will spark renewed enthusiasm in the local remote sensing community. The activities of the NSRS Center will increase the use of remotely sensed data by government and industry. The acquisition of a digital image analysis system by NSLSI should increase the use of Landsat data. The future development of SAR imagery on a regular basis is vital to the effective monitoring of the 200 mile fishing zone. The deployment of higher resolution sensors is important to the future development of satellite remote sensing in Nova Scotia.

6.6.8 Recommendations

(1) As pleased as the members of this Committee are with the large variety of remote sensing products developed and provided by CCRS, our experience in requesting and purchasing the basic airborne and satellite products is that much greater emphasis needs to be given to their quality and consistency.

(2) As airborne flights for operational remote sensing are no longer available from CCRS and as the cost of remote sensing flights in Nova Scotia will increase with respect to transit charges for commercial aircraft, it is recommended that CCRS work actively to ensure that the total cost of airborne image acquisition be equal in all regions of Canada.

(3) As Landsat D and other higher resolution satellites are vital to the meaningful interpretation of the more complex Maritime scene, it is recommended that the priority for Landsat D and SPOT image acquisitions be given to the Atlantic region in particular and eastern Canada in general.

6.6.9 List of Members

Mr. Tom Alföldi
Canada Centre for Remote Sensing

Mr. Ed MacAulay
NS Dept. of Lands & Forests

Mr. George Dargie
Dept. of Regional Economic Expansion

Mr. Ken Webb
Soil Survey Institute

Mr. David Coleman
Atlantic Air Survey Ltd.

Mr. Graham Doyle
Canadian British Consultants

Mr. Dave Smith
Inland Waters Directorate

Mr. Duncan Keppie
NS Dept. of Mines

Dr. Desmond Lord
Environmental Protection Service

Ms. Julia Davidson
Community Planning Division
NS Dept. of Municipal Affairs

Ms. Nancy A. Prout
Lands Directorate

Dr. Carl Amos
Bedford Institute of Oceanography

Mr. John F. Wightman (Chairman)
Nova Scotia Land Survey Institute

Professor R.H. MacNeill
Department of Geology
Acadia University

Mr. Neale Lefler
Maritime Resource Management Service

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: 21
No. of replies: 14
Government: 3 of 5
Universities: 4 of 6
Industry: 7 of 10

6.7.1 Airborne Remote Sensing

Dr. P. Howarth of the Department of Geography, McMaster University, reports the acquisition of hand-held 35 mm aerial photography and the use of panchromatic, colour and colour infrared aerial photography, in combination with satellite imagery, by graduate students in the preparation of their theses. A very limited amount of thermal data was also used.

Dr. J. Vlcek of the Faculty of Forestry and Landscape Architecture, University of Toronto, reports the use of approximately 500 black and white photographs, colour and colour infrared coverage, and thermal and radar data, in the teaching of image interpretation.

Dr. R. Protz of the Department of Land Resource Science, University of Guelph, employed black and white photographs in conducting research in the James Bay Lowlands, and used 150 thermal images in research on soil temperature measurement. He reports that research is being done on the use of SLAR for soil and crop cover identification.

Dr. A.B. Kesik of the Faculty of Environmental Studies, University of Waterloo, reports that the Department used 1,500 black and white photographs for undergraduate instruction and some colour coverage. Approximately 600 70 mm colour infrared photographs were used in research. A small amount of thermal and radar imagery was also used in teaching.

The Ministry of Transportation and Communications reports the use of black and white, colour and colour infrared aerial coverage in the planning, design, construction and maintenance phases of its programs.

The Great Lakes Surveys Unit of the Ministry of the Environment reports obtaining aerial photogrpahic coverage of test sites along the Lake Ontario shoreline for the mapping of Cladophora and the monitoring of changes in shoreline features, particularly landfill sites along the Metro Toronto waterfront. In addition, airborne thermal coverage was obtained for the mapping of thermal plumes from two nuclear generating stations.

The Ontario Centre for Remote Sensing used federal aerial photographic coverage of a 150,000 km^2 area of Northern Ontario, in its major surficial geology and wetlands mapping project. Approximately 170 flying hours of multi-camera airborne sensing was conducted by the OCRS remote sensing airborne program in 1978. Two Sursat SAR missions were flown for OCRS research projects, and 12 thermography flights were flown for the Centre's applications projects, for the most part by Intera.

Airphoto Analysis Associates used 4,700 black and white Forest Resources Inventory aerial photographs and 250 black and white photos of various scales, in conducting resource and biophysical inventories, and an additional 300 photos in conducting a biophysical inventory for a national park.

Acres Consulting Services used standard aerial photography in several projects related to the mapping of vegetation associations, and a further 700 photos in geological investigations and other phases of geotechnical design work.

Barringer Research reports the use of aerial photography to assist in flight path orientation and photo-mosaicing for an airborne survey project.

Beak Consultants report the use of approximately 300 black and white aerial photographs in the planning of field trips, to select sampling sites, to identify aquatic weed beds and to measure approximate distances between objects along a river bank.

Gartner Lee Associates employed approximately 5,000 aerial photographs in engineering terrain evaluation, hydrogeological projects, land use planning studies, route evaluations, aggregate studies and environmental investigations.

Philip A. Lapp Ltd. reports the use of colour aerial photographs for ground truth reference in a thermographic study of building heat loss. This coverage was obtained by CCRS, as was the thermographic coverage of the project site of 5 line-miles over Charlottetown, P.E.I.

6.7.2 Spaceborne Remote Sensing

In McMaster University three Master's theses and one doctoral thesis, which entailed the visual and digital analysis of Landsat, were completed. In additon, four theses are being prepared at the present time which employ Landsat data.

The University of Toronto employed Landsat in the teaching of image interpretation.

The University of Guelph used a small number of Landsat frames of various parts of the world for teaching purposes, and also employed Landsat in research on the James Bay Lowlands.

The University of Waterloo reports that a collection of about 300 Landsat images has been employed in the teaching of visual image interpretation. Approximately 100 band 4 and 6 images were interpreted for surface cover characteristics in support of atmospheric modelling.

The Great Lakes Surveys Unit of the Ministry of the Environment employed NOAA weather satellite imagery to support findings of a study of ice cover.

The Ontario Centre for Remote Sensing employed over 500 Landsat images in its major surficial geology and wetlands mapping program in Northern Ontario, and used a further 60 Landsat computer-compatible tapes. The Centre employs GOES weather satellite data, received twice daily, for the planning of airborne missions.

Airphoto Analysis Associates report having used several Landsat images for the macro-scale component of a planning study, and for display and presentation purposes.

Acres Consulting Services made limited use of Landsat for a project to study the agricultural land use and soils of a site in Iran.

Barringer Research employed Landsat as an aid to photo interpretation for mineral and hydrocarbon exploration.

6.7.3 Technical Developments

The Great Lakes Surveys Unit of the Ministry of the Environment reports involvement in the development of data analysis techniques for the areal delineation of Cladophora biomass in the nearshore zone of the Great Lakes. Development is currently underway of computer algorithms for the extraction from thermal linescanning data of the dimensional characteristics of surface water thermal plumes.

The Ontario Centre for Remote Sensing has expanded its digital analysis capability in 1978, and has implemented computerized aerial photographic camera operation for the control of four cameras and possibly in the future for the operation of other sensors as well.

Barringer Research reports the continuation of development of the COTRAN electromagnetic remote sensing system for mineral exploration.

Philip A. Lapp Ltd. reports a development in the technique for acquiring thermographic coverage for building heat loss. A portion of a dry roof is sprayed before the acquisition of imagery, so that the correct adjustment in brightness/temperature for wet and dry surfaces can be obtained, a figure required for subsequent analysis of the thermographs.

Moniteq Ltd. was involved in the development of a number of instruments for the remote sensing of air quality including an SO_2 sensor based on correlation spectroscopy, and performed a detailed lens study for CCRS for a scanning array sensor. Regarding developments in analysis techniques, Moniteq developed a data analysis methodology for the determination of mass flux of sulphur dioxide and the estimation of downwind ground deposition of this substance. Moniteq was also involved in quantitative optical remote sensing of water quality and applied a methane infrared detection system for leak detection.

6.7.4 Applications and Benefits

At McMaster University graduate students completed theses reporting the application of remotely-sensed data to the following investigations:

- ecological land classification of an area southeast of Lesser Slave Lake by means of aerial photographs, digital and visual interpretation of Landsat and supporting field study;
- land use classification in Venezuela, by means of Landsat imagery and tapes, high-altitude and multispectral photography, an existing land use map, and field familiarization;
- application of Landsat and GOES imagery analyzed visually, to hydrologic models of regional watersheds, using a study site in Venezuela.

A doctoral thesis was also prepared on the use of Landsat imagery for the prediction of the movement of drifting open pack ice and

for the determination of wind fields and ice parameters.

Other graduate theses are in preparation reporting various studies of the physical environment, using primarily Landsat data.

The University of Toronto assessed remotely-sensed data as a valuable tool in terrain, vegetation and environmental studies.

Research was conducted on the application of thermography to soil temperature measurements and SLAR imagery to soil and crop cover identification at the University of Guelph. Dr. Protz comments that without remote sensing imagery (both spaceborne and airborne), he could not have planned his research on the James Bay Lowlands.

At the University of Waterloo research was conducted on the application of Landsat and thermography as support for air quality modelling.

The Ministry of Transportation and Communications reports that aerial photography has been established as beneficial to its programs, and that the applicability of other forms of imagery has yet to be determined.

The Great Lakes Surveys Unit of the Ministry of the Environment was engaged in the mapping of discharge plumes from the Bruce and Pickering generating stations, by means of airborne thermography, and in the mapping of Cladophora in a Lake Ontario test site near Oshawa. Cost savings were realized over conventional in situ field studies.

The Ontario Centre for Remote Sensing had a program of 22 research projects and 47 applications projects in 1978. Some highlights are as follows:

- continuation of the surficial geology and wetlands mapping of Northern Ontario; completion of 12 surficial geology map sheets covering 150,000 km_2
- continuation of work on the digital analysis of Landsat for forest cover mapping
- continuation of the forest regeneration success survey program using both airborne sensing and Landsat
- project to calculate the area of productive forest land in Ontario
- continuation of research on the application of airborne thermography to the monitoring of building heat loss
- two habitat classification projects
- continuation of work on the establishment of a technique for forest fuel mapping from Landsat
- research on the use of impulse radar for permafrost measurement
- a SURSAT-SAR project on coniferous regeneration success
- a SURSAT-SAR project on the determination of structural geology
- investigation of frost pockets in cutover areas by airborne thermography
- completion of the data analysis and compilation procedures for the aerial forest sampling methodology
- location of springs on aerial thermography.

Airphoto Analysis Associates reports that aerial photography is used to co-ordinate the efforts and capabilities of a multidisciplinary staff.

Acres Consulting Services mapped vegetation along hydro rights-of-way, prepared for geological investigations and conducted phases of design work, using standard aerial photography. Landsat was applied to the overall review of agriculture and soils in a study area in Iran.

Barringer Research used aerial photography for flight-line orientation and for mosaicing, in connection with airborne surveys conducted in the southwest United States. Barringer reports the particular importance of non-imaging remote sensing, such as the electromagnetic determination of sand and gravel locations and aerogeochemical prospecting.

Gartner Lee Associates reports that aerial photographic interpretation is essential to carrying out its commitments.

Philip A. Lapp Ltd. conducted a project to study improvements to the detection of heat loss from flat roofs partially covered with water, through airborne thermography,

using test sites in Charlottetown, P.E.I. The study yielded positive results as to the inherent thermal signature of roof types and the misleading effects of moisture on thermographic coverage.

Moniteq Ltd. is interested in the use of thermography for the detection of thermal pollution and heat loss and are working toward developing these applications further.

6.7.5 Training

At McMaster University, the Department of Geography gives two undergraduate remote sensing courses, with the emphasis on laboratory practice with image interpretation (with a total of 138 students in 1978) and a graduate course on aerial survey. In addition, Dr. P. Howarth, as Chairman of the Geography Working Group, helped to organize a one-day workshop on "Remote Sensing of the Southwestern Ontario Landscape". Dr. Howarth also took part in a two-week workshop on Remote Sensing for National and Regional Planning held in Ibadan, Nigeria.

The University of Toronto reports involvement in the teaching of image interpretation.

The University of Guelph reports that Dr. R. Protz and another staff member took short remote sensing courses at Purdue in 1978. Dr. Protz taught a remote sensing course to 34 students.

The University of Waterloo offered remote sensing instruction to 231 undergraduates, 10 graduates and one doctoral student in 1978.

The Ministry of Transportation and Communications reports that staff training and development in remote sensing is an ongoing process.

The Great Lakes Surveys Unit of the Ministry of the Environment reports that D.I. Ross, Senior Environmental Scientist with the Unit, is engaged in preparing a postgraduate thesis at CRESS (York University) on the digital analysis of waterborne thermal plumes using digital low-altitude infrared linescanner data.

The Ontario Centre for Remote Sensing was engaged in remote sensing training in 1978 as follows:

- two one-week comprehensive courses to government land-use planners in the practical application of all types of remote sensing;
- a one-week course in remote sensing and tree species identification for foresters;
- a one-week forest soils course;
- a one-day remote sensing seminar for geography teachers;
- presentation of lectures at four different Ontario universities;
- five half-day presentations at the Centre for visiting university students.

With regard to learning in the field of remote sensing, the OCRS extended its knowledge of radar imagery interpretation and digital analysis of satellite data, and continued the development of airborne sensing techniques to provide optimal imagery for the purpose of each research and applications project requiring the acquisition of coverage.

Barringer Research reports that its involvement in remote sensing education in 1978 has consisted of attendance and presentations at remote sensing symposia.

Gartner Lee Associates delivered lectures at Government seminars and universities on air-photo interpretation and engineering geology.

6.7.6 Conclusions and Forecast

Dr. J. Vlcek of the University of Toronto comments that remote sensing activity is flourishing in Government and universities but that the private sector requires more information on the usefulness of remote sensing.

Dr. A.B. Kesik of the University of Waterloo believes that a better flow of information among universities, Government departments and industry would improve the practice of remote sensing in Ontario, but predicts ongoing growth in the field.

Mr. R.C. Ostry of the Water Resources Branch, Ministry of the Environment, predicts very slow growth for remote sensing use in Ontario. The Great Lakes Surveys Unit of the same Branch regards the current economic situation as limiting the growth of remote sensing practice, which is indeed applicable to Ontario.

The Ontario Centre for Remote Sensing is particularly encouraged by a growing demand for practical remote sensing training,

and recognizes that the dissemination of information on the applicability and benefits of remote sensing is more necessary than ever in view of current economic conditions. The Centre intends to do what it can to meet these needs, by developing an expanded training program and by initiating the distribution of bulletins and an annual report on OCRS activities.

6.7.7 Recommendations

The Ontario Centre for Remote Sensing recommends that CCRS orient its resources and efforts towards improving the quality and usefulness of quicklook satellite information. The value of quicklook satellite information has great potential, particularly in areas such as environmental monitoring. This potential will not be fully realized until greater emphasis is placed in this area.

The Ontario Centre for Remote Sensing recommends that a direct data link be established between satellite receiving stations and users. Direct data access is an alternative to quicklook imagery which should be considered, at least in principle, by CACRS.

Dr. R. Protz of the University of Guelph, suggests that a joint teaching program be set up by several Ontario universities.

6.7.8 1978 Publications/Prepared Papers

Barringer, A.R., J.H. Davies and R. Dick. AIRTRACE: Applications to Meteorological Optics. Presented at Meeting on Meteorological Optics, August, 1978.

Barringer, A.R., J.H. Davies and L.Daubner. SURTRACE - An Airborne Geochemical System. Presented at Twelfth International Symposium on Remote Sensing of Environment, Manila, Phillipines, April, 1978.

Barringer, A.R., J.H. Davies and R. Dick. Electro-Optical Correlation Techniques for Remote Sensing of Air Pollutants. Presented at Meeting on Meteorological Optics, August, 1978.

Barringer, A.R. and J.H. Davies. Remote Sensing for Air Pollution Control. Presented at Twelfth International Symposium on Remote Sensing of Environment, Manila, Phillipines, April, 1978.

Brisco, B. and R. Protz. Evaluation of High-Resolution Side-Looking Airborne Radar on the University of Guelph Test Strip. Fifth Canadian Symposium on Remote Sensing, Victoria, B.C.

Duff, J. The Effect of Selected Soil Properties on Surface Temperature Measured by Thermal Infrared Imagery along the North Shore of Lake Erie. M.Sc. Thesis, University of Guelph.

Feldman, V. Predicting the Motions of Detached Ice Floes. Unpublished Ph.D. Thesis, McMaster University.

Howarth, P.J. Remote Sensing for Coastal Studies in Canada. Presented at Coastline of Canada Conference, Halifax, N.S., May, 1978.

Karpuk, E. Ecological Land Classification of an Area Southeast of Lesser Slave Lake, Alberta, Using Airborne and Spaceborne Remote Sensing. Unpublished M.Sc. Thesis, McMaster University.

Kesik, A. Application of Landsat Mosaics for the Compilation of Small-Scale Geomorphological Map of Yukon Territory. ISP and IUFRO Symposium, Freiburg, West Germany.

Kozlovic, N. 1977. Aircraft and Satellite Remote Sensing for Biophysical Analysis at Pen Island, Northwestern Ontario. Unpublished M.Sc. Thesis, McMaster University.

Lairet, J. An Evaluation of Landsat Imagery for Land Use Mapping in the Valencia Lake Basin, Venezuela. Unpublished M.A. Research Report, McMaster University.

Lairet, R. Satellite Data Applied to Hydrologic Models for Regional Watersheds: A Case Study, Apure Llanos, Venezuela. Unpublished M.A. Research Report, McMaster University.

Lawrence, Garth R., Tracey J. Ellis and Patricia B. Smith. The Value of Qualitative Interpretation of Aerial Thermography in Residential Heat Loss Studies. Presented at Fifth Canadian Symposium on Remote Sensing, Victoria, B.C.

LeDrew, E.F., R. Douglas and V. MacGillvary. Potential of Remotely-Sensed Data for Air Quality Forecast. Fifth Canadian Symposium on Remote Sensing, Victoria, B.C.

Mathur, B. Sen. Remote Sensing Sensors for Environmental Studies. Paper presented at 1978 Annual Convention, American Society of Civil Engineers.

Pala, Simsek. Spaceborne Remotely-Sensed Data as Applied by the Ontario Centre for Remote Sensing: Present and Future. Presented at ISP and IUFRO Symposium, Freiburg, West Germany.

Philip A. Lapp Ltd. Resolving Ambiguities in Interpreting the Thermal Signature of Ice and Water in Aerial Thermograms of Flat Roofs. Contract Report, DSS Contract #195Q23414-8-3000, November 24, 1978.

Vlcek, J. Determination of Thermal Emissivity in Situ. Fifth Canadian Symposium on Remote Sensing. Victoria, B.C.

Vlcek, J. Use of AGA Thermovision Camera in Close-up Terrain Thermal Studies. Annual Meeting, American Society of Photogrammetry, Washington, D.C., March, 1978.

Zsilinszky, Victor and Simsek Pala. Digital Analysis of Landsat Data for Selective Forest Stand Typing - an Initial Feasibility Study. Presented at ISP and IUFRO Symposium, Freiburg, West Germany.

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6.8 Report from the Prince Edward Island Remote Sensing Committee

6.8.1 Airborne Remote Sensing

As was the case during the previous year, we had limited activity on a commercial scale. However, as part of our Land Management Program, the Technical Services Branch of the P.E.I. Dept. of Agriculture and Forestry made considerable use of airborne imagery obtained from a light aircraft (C-172) and using a platform mounted 35 mm camera. The camera was attached to a "dolly" which was suspended inside a plexiglass housing protruding from the baggage access door of the aircraft. Most of the photography was flown at altitudes ranging from 1,000 ft. to 5,000 ft. of ASL, depending upon the desired scale. Primitive and makeshift as it might sound, it had three major benefits:

(1) We obtained the photography we wanted

(2) At a very affordable cost, and

(3) We could normally obtain the photography when we needed it, weather permitting.

The photography was required as a tool in two projects:

(1) Colour photography was needed to inventory current land use in various watersheds, as well as to develop quick, accurate acreage measurements on proposed land clearing sites.

(2) Both colour and false colour IR were used to aid in defining the location of unmapped subsurface drainage systems. However, as the result of recent communications with the Ontario Centre for Remote Sensing, we are planning to evaluate the use of B/W IR as a more effective means of locating old tile lines, particularly during that time of the year when no soil cover exists (i.e., early spring and late fall months). We have found that this method of carrying out land use studies has a distinct cost advantage over surface oriented programs and anticipate that it will be continued, particularly given the experience gained to date.

6.8.2 Spaceborne Remote Sensing

For several years, we have been somewhat vocal on the issue that "black box" technology seemed to be progressing beyond user needs, admitting that we were experiencing problems in keeping abreast of the flow of developments. A great deal of our frustration arose from problems related to input requirements, output quality and subsequent application of printout data. We viewed satellite image analysis as the most probable tool to use in province-wide scale agricultural land use studies. However, as last year, we encountered the same old problem of scale-skewedness in the 1:125,000 scale printout maps. A secondary problem was that the image analysis system produced maps for each mapping unit requested. Although the system was probably producing accurate results over a limited area on the printout, field verification varied from difficult to impossible.

Thanks to Dr. Bob Ryerson and his colleagues, a system was developed which appears to meet the bulk of our demands. We decided that some land use criteria could not be accurately determined (i.e., idle land). Therefore, we narrowed our demands. Secondly, since it was obvious that the 1:125,000 scale was not useable in the field, 1:50,000 could be used and skewedness was greatly reduced. Thirdly, all criteria were printed on the same map sheet. This meant that only about 1 pixel in 3 could be printed. However, this apparent loss in boundary limit accuracy is not viewed as a serious constraint in our program. Total evaluation of this modification is, to date, incomplete, and 1979 will be a test year.

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6.9 RAPPORT DU QUEBEC

6.9.1 Télédétection aérienne

Sur un total de 23 projets de télédétection aérienne portés pour 1978 au programme des Opérations aériennes du Centre canadien de télédétection pour le Québec, 18 ont pu être complétés. Onze projets avaient été acheminés par l'intermédiaire du Centre québécois de coordination de la télédétection (C.Q.C.T.). Trois missions ont été effectuées avec le radar à ouverture synthétique, dans le cadre du projet SURSAT.

De plus, le C.Q.C.T. a commandé à la compagnie Intertech Remote Sensing Ltd, à l'automne 1978, la couverture de 10 villes par thermographie aérienne. Trois de ces missions ont pu être réalisées. Le reste sera éventuellement reporté à 1979.

Les 18 missions complétées représentent un total de 2292 milles nautiques de couverture, parmi lesquels 858 ont été couverts dans le cadre du projet québécois Télédétection - foresterie.

Une partie de l'imagerie prise pour le projet Télédétection - foresterie a été interprétée au Centre de recherches forestières des Laurentides. Cela a conduit à la cartographie de la mortalité forestière due à la tordeuse du bourgeon de l'épinette. Une cartographie en cinq classes de mortalité a été effectuée à partir de la photographie aérienne couleur infrarouge au 1:60 000; une cartographie en trois classes a résulté de la photographie prise simultanément à l'échelle du 1:110 000.

Dans le cadre du même projet, le Service de la recherche du ministère des Terres et Forêts a examiné l'utilité de la photographie aérienne sur émulsion couleur infrarouge à très petite échelle (1:110 000, prise avec objectif super grand angulaire) pour la mise à jour de la carte forestière au 1:20 000. La photo-interprétation et la cartographie ont été réalisées avec un stéréoscope Zoom à transfert. Ces travaux seront complétés à l'été 1979 par des relevés-terrain.

Des travaux de recherche ont été menés à l'Université de Sherbrooke dans le but de démontrer les possibilités de la thermographie aérienne pour cartographier les risques de gelées nocturnes dans des zones agricoles.

6.9.2 Télédétection spatiale

La Société de développement de la Baie James continue à utiliser régulièrement les données Landsat. A l'automne 1978 a commencé l'inondation derrière le barrage hydroélectrique LG2. On met à profit les images Landsat du secteur comme source d'information sur le phénomène.

L'Hydro-Québec a commandé à l'Université Laval et au Centre de recherches forestières des Laurentides des travaux d'analyse numérique des données de Landsat portant sur les régions d'exploitation future. L'Université Laval a réalisé des travaux sur la distribution morphométrique des lacs. Le Centre de recherches forestières des Laurentides a entrepris la cartographie d'écologie forestière sur une zone de 80 000 milles carrés.

La Société de Conservation de l'Outaouais a participé encore cette année aux démonstrations de cartographie du combustible forestier sur son territoire de contrôle, menées par le Forest Fire Research Institute.

La Société utilise également les données de Landsat, de façon routinière, depuis deux ans. On possède une collection d'images couvrant tout le territoire, à une échelle voisine du 1:200 000. Ces images, préparées par le Forest Fire Research Institute, résultent d'une accentuation de couleur effectuée par traitement numérique.

Ces documents aident à la prise de décision sur le mode d'intervention à utiliser dès qu'un feu est détecté et rapporté au centre de décision.

Une nouvelle collection d'images, de qualité supérieure (fabriquées avec le système Aries) sera mise à l'essai au cours de la prochaine saison de protection.

Au Centre québécois de coordination de la télédétection, on continue à offrir un service de consultation pour le choix et l'acquisition des données Landsat. On a grandement amélioré ce service cette année par l'addition d'un synthétiseur multispectral et d'une commande systématique des images du Québec provenant de Landsat-3, dans un format compatible avec le synthétiseur.

Ce système a connu un grand succès (même si le fournisseur n'a pas toujours pu nous procurer les images de façon régulière, à cause de pannes sur ses installations). Les

usagers peuvent visionner une image couleur, composée selon leur choix, quelques jours seulement après le passage du satellite. Ils peuvent même repartir, après leur séance de travail, avec une copie de leur image sur papier photographique couleur.

Ces services s'adressent principalement de façon ponctuelle à des utilisateurs variés. Il est malheureusement impossible d'en évaluer toute la portée et toutes les retombées.

6.9.3 Autres applications

Le ministère des Terres et Forêts a utilisé de façon régulière un thermographe portatif au cours de la saison de protection 1978. L'appareil, utilisé depuis un hélicoptère, sert à la détection des points de feu rémanents, dans la phase finale de la lutte contre un feu de forêt.

Le même appareil est utilisé à des fins de conservation de l'énergie au cours de l'hiver. Sous la responsabilité du C.Q.C.T., il est prêté à diverses agences gouvernementales. Le ministère des Travaux publics a utilisé l'appareil pendant 6 semaines au cours de l'hiver 1978-79, pour l'inspection d'édifices gouvernementaux. Le Bureau des économies d'énergie l'a aussi utilisé pour une durée équivalente, dans le secteur résidentiel.

6.9.4 Projets spéciaux

6.9.4.1 Mosaïque couleur

Le Centre québécois de coordination de la télédétection a publié une mosaïque couleur de l'ensemble du Québec produite à partir des images Landsat. "Le Québec vu par satellite" est reproduit par lithographie, à l'échelle du 1:2 500 000. Le montage de base a été réalisé à la Direction des levés et de la cartographie du ministère de l'Energie, des Mines et des Ressources.

Ce produit connaît un très grand succès. On peut juger que c'est le produit provenant des satellites Landsat qui aura connu la plus grande diffusion au Canada.

6.9.4.2 Projets Télédétection - foresterie

Conçu depuis l'année précédente, ce projet a été lancé en 1978. L'objectif de ce projet est de faire passer les applications de la télédétection à la gestion forestière à un stade opérationnel. Sa démarche en est une de démonstrations sur des thèmes et des sites choisis par des gestionnaires de la forêt québécoise. Les principaux artisans du projet sont le Centre de recherches forestières des Laurentides, l'Université Laval, le Centre canadien de télédétection et le ministère des Terres et Forêts. Le C.Q.C.T. y assume la coordination des travaux, alors que le Service de la recherche a engagé spécifiquement un ingénieur forestier, pour une période de deux ans, afin d'assumer sa participation.

6.9.4.3 Ballon captif

Un programme expérimental avec un ballon captif a été mené par le C.Q.C.T. au cours de l'été. Il avait pour objectif de vérifier les performances d'un tel système et d'identifier les secteurs d'application appropriée. Suite à ce programme, on a décidé de réduire, pour l'année suivante, les sorties à des cas bien précis et adaptés aux particularités du système.

6.9.4.4 Système de traitement numérique

Des discussions exploratoires ont été entreprises entre le ministère des Terres et Forêts et l'Université Laval à l'effet de mettre en commun des équipements pour constituer un système de traitement numérique. Ce système serait de taille comparable à celui du Centre ontarien de télédétection (O.C.R.S.) et serait éventuellement complètement compatible avec ce dernier.

6.9.5 Coordination

Le Centre québécois de coordination de la télédétection est passé en 1978 d'une existence provisoire à un statut permanent. Il compte maintenant quatre employés permanents.

Son mandat a été redéfini en fonction de ces effectifs. Le rôle de coordination s'y divise en trois volets: documentation (ouvert à tout québécois, sans restriction) ; soutien de projets pilotes (ouvert aux agences gouvernementales); et soutien à la recherche.

En plus de sa participation à plusieurs activités mentionnées plus haut, le C.Q.C.T. publie le bulletin d'information "La télédétection au Québec" (700 exemplaires) et diffuse des références bibliographiques à 160 abonnés par le système SYDOSAT (Système de documentation sélective automatique sur la télédétection.

6.9.6 Perspectives d'avenir et conclusion.

Un survol des activités en télédétection au Québec démontre que cette technique est sur le point d'être utilisée de façon concrète, comme apport d'information, dans tout le secteur touchant la connaissance de la forêt, l'écologie forestière et l'environnement des vastes étendues du nord québécois. Un système de traitement numérique local, de taille moyenne, accélérera grandement cette tendance.

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7.1 REPORT OF THE AES PANEL ON REMOTE SENSING

7.1.1 INTRODUCTION

The AES has a diversified remote sensing program which embraces almost all components of the Service and most of the operational and research activities to a greater or lesser extent. The past year has witnessed a considerable expansion in the programs and a far greater involvement on the operational side. This year's report of the AES panel contains an outline of the operational program and short accounts of a number of the R & D programs.

7.1.2 OPERATION

The Aerospace Meteorology Division's Satellite Data Laboratory (SDL) has the responsibility to acquire directly transmitted meteorological data from the operational U.S. weather satellites. Data for operational and for research applications is acquired on a 24 hour basis for processing, re-formatting and distribution by land line, in real or near real-time, to major weather offices across the country and to the Ice Forecasting Central. Additionally, magnetic tape data and/or selected imagery is provided for training, research and development purposes, both in-house and to Departmental agencies for specific projects.

7.1.2.1 VERY HIGH RESOLUTION RADIOMETER (VHRR)

Data from the VHRR in both visual and infrared is acquired from the High Resolution Picture Transmission (HRPT) system on the polar orbiting U.S. weather satellite NOAA 5. The acquired analogue data is digitized, computer processed, to compress the data and remove panoramic distortion, and to add annotations and geographical outlines and output in a facsimile compatible format suitable for distribution over voice quality national meteorological land line circuits in near real time. Additionally, the VHRR data at full resolution for specific areas of interest to Ice Branch are processed, enhanced for ice details, and formatted to be facsimile compatible for transmission by dial telephone circuits to the Ice Forecasting Central in Ottawa.

The data are transmitted to some 15 photographic facsimile recorders in the major weather offices from coast to coast and reproduced as hard copy photographic images for use in each of the forecast offices.

Another VHRR receiving station is located at Edmonton's Arctic Weather Centre to provide satellite coverage of the Beaufort Sea area. It employs a Weather Information Processor System (WIPS) using a microprocessor to obtain real-time data from the VHRR system and to output facsimile compatible imagery for line distribution similar to that done at the Satellite Data Laboratory.

7.1.2.2 ADVANCED VERY HIGH RESOLUTION RADIOMETER (A/VHRR)

Since the NOAA 5 spacecraft is the last of the Improved TIROS Operational Satellite system (I-TOS) and was scheduled to be de-activiated at the end of February, 1979, a new type of data known as A/VHRR will be transmitted from the new satellite series known as TIROS-N. The first spacecraft, TIROS-N, is now in orbit and will shortly be joined by a twin spacecraft in an opposed orbit to provide complete global coverage on a 6-hour cycle upgrading the 12-hour cycle provided by the I-TOS spacecraft.

Data from the satellite's HRPT system will come from the A/VHRR system in 2 visual channels and 2 infrared channels. These data will be transmitted as a digital bit stream containing the A/VHRR data from the four channels with provision for a 5th channel, plus other meteorological data from the TIROS Operational Vertical Sounder (TOVS) system and Data Collection System (DCS). In order to acquire these data, modifications have been installed and software developed to enable this new type of imagery and data to be acquired and processed. The processing will be carried out in the present Interdata 7/16 computer and outputted to users in similar format as that used for the present VHRR data. It is anticipated that this SDL system will be in operation early in March, 1979. The WIPS system ground station in Edmonton has been modified for A/VHRR receptions from the TIROS-N series of spacecraft which are scheduled to operate until the mid-1980's.

7.1.2.3 VISUAL INFRARED SPIN SCAN RADIOMETER (VISSR)

The recently installed 10 metre antenna, RF system, and sectorizer equipment are now routinely operating to acquire VISSR data transmitted by the geostationary meteorological satellite known as GOES-East. This spacecraft, at 35,000 kilometres above the equator at longitude 75° West, transmits

visual and infrared VISSR data covering the full earth disc, from north pole to south pole, every half hour during day and night. The SDL sectorizer equipment has the capability to acquire and process North American data, to break these data down to output simultaneously 4 sectors of selective resolution enhancement and location. Each sectorized image is distributed in fax compatible format for real-time reception over the national meteorological network. It is planned to divide this network in the future to cover the following sectors: the Maritime area; the Quebec area; the Ontario area; and the Manitoba area; so that real-time information is received, half-hourly in both spectral bands, at Halifax, Montreal, Toronto and Winnipeg weather centres. In addition to producing the 4 different sectors, the SDL system will also archive data on magnetic tape for a 5th sector for research and development use. The data output from the system are in the same format as that used for the VHRR data and the TIROS-N data, thus the photofacsimile units at each location are used to reproduce data from all systems.

The repetitive coverage provided by the VISSR data every half hour will enable the respective regional weather offices to track and monitor the development of storm centres as they move across their particular area of interest. A similar VISSR type station is planned for installation at Vancouver, B.C. to cover systems over the Gulf of Alaska, British Columbia, and the Western Prairies so that the whole of Canada from coast to coast will be under meteorological surveillance in both visual and infrared modes on a half hourly basis.

7.1.2.4 AUTOMATIC PICTURE TRANSMISSION (APT) SYSTEM

The APT system carried on all the weather satellites since 1966 to provide direct low resolution satellite imagery to simple VHF ground stations in real-time will be continued on the TIROS-N series. Two APT stations located at Halifax and Vancouver acquire APT type data for regional use primarily over the offshore ocean areas. These stations will be modified to enable them to read out the TIROS-N APT type transmissions. These data are taken from the A/VHRR system, processed on board the spacecraft to remove panoramic distortion and converted into analogue form. The imagery is transmitted to the simple ground station in a facsimile compatible format for imagery reproduction in both visual and IR modes. Additionally the Halifax station is equipped with a suitable antenna and receiver to acquire pre-processed weather facsimile (WEFAX) type data that are retransmitted on pre-arranged schedule from the GOES-East geostationary satellite.

7.1.3 ICE BRANCH

Ice Branch is one of the major users of remotely sensed data in the Atmospheric Environment Service. For several years the Ice Forecasting Centre and the Ice Climatology Division have made extensive use of NOAA, LANDSAT and aircraft data. The highlights of the 1978 program in the area of remote sensing were:

- Early in February, the AN/APS-94D SLAR system installed on one of the ice reconnaissance L-188C aircraft was finally introduced into operational service. During the year, approximately 1300 hours of sea ice imagery were collected with the system, mostly for near real-time inflight analysis and ship support application. The system has become an extremely valuable asset to the program. Two operational workshops for ice observers were held during the year to develop and enhance interpretation procedures.

- In October, several Ice Branch staff members participated in a WMO-sponsored international workshop on remote sensing of sea ice held in Washington, D.C. With thirteen countries participating in the operationally oriented workshop, a valuable interchange of information and discussions resulted.

- Ice Branch has been actively involved in the planning and organization of SURSAT experiments scheduled for 1979. The AES APS-94D SLAR as well as NOAA 5 satellite data output will have a significant role in the experiments.

7.1.4 RESEARCH AND DEVELOPMENT

7.1.4.1 GROUND BASED REMOTE SENSING

Not all of the AES remote sensing programs are downward looking and some of the ground based remote sensing programs, such as the weather radar program, have been in operation for many years. One of the ground based remote sensing programs underway in AES is the acoustic sounding program.

Laser Scintillometer

An active source scintillometer for measuring boundary layer turbulence parameters has been built, tested, evaluated and refined for field operation by the Boundary Layer Division. An advanced model capable of measuring cross-winds is under development. The device has application in run-way wind monitoring and general boundary layer support.

Remote Sensing Report

Acoustic Sounding

A prototype system is being assembled and tested by the Boundary Layer Division to evaluate the feasibility of monitoring the diffusivity of the near-surface atmosphere with application to Air Quality problems. The system consists of a distributed processor, large acoustically efficient horns and real-time processing and display. Associated equipment has been used by the scientific staff in several field experiments in support of environmental assessments.

7.1.4.2 AES SURSAT PROGRAMS

The Atmospheric Environment Service is taking an active part in the evaluation of SEASAT-A. This proof of concept satellite was equipped with four microwave sensors - synthetic aperture radar, altimeter, scatterometer and multi-channel microwave radiometer - capable of providing a variety of meteorological and related parameters.

The AES has submitted fifiteen evaluation experiments as our contribution to the Canadian Sursat Project. These experiments can be grouped into three categories:

(i) Meteorological experiments

- All weather sea surface temperature mapping
- Surface wind speed and direction over ocean areas
- Significant wave height
- Application of Seasat-A data for operational weather forecasting
- Atmospheric parameters such as water vapor and liquid water

(ii) Ice

- Comparative evaluation of SEASAT-A Synthetic Aperture Radar and aircraft-borne Side Looking Radar
- Evaluation of Seasat data for operational ice forecasting
- Ice dynamics studies
- Ice properties (i.e. ice type, ice roughness, concentration etc.)

(iii) Snow

- Application of microwave remote sensing to snow studies.

7.1.4.3 STRATOSPHERIC RESEARCH

For the past year the Experimental Studies Division of the Atmospheric Environment Service has been involved with NASA in a cooperative correlative ground truthing project for the Nimbus-G satellite. Nimbus-G carries three remote sensing systems for stratospheric gases: a) LIMS measuring O_3, HNO_3, NO_2, and H_2O; b) SAMS measuring H_2O, O_3, CH_4 and NO_2; c) SBUV-TOMS measuring O_3.

Two stratospheric balloon campaigns were mounted in support of this satellite. The AES stratoprobe payload was flown twice at the NCAR-NSBF (National Scientific Balloon Facility) at Palestine, Texas along with the NASA LIP balloon payload on October 30 and November 8, 1978. These measurements included HNO_3, NO_2, NO, O_3, H_2O and CH_4. In addition, twenty-three ECC ozonesonde profiles (SFC to 30 km) were obtained, and ground based ozone measurements were made using the Canadian Brewer Ozone Spectrophotometer. The Stratoprobe payload was flown to 40 km on a 20 .1 MCF balloon. The LIP payload was flown to 35 km on a 5.3 MCF balloon.

In February of 1979 the NASA-LIP payload was flown at CFB Cold Lake. The AES effort was to fly two instruments on a smaller payload provided from York University which flew instruments to measure NO and NO_2 photolysis rate. Among the constituents measured were NO_2, HNO_3, and NO. The vertical ozone distribution was obtained from surface to 30 km using aerological balloon-borne ECC ozonesondes. Ground based ozone total column was measured using the Dobson Spectrophotometer at the Stoney Plain (Edmonton) observatory. Intercomparisons of HNO_3, NO_2 and NO from the AES/York balloon flight will be made with Nimbus-G measurements of HNO_3, NO_2 and O_3. As well, HNO_3 and H_2O measurements from the AES/York flight will be cross-compared with similar measurements by different instruments on the LIP payload flight.

Three further ground truth flights with the AES/York payload are planned from Alice Springs, Australia and Mildura, Australia in April and May, 1979. Again, correlative measurements of O_3, HNO_3, NO_2, NO, and H_2O will be made up to 32 km for intercomparison with Nimbus-G. Future ground truth balloon flights in conjunction with the shuttle/UARS experiment, "HALOE", are proposed for 1981-82.

7.1.4.4 CANADIAN CLIMAT CENTRE

The Canadian Climat Centre makes extensive use of meteorological satellite data in many of the Centre's programs. Two of the applications of satellite data are related to snow cover mapping and lake surface temperature mapping.

Snow Cover Mapping by Satellite in the Saint John River Basin

The AES Hydrometeorology Services Division has proposed to supply regular maps of snow cover using NOAA-5 and GOES data to the Saint John River Basin Flood Forecasting Centre. This is part of the Canada/New Brunswick flood forecast agreement and is an extension of the service previously supplied by NESS. Snow cover information will be supplied when cloud cover permits, approximately once a week during spring.

Lake Temperature Determination from NOAA-5 and TIROS-N IR data

Eleven analyses of surface water temperature of Lake Winnipeg were completed by AES-HQ (Hydrometeorology Division and Meteorological Services Research Branch) for the period June 1 to September 15, 1978. The maps were provided to AES Central Region for use in cooperative studies with Provincial agencies.

It is planned to provide bi-weekly maps of Great Lakes surface temperatures when TIROS-N data are received operationally. Present studies indicate that satellite retrieved temperatures are within 1.5 K of ART and buoy measurements. ART (Airborne Radiation Thermometry) flights are still the only means to obtain surface temperatures in a period of persistent overcast conditions.

7.1.4.5 AEROSPACE METEOROLOGY DIVISION

The R and D activities of the Aerospace Meteorology Division have continued to centre on the conversion of satellite derived radiances into environmental parameters in formats compatible with AES operational and research systems. There are three main thrusts to the program, satellite sounding, sea ice and precipitation forecasting.

Satellite Sounding

The satellite sounding program is concentrating on the conversion of microwave radiances, from the Tiros-N Operational Vertical Sounder (TOVS), into temperature fields which will provide a higher spatial resolution than is available from the conventional rawinsonde network. First quasi-operational tests of this system are expected to take place towards the end of 1979. In addition to this program, MacDonald-Dettwiler and Associates have been designing a TOVS processor under contract. Finally, the Division de Recherche en Prévision Numérique are embarking on a project to study direct assimilation of radiance data into their objective analysis scheme for large scale numerical weather prediction.

Sea Ice

The development of the Ice Status System is still progressing. This system will map HRPT data onto a fixed geographical base and allow both spectral and temporal analysis to be carried out. Delivery of part of the system has taken place with final delivery of the software scheduled for the fall of 1979. Interaction identification of ground control points is used to develop the transformation from the image projection to the data base via time series estimate of the spacecraft altitude parameter. Both average radiance values and variances in radiance are used in the classification process.

Short-range precipitation prediction

A short range precipitation system is being developed by the Aerospace Meteorology Division. The system will use digital GOES-VISSR imagery as the basic data set and weather radar data for real-time ground truthing and training the spectral classification scheme. Initially the forecasts will be based on extrapolation of precipitation areas with additional physics being added after experience has been gained with the system. It is expected to run the first system tests in about two years time, the summer of 1981.

7.1.5 TRAINING

The Training Branch has provided a course on the interpretation of GOES-VISSR imagery to the staff of a number of AES and DND weather offices as well as to a group of meteorologists from the Columbian Meteorological Service. The course consists of four modules; cloud element identification, atmospheric structure identification, cloud systems and cyclogenesis and the use of satellite imagery in weather forecasting.

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7.2 FOREST FIRE RESEARCH INSTITUTE

7.2.1 SPACEBORNE REMOTE SENSING

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. Part 1 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 database covering a large forest region is feasible to construct and use. This database 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 database 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 database is established.

7.2.2 APPLICATIONS

Work carried out during the last 5 years includes the demonstration to most Canadian fire control agencies of the usefulness of Taylor[1/] enhanced imagery. This work involved the production of enhanced images covering areas from 1 to 30 million acres at various scales. Over the past few years we have developed standard colour schemes and seasonal data constraints for Boreal forest areas. Quality has continually been improved. During the past year the Institute used the Canadian Forestry Service's ARIES system to produce the following Taylor enhancements:

a) A 5 million acre area of Northern Saskatchewan for demonstration purposes.

b) A 30 million acre area, that includes most of the area of the Ontario Ministry of Natural Resource's (OMNR) North Central fire management region, for the 1979 operational fire control dispatching trials.

c) A 7 million acre area in the Outaouais fire control region for scale tests.

d) A 7 million acre demonstration area in the Yukon and Northwest Territories.

High quality imagery for these projects was produced using the ARIES Dicomed imaging system. 70 mm positive transparencies were enlarged by the National Air Photo Library processing centre to 20" x 20" prints. Scales ranging from 1" - 1¼ miles to 1" - 2½ miles were used. Contrast stretched band 5 images, designed for road and clearcut enhancement, were produced for the 30 million acre area of North Central Ontario in addition to the broad forest type enhancements.

Severe conifer defoliation, by the spruce budworm, presents a major fire control problem to Eastern Canadian fire control agencies. Maps showing the location of severe defoliation would be of considerable use. Methods involving Landsat data were researched by the Institute to accomplish this. It appears that this is possible using the Taylor enhancement of temporal overlaid winter data (with complete snow cover) where one data set is made before defoliation and one made after defoliation. In effect, we are looking for areas where conifers change to resemble hardwoods. A test of this method was carried out in the Gogama forest district of the OMNR. Field checks, using inventory maps and helicopter overflights, verified the scheme's ability to map the defoliation areas in the test area. A 3 million acre area, including the whole Gogama District, has recently been completed to test the methods consistency. In addition, the method has been applied to the heavy defoliation area of the Cape Breton Highlands. Field checks of this imagery have yet to be made.

Progress to date in the construction of a Landsat database has been painfully slow partially because of equipment failures. Winter and summer frames of the same Outaouais area have been UTM corrected and resampled to ½ ha square resolution units. These frames have been classified using CCRS's unsupervised histogram clustering algorithm to provide the initial block of data for the Institute's Outaouais database. These data are currently being transferred to the Institute's DEC PDP11-T34 computer. CCRS's Unidisk data management package has been converted and exercised on the Institute's computer and is ready to handle the classified data.

The Institute has participated in numerous demonstrations for visitors and has presented several talks describing the role of

1/ Dr. M.M. Taylor, Defence and Civil Institute of Environmental Medicine, Dept. of National Defence, Downsview, Ont.

Landsat technology in fire control. Interest by fire control agencies in the use of Landsat has built up considerably in the past year and demand for enhanced imagery now far exceeds our ability to supply it. The new image processing system of the Ontario Centre for Remote Sensing should find a considerable amount of business in the fire management field.

The Forest Fire Research Institute (FFRI) will merge on April 2nd with the Forest Management Institute and the Petawawa Forest Experiment Station to form the Petawawa National Forestry Institute (PNFI). The remote sensing work presently being carried out by FFRI and FMI will be moved to Petawawa during the fall of 1979. The ARIES image processing system will be moved to the PNFI at this time and a new forestry remote sensing section will likely be formed. PNFI hopes to maintain its close contact with CCRS and plans to participate in the testing of the first CCRS remote video processing terminal that will be linked to the CCRS image analysis system via high speed communication lines.

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7.3 FOREST MANAGEMENT INSTITUTE

The main task of the FMI Remote Sensing Program has been the development of "ARIES", a large and powerful computer system for the interpretation of digital satellite data. A few years ago FMI had initiated tests of computer-assisted interpretation using a minicomputer with the objective of developing a "poor man's interpretation system". This work and studies relying on facilities in other organizations progressed reasonably well and several significant research results were obtained such as, for example, the successful creation and analysis of multi-date overlays and work on filtering programs. Another advance of importance for mapping applications, was the establishment of criteria for judging the accuracy of remote sensing interpretation. However, in the course of these studies, it became increasingly evident that an efficient Landsat interpretation system would have to be far faster than the FMI general purpose minicomputer; also it would require a very well designed interface between the interpreter and the computer.

The Forest Management Institute, therefore, underwrote a two-year contract with Computing Devices Company for the development of a new interpretation system, ARIES, which was to take full advantage of the high-speed data-handling capability offered by microprocessor technology. This system was delivered to FMI in September, 1978, and is now operated by Dipix Systems Limited, under contract to FMI. It includes a strong software package with supervised and unsupervised classification, enhancements, geometric correction, registration of multi-date scenes, overlay of coordinate grids, planimetry of subscenes, and other algorithms.

ARIES is used by scientists from FMI and other Canadian Forestry Service establishments, such as the Forest Fire Research Institute, the Laurentian, Northern and Pacific Forest Research Centres. Among the current FMI projects are experiments to map forests and wetlands in northern Ontario in cooperation with the Great Lakes Forest Research Centre and the Ontario Centre for Remote Sensing. Another application which promises to develop into a long term commitment is the use of ARIES to support the CFS Forest Resource Data Program: FMI is engaged in a pilot study to establish if national forestry statistics can be efficiently and reliably obtained from Landsat data for northern Canada. The possibility of expanding this work to derive estimates of biomass is being considered. ARIES has also been used to monitor logging operations on an experimental basis and to support the Integrated Resource Surveys Program in its biophysical surveys of Canada's national parks, carried out for Parks Canada.

While most of the FMI remote sensing activities support the high priority tasks of forest inventories and mapping, the studies of the spectroradiometry of forest trees have been of a more basic character. They have involved investigations of the patterns of visible and infrared radiation reflected by trees, as well as of the effects of diurnal and seasonal changes. Knowledge of these reflectance patterns, the spectral signatures, will improve the efficiency of remote sensing data interpretation.

The Forest Management Institute Remote Sensing Program has always had strong links to the international scientific community. From 1972 to 1976, FMI provided the President and Secretary of Commission VII (Interpretation) of the International Society for Photogrammetry (ISP) and at present members of FMI have responsibility for an ISP task in environmental monitoring which developed from earlier studies.

An FMI scientist, Mr. Z.D. Kalensky, has just returned from a two-year assignment to Indonesia, where he acted as remote sensing advisor to the Government of Indonesia in a large national resource survey project. One of the many results from his involvement has been a resource map of Lombok Island, produced from Landsat data with the aid of ARIES. This assignment has also led to a series of lectures and seminars on remote sensing and resource mapping at the remote sensing agencies in Bangladesh, India and Thailand, at the Forest Directorates in India, Indonesia and the Philippines, at the mapping agencies in Indonesia and Malaysia, at Universities in Indonesia, Iran, Singapore and Thailand and at UNESCO in France. FMI staff have often been invited to give lectures at universities in Canada and United States. Staff members have contributed to several major remote sensing congresses and seminars in Canada and abroad including the ISP

Congress in Helsinki, Finland and the FAO/ UNESCO Remote Sensing Training Seminar at Lenggries, Germany, and the International Symposia on Remote Sensing of Environment at Ann Arbor and Manila. Another significant event has been participation, through the Department of Energy, Mines and Resources and the Panamerican Institute of Geography and History, in a series of cooperative experiments and seminars linking the Canadian forestry remote sensing program with programs in Guatemala, Colombia and Chile.

Landsat at present dominates the FMI remote sensing program, although contact is maintained with the developments of other space and airborne systems such as the Spacelab metric camera, side-looking airborne radar, thermal scanners and solid-state array cameras.

As in previous years, FMI has again completed an analysis of remote sensing priorities in forestry. The top priority is to advance Landsat interpretation to the point where satellite data can be consistently used to provide reliable land classifications, under a standard system of classification; this relates closely to the principal FMI objective of advancing remote sensing as a method for resource mapping in Canada. The second priority should be to support intensive forest management. This is followed by requirements to support damage assessment, fuel-type mapping, environmental monitoring and to develop methods for estimating forest biomass supply.

The remote sensing program has close ties with the FMI programs in forest appraisal and integrated resource surveys. Highlights in these programs have included new developments in low altitude sampling photography and the completion of biophysical surveys in several national parks. A listing of all FMI publications is available from the Forest Management Institute, Canadian Forestry Service, 396 Cooper Street, Ottawa.

Recent developments

In October 1978 the Department of the Environment decided to cut its forestry research program and in the process to move the remote sensing, appraisal, and integrated resources programs to the Petawawa Forest Experiment, 120 miles from Ottawa. As a result key personnel associated with these programs have decided to leave the Department and the forestry remote sensing research and applications programs have received a very severe setback.

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7.4 SPECIALTY CENTRE REPORT
LANDS DIRECTORATE
ENVIRONMENT CANADA

7.4.1 Introduction

The further development of remote sensing techniques for land use monitoring and ecological classification forms a key element in Lands Directorate programs. Operational survey methodology, resources inventory, provision of advice and training are components within these continuing activities. Staff with remote sensing research programs are now centred in Halifax, Ottawa, and Burlington.

7.4.2 Ecological Classification

LANDSAT imagery provides an appropriate data source for identification of major ecological land units. These can be identified at varying levels within a classification hierarchy developed through the Canada Committee on Ecological Land Classification. An ecoregion map of Canada based significantly on satellite imagery analysis will be completed in 1979. LANDSAT colour imagery and standard low-altitude aerial photography have been extensively used by Lands staff for ecological surveys in the Northern Yukon, Hudson Bay Lowland, Labrador, St. Lawrence North Shore and Maritime Coastal Zone in 1978-79. An in-house collection of colour LANDSAT images for all of Canada has now been compiled in Ottawa.

An evaluation of LANDSAT digital data has shown that monitoring of vegetation cover types and flooding in the Peace Athabasca delta can be accomplished effectively with this data source (Wickware). Similar use of such data for coastal resources and boreal land cover has been demonstrated (Prout, Rubec).

7.4.3 Land Use Monitoring

The interpretation of LANDSAT imagery for land unit description and use of the Canada Land Data System has been demonstrated as a practical methodology for identification of homogeneous Land Use Systems at 1:250,000 scale. The relationship of ecological land characteristics to land use is being explored at present (Rubec).

In late 1978, the arrival of Mr. Paul Rump to head the Land Use Monitoring Division gave new impetus to a national monitoring program. The utilization of aerial photography for updating the land data base in urban/rural fringe forms a key component in this program. An evaluation of urban expansion for 1971-76 is nearing completion for Canada's cities over 25,000 population (Warren, Gierman). Development of a land use sampling methodology and new classification system to permit data base update in 1981 is in progress (Rump, Gierman). Evaluation of airborne radar imagery, as part of the SURSAT Project, for land use and ecological classification is nearing completion. Two test areas in Manitoba have been examined (Rubec, Warren). The use of satellite digital data has also been demonstrated as a practical method for detailed monitoring of the forest/agricultural fringe in the Prairie provinces (Rubec).

7.4.4 Canada Land Data System (CLDS)

The Canada Land Data System stores and allows interactive computer graphics analysis of land data for all of Canada. The CLDS includes Canada Land Inventory (CLI) information covering about 2.6 million km^2 in southern Canada. The CLI provides land capability information on agriculture, forestry, wildlife, recreation and sportfishing. In addition, maps of land use, census enumeration areas, watersheds, etc. have been incorporated. Ecological land survey maps have also been recently entered into CLDS, demonstrating the ability of the system to handle land-related data from many sources and specializations (national parks, hydro-electric development, ecological baseline studies). The expansion of the land data in this system is proceeding at a rapid pace. Land data beyond the CLI region have been stored for analysis. These include forestry inventory and capability data from northern Alberta, Ontario, Nova Scotia and the Forest Management Institute. Regional user terminals in Halifax, Quebec City, Burlington, Winnipeg, Edmonton and Vancouver permit access to the CLDS data bank.

CLDS staff cooperate in a small, ad hoc working group with CCRS, Agriculture Canada and Statistics Canada on the development of data system links and formats for digital satellite information and geographic information such as CLI and census data.

7.4.5 Recommendations

(1) CCRS should assign high priority to research and development work towards establishment of direct links between digital analysis and computer information systems.

(2) The existing ad hoc Interdepartmental Working Group on Spatial Data Transfer Standards should encourage CCRS to develop software to implement data transfer between the Canadian Image Analysis System at CCRS and the Canada Land Data System at DOE.

(3) High priority should be given to the establishment of a committee at the technical management level to provide a more effective link between federal user departments and CCRS. Such a committee should annually define federal departments needs and priorities vis-à-vis remote sensing. This would allow CCRS to improve its awareness of the needs of other federal agencies by expanding its sources of information and cooperation.

7.4.6 List of 1978 Remote Sensing Reports, Publications and Papers

COWELL, D.W., G.M. WICKWARE and R.A. SIMS. 1979. Ecological land classification of the Hudson Bay Lowland coastal zone. Proc. 2nd Meeting Can. Comm. Ecol. Land Classif. (ed. by C.D. Rubec). Victoria, B.C. April 1978. Lands Directorate ELC Series #7. pp. 165-177.

PROUT, N.A. 1978. Development of automated land classification methods for Atlantic provinces coastal resources. Proc. 5th. Can. Sym. Remote Sensing, Victoria, B.C.

RUBEC, C.D.A. and J. THIE. 1978. Land Use Monitoring with LANDSAT digital data in southwestern Manitoba. Proc. 5th Can. Sym. Remote Sensing. Victoria, B.C.

RUBEC, C.D.A. and G.M. WICKWARE. 1978. Automated land classification in the boreal zone using LANDSAT digital data. Proc. 5th Can. Sym. Remote Sensing. Victoria, B.C.

RUBEC, C.D.A. 1979. Land Use Systems Definition Using LANDSAT and the Canada Land Data System. Lands Directorate, Ottawa. Internal Discussion Paper.

SCHUBERT, J.S. 1978. Computer Processing of LANDSAT Data as a Means of Mapping Land Use for the Canada Land Inventory. Canada Land Inventory Report #13, Ottawa. 72 p.

THIE, J., N. CHARTRAND and G. MILLS. 1979. Interpretation of an ecological data base using the Canada Land Data System. Proc. 2nd Meeting Canada Comm. Ecol. Land Classification. Lands Directorate, Environment Canada. ELC Series #7.

WICKWARE, G.M. 1978. Wetland mapping and environmental monitoring using digital LANDSAT data. Proc. 5th Can. Sym. Remote Sensing. Victoria, B.C.

8.1 REPORT OF THE CACRS AD HOC COMMITTEE ON THE ROLE OF EDUCATION IN THE NATIONAL REMOTE SENSING PROGRAM

8.1.1 Introduction

The development of remote sensing in Canada is well documented in the annual reports of the Canadian Advisory Committee on Remote Sensing (CACRS). A review of these reports indicates that no provision was made for the orderly and rational development of remote-sensing education in the national program. Education falls outside the mandate of the Canada Centre for Remote Sensing (CCRS) and it is not a major component of the provincial or specialty centres. Several educational institutions, however, have incorporated remote sensing into their programs. This has been achieved by individuals working in a variety of disciplines.

There has been a growing awareness that education has been lagging behind other aspects of the national program. In addition, there are no clear directions or guiding principles for the integration of education into the program. Concern with this situation was expressed when the following recommendation was passed at the April, 1978 meeting of CACRS:

> "It is recommended that an ad-hoc committee on the role of education in the national remote sensing program be established under the chairmanship of Dr. Phil Howarth" (CACRS, 1977 Report, p.8).

This report presents the initial thoughts and recommendations of the ad-hoc committee.

8.1.2 Committee Members

Members of the ad-hoc committee were selected from post-secondary educational institutions in Canada with active programs in remote sensing. Not all institutions could be invited to send participants. Members were selected to represent different geographical areas and the different disciplines involved in remote sensing. A list of persons who attended the major meeting of the committee held in Ottawa in December, 1979 is given in Appendix 1.

Several observers (Appendix 2) were also invited to participate in this meeting. Dr. Morley described events leading to the establishment of the ad-hoc committee and Dr. Slaney discussed his report presented to CACRS in 1977 (see Section 8.1.3). Information on the activities of the Associate Committee on Space Research of the National Research Council of Canada were presented by Mr. Hussain. Finally, Dr. Ingraham outlined the programs of the Natural Sciences and Engineering Research Council (NSERC) that are directed towards the funding of research at universities.

Three members of the committee met in Toronto in March 1979 to finalize the recommendations of the ad-hoc committee for presentation to CACRS.

8.1.3 CACRS and Education

It is important to emphasize that the deliberations of the ad-hoc committee do not represent the first time that CACRS has considered the question of education. In 1976, a CACRS committee headed by Slaney undertook a study "to investigate the need for the establishment of a training centre in remote sensing" (Slaney, 1977, p.138). The report of this committee provides information on educational activities in remote sensing prior to the CACRS meeting of April 1977. For example, Slaney (1977) cites recommendations from the CACRS Working Groups on Forestry, Wildlife and Wildlands, on Geography and on Geosciences that more attention be given to education in remote sensing.

The report also records the ways in which a person might develop expertise in remote sensing and documents the Canadian university and college courses in this field of study. Slaney (1977) points out that although the list of courses initially appears impressive, the remote-sensing content in many of them is minimal, perhaps only involving the use of a few aerial photographs in a discipline-oriented course.

The report concluded that the establishment of a training centre was "impractical" at present (Slaney, 1977, p.139). The committee members point out that "over the long term, the universities and colleges of advanced technology will deserve more of our attention because they will provide our next generation of scientists ..." (Slaney, 1977, p.138). They recommended the establishment of a CACRS Working Group on Education, but to-date this has not been formed.

Further CACRS interest in education was seen at the April, 1978 meeting when two invited reports on current education programs were presented. The first report by Murtha (1978) describes the interdisciplinary program in remote sensing that has recently been established at the University of British Columbia (UBC). The aim of this program is "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" (Murtha, 1978, p.90).

The second report presented by Wightman (1978) describes the remote sensing training program at the Nova Scotia Land Survey Institute (NSLSI). Building on a tradition of survey, cartography and photogrammetry, the training program was instituted in September 1977. Its aim is to provide students (already possessing a background in an environmental discipline) with the knowledge and technical expertise to undertake remote-sensing analyses in an operational setting.

It is with the background of the Slaney Committee report and the establishment of the programs at UBC and NSLSI that the present ad-hoc committee was established to look in broad terms at the role of education in the national remote sensing program.

8.1.4 Scope of the Report

The ad-hoc committee felt it important to focus attention on current remote-sensing activities in Canadian universities and colleges. Exchange of information on present programs and discussion of current concerns has led to the formulation of the recommendations presented in this report. Rather than present details on individual programs, it was decided to describe the current situation in educational institutions and outline the concerns and aspirations of faculty involved in training the next generation of remote-sensing specialists. The ways in which CACRS might facilitate this task are identified in the recommendations.

8.1.5 Role of the University

The university has four main functions. First, it has to provide education for the undergraduate. Increasingly, students registered in environmental science programs are recognizing the importance of remote sensing and are taking one or two introductory courses in this subject. As indicated in the Slaney Committee report, most universities offer introductory courses in remote sensing. These undergraduate courses are important. They often have large numbers of students registered in them, many of whom can make use of remote-sensing in their future studies. In addition, it is from the undergraduate programs that the future graduate remote-sensing specialists will emerge.

The second function of the university is to provide instruction at the graduate level. Some graduate students take remote-sensing courses as part of their general education. Others are concentrating their graduate work in remote sensing and thus make such courses core subjects in their programs. The extent to which a graduate student becomes involved in a remote-sensing program frequently depends upon the extent to which his supervisor is active in this area. Varying involvements from minimal to 100% of working time can be encountered.

A third area of emphasis in the university is research. Faculty members obtain funds for carrying out research projects, usually by application to national granting agencies such as NSERC (occasionally by application to provincial government sources of funding) or by undertaking research contracts for government and industry. The results of such work are usually published in scientific journals or conference proceedings.

A second and important aspect of research is the training of graduate students. Students are in part supported by the research projects being undertaken by faculty. The work that is done is written up as a thesis and examined by the university. It should be pointed out, however, that the life of a graduate student is not a sinecure. In addition to taking courses and writing a thesis, the graduate usually acts as a laboratory instructor, all for a salary of approximately $450 per month, out of which fees must be paid. The graduate student specializing in remote sensing today is the person who will become tomorrow's research scientist. It is imperative for the future advancement of our field of study that such persons receive the best training possible with adequate resources

available for this task.

A final role of the university is to provide continuing education through extension programs. As new technology develops, this is becoming an increasingly important task. Educators in remote sensing recognize that more attention has to be given to this aspect of their activities. Short courses and evening programs will provide an up-date for persons already involved in environmental disciplines or aerial surveys.

8.1.6 Role of the Technical Colleges

The purpose of technology education is to provide the necessary technical skills and knowledge for individuals to work efficiently and effectively in operational roles. These individuals come from a variety of educational backgrounds. Some enter college directly from high school graduation; others have had several years of employment or transfer to colleges from university programs. Many students have already obtained their bachelor's degree and are interested in obtaining specific occupational skills.

Across the country, a number of technical institutes or colleges of applied arts and technology offer individual courses of an introductory nature in air photo interpretation and remote sensing. These courses are part of programs in such areas as cartography, photogrammetry, planning, forestry and geology. In addition to full-time courses, these institutions are normally able to service the continuing education needs in many areas of study.

8.1.7 Universities and Colleges: Complementary Roles

University and technology programs perform complementary roles in the education of future remote-sensing specialists. The graduate student will become the research scientist and/or advanced educator. The person who graduates at the bachelor's level in an environmental science with some remote sensing is equipped with the knowledge to incorporate remote sensing into his or her studies. The technologist with a remote-sensing specialty will become the operational analyst studying imagery on a routine basis. Personnel from both educational systems are important elements in ensuring the adequate development of the national program.

8.1.8 Remote Sensing in Universities

Remote-sensing programs are located in departments which specialize in either space science or one of the environmental disciplines. A survey of Canadian activities in space science is provided in a report on "Canadian Research Opportunities in Space" prepared by Forsyth (1975). The Space Science Co-ordination office of the National Research Council oversees Canadian activities in space physics, astronomy, etc. and integrates the efforts of universities, industry and government agencies. In addition, a corporation representing several universities has recently been formed to co-ordinate experiments and applications for research support in space science.

Remote sensing is also located in the environmental disciplines. In most cases, a university will have no more than one or two environmental scientists who have made remote sensing their forté. Although a majority of remote-sensing courses appear to be offered in departments of geography, specialists can also be found in forestry, geology and soils, as demonstrated by the membership of the *ad hoc* committee. The disparate nature of these environmental scientists has led to little previous co-operative activity.

8.1.9 Funding of Educational Institutions

A point that is not always appreciated is the method by which university activities are funded. There are important differences between the funding of teaching and research.

8.1.9.1 Teaching. Federal and provincial monies are directed towards the support of teaching in universities, but the control of the funding is entirely provincial. The economic health of a post-secondary educational institution is largely determined by student numbers and the level of funding that is made available per enrolled student (basic income unit). Student fees also contribute to the total sum available. Although there are variations between provinces, the general pattern of development can be identified.

It is recognized that the 1960s was a period of rapid growth for educational institutions in Canada with increasing student numbers and financing readily available to establish new programs. Growth slowed in the first half of the current decade and the effects of inflation more than counteracted the increases that were made in

the basic income unit. It was recognized from demographic statistics that student numbers would start to decline round about 1982-83, but this has happened earlier than anticipated as fewer students have elected to continue in post-secondary education. It is thought that this is related to the high levels of unemployment among recent graduates and the general economic situation. In Ontario, for example, an average annual increase in student enrolment from 1970/71 to 1975/76 of 5.6% became a decrease of 2.8% over the previous year in 1977/78. Preliminary data for 1978/79 show a 2.5% decrease (Council of Ontario Universities, 1978). Declining enrolments and an annual increase in the basic income unit that fails to keep up with inflation are the root causes of the current financial problems in post-secondary institutions. The growth in the 1960s has become one of decline in the 1970s. In Ontario, for example, it is estimated that universities will have to reduce faculty by 10-15% over the next three years as part of an overall program of restraint.

As far as the situation in universities is concerned, remote sensing arrived a decade too late. Although remote sensing expanded during the 1970s, it has been difficult to develop viable programs within the universities. Expansion, with the appointment of new faculty and the provision of major funding for equipment, has not occurred in recent years. Where there have been developments in remote sensing, it has been the result of a group of individuals within the university obtaining support for the establishment of a program using existing facilities. Future developments will probably have to be based upon existing facilities, with the assistance of external funding.

8.1.9.2 Research. It is important to emphasize that research is an integral part of the university system. As pointed out earlier, it involves not only the investigations of individual faculty members, but also the training of graduate students. Research involving graduate students may be either theoretical or applied and may be done at the Master's or Doctoral level. Post-doctoral research is also an important element in established programs. Research at the Master's level tends to be application oriented, whereas research for a Ph.D. should be more theoretical in its design and at the same time explore "the frontiers of human knowledge". It is difficult to do this in remote sensing unless (as in most university research) adequate funding and equipment are available.

In contrast to teaching, most research funding comes from federal sources. Research grants are made available through several federal government agencies, but the major source of funding for university faculty is the Operating Grant of the Natural Sciences and Engineering Research Council (NSERC). University applicants are in competition with each other for the available funds, the disbursement of the funds being decided by peer grant selection committees. Within one subject area, it is obviously difficult to evaluate the relative merits of two widely differing research proposals, but in general terms university faculty feel that the system is fairly operated.

In the environmental disciplines, however, levels of funding are relatively small. In 1978-79, for example, the average size of the Operating Grant for faculty evaluated by one of the NSERC environmental committees was approximately $10,000. After the costs of airborne and/or satellite data, field work and student support are accounted for, there is obviously little, if anything, left for the purchase of equipment.

In addition to Operating Grants, NSERC has recently introduced a Strategic Grants program "to foster research in areas of national concern". Special emphasis in 1979-80 is being given to studies involving communications, energy, environmental toxicology, food/agriculture and oceans. Some aspects of remote sensing would appear to be suitable areas of study for inclusion in a Strategic Grants program; for example, topics related to the establishment of environmental monitoring centres.

As remote sensing only started to emerge in the universities in the 1970s, relatively small amounts of equipment are available in most institutions. Unfortunately, interpretation equipment is very costly and consequently is outside the limit of most research budgets. A few Equipment Grants are available from NSERC for major expenditures, but there is considerable competition for them.

A few other specialized grants are available. Full details of all these programs are given in the publication "Awards to University Staff" distributed annually by NSERC.

8.1.10 Current Programs

In spite of the difficulties described in this report, several remote-sensing programs are already established. There are a number of ways in which these programs have been implemented.

8.1.10.1 Interdisciplinary Program. The program at the University of British Columbia, described by Murtha (1978), is the only full interdisciplinary remote-sensing program in Canada. Faculty from the departments of computer science, civil engineering, forestry, geography and soil science contribute to it. The program has been approved by the university administration and funding has been made available by the university and the Province of British Columbia.

8.1.10.2 Technical Program. The only complete program in remote sensing at the technology level is offered at the Nova Scotia Land Survey Institute. This multidisciplinary program offers fifteen courses in photo-interpretation and remote sensing, which are equivalent to ten full credits. In addition, a thesis on a significant remote-sensing topic must be presented by each student in the program.

8.1.10.3 Sensor Development. A graduate program involving, among other things, sensor development is established in the Centre for Research in Experimental Space Science at York University. There are similar programs in space sciences established in a few other universities across the country, but York probably has the closest affinities with remote-sensing specialists in environmental disciplines.

8.1.10.4 Photogrammetric Base. In Laval University, a remote-sensing program has developed in a department which traditionally emphasized photogrammetry. Several courses are given at both the undergraduate and graduate levels, and at the present time a training program is being undertaken for a small group of foreign students.

8.1.10.5 Graduate Diploma. McGill University has established a Graduate Diploma in Environmental Remote Sensing. Students are able to choose from several existing courses and, in addition, must produce a project report. The diploma is seen as being "particularly appropriate for overseas students" and "Canadian students wishing to acquire a post-graduate training in remote sensing as an adjust to their first degree".

8.1.10.6 Interuniversity Program. The proximity of universities in southern Ontario aided the establishment in the early 1970s of an inter-university course on integrated aerial surveys. It has involved faculty and graduate students from the universities of Guelph, McMaster, Toronto and Waterloo. In recent years there has been increased emphasis on the remote-sensing component of the course. Graduate students registered in any university may enrol in the course.

8.1.10.7 Departmental Programs. The most common type of remote-sensing program is located in a department specializing in an environmental science. In many cases, the program is run by only one person, but very effective research work and training of students can nevertheless be undertaken.

No attempt has been made to identify universities where "programs" in remote sensing exist, as opposed to universities where one or two undergraduate service courses in remote sensing are given. Such a task, however, would be valuable and would help to sort out the plethora of courses listed in the Slaney Committee report. This information could be incorporated into a "Directory of Programs" which would give a good overview of the present situation in remote-sensing education in Canada.

8.1.11 Centres of Excellence

The ad-hoc committee briefly discussed the concept of "centres of excellence" or "centres of concentration". In the past, such centres have been established for several disciplines with the support of funds from the National Research Council (the federal source of university funding prior to the establishment of NSERC). The ultimate idea is that such centres should become self-supporting, but it is understood that this has not always worked as planned.

In principle, it is a logical manoeuvre to identify a few educational establishments as centres of excellence and therefore worthy of increased financial support. In practice, however, such a procedure is fraught with divisive elements as competing institutions vie for recognition and funding. At the present time, the need is for co-operation among specialists in educational institutions to bring increased attention to remote sensing.

A point for discussion is that educational institutions and regional monitoring centres can both be considered

centres of concentration for remote sensing. If the decision is made to establish regional monitoring centres, it would seem logical to place these in close proximity to educational facilities, whenever feasible. In this way, facilities and equipment could be made available for the complementary roles of monitoring and training.

8.1.12 Training Courses

The ad-hoc committee discussed training courses in remote sensing. Two types of program were identified. First is the brief training course or workshop lasting for no more than a week or two and designed to up-date Canadian scientists and managers in one or more aspects of remote sensing. Second, is the longer training course of perhaps two or three months duration that is provided for a specific group of individuals, often from developing countries.

Individual universities or groups of faculty from several universities obviously have the capability to present short remote-sensing courses. In fact, many of the short courses and workshops held in Canada between 1975 and 1977 (Slaney, 1977) involved university participation. To a certain extent, the initiative and organizational effort to mount such courses should come from individual faculty and universities. In some circumstances, however, the initial request for a training program is directed to CCRS. There have been a number of cases where CCRS has involved universities in the fulfilment of these programs, and this action is appreciated.

Members of the ad-hoc committee felt they should re-iterate the desire and capabilities of the university and college communities to participate in remote-sensing training programs. Educational institutions would be willing to jointly sponsor courses with government establishments and participate in training programs.

8.1.13 Working Group

This report has identified some of the activities of the university and college communities that contribute to the national remote sensing program. At the present time, discipline and technical working groups, specialty centres and the provinces have a direct input to CACRS, but there is no direct voice speaking for or answering questions related to education. The educational community is a relatively large and active one that wishes to make its contribution to the national program.

The ad-hoc committee would like to re-iterate the recommendation made by the Slaney Committee that a CACRS Working Group on Education be established. An important initial task for the Working Group to undertake would be the establishment of a Directory of Programs giving details on remote-sensing courses and programs in educational institutions across the country. In addition, the Working Group would be able to monitor the development of remote-sensing education in order to avoid excessive duplication and overlap in effort.

8.1.14 Recommendations

From the points discussed above, the ad-hoc committee has identified several actions by which CACRS might help teachers and researchers in universities and colleges make a larger contribution than at present to the national remote sensing program. These are as follows:

8.1.14.1 NSERC. It is recommended that the Chairman of CACRS write to the President of NSERC to

a) emphasize the importance to the national remote sensing program of funded university research in remote sensing,

b) ask for the establishment of an NSERC code category for remote sensing, and

c) suggest that remote sensing investigations be included within the "Strategic Grants" category.

8.1.14.2 Support. It is recommended that the Chairman of CACRS actively encourage CCRS to continue and expand its support in kind of university research by

a) ensuring that special pro-rated costs be implemented in the acquisition of airborne data for university research,

b) maintaining the policy of free access to CCRS analysis equipment for use in projects approved by CCRS, and

c) aiding in the support of university remote-sensing programs by all appropriate methods.

8.1.14.3 Grant. CCRS should act upon, and not just "consider" the recommendation of the April, 1978 CACRS meeting for "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", and have it implemented in the 1979-80 fiscal year.

8.1.14.4 Research Funds. In view of the limited research funds at present available to remote-sensing specialists, it is recommended that CCRS give "Announcements of Opportunities" on a regular basis (at least once a year), thereby permitting the university research community to act on these announcements. CACRS should also request specialty centres and other government agencies to take similar action, if possible.

8.1.14.5 Equipment. In view of the costs of equipment, it is recommended that, whenever possible, the facilities of regional monitoring centres be used for the dual purposes of monitoring and training. The positioning of such centres in close proximity to existing educational institutions would be appropriate.

8.1.14.6 Training. In view of their commitment to and expertise in teaching, it is recommended that university and college instructors be involved as much as possible in remote-sensing training courses and workshops for Canadian and overseas scientists.

8.1.14.7 Working Group. To provide on-going information to CACRS on matters related to education in the national remote sensing program, it is recommended that a CACRS Working Group on Education be established. The Working Group members should consist primarily of representatives from post-secondary institutions.

8.1.15 References

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8.1.16.1 Appendix 1

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8.1.16.2 Appendix 2

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8.2 An Insight Into the Problems of Landsat Technology in Forestry

Peter Kourtz
Forest Fire Research Institute
April 11, 1979

8.2.1 Introduction

Since the launching of the first earth resource inventory satellite in 1972, the Canada Centre for Remote Sensing (CCRS) has carried out a vigorous and successful program to develop a Landsat data processing technology. Unfortunately, during this time, CCRS has not had the authority to pursue a direct discipline-oriented applications program. As a result, applications are lagging far behind Landsat technology development. The time has come to closely examine the problems of application and to formulate policies and programs to speed up the transfer of this technology to the users. Landsat technology advancement will soon be halted by the political process unless the gap between applications and development can be narrowed.

In theory, at the very start of the Landsat program, potential users should have been communicating their interests to scientists involved in the software and hardware development. This did not happen mainly because of the advanced technical nature of the program, the difficulty in identifying potential users and the uncertainty as to the potential role that Landsat might play in the various resource orientated disciplines. Landsat technology has evolved relatively independent of our user community.

In fact, the situation is not too dissimilar to that of Canadian foreign aid programs and Third World's technology needs. We possess certain technologies that, we think, should be useful to them and that we are willing to share. However before the transfer process begins, whether we are considering industrial technology for the Third World or Landsat technology for provincial geographers and foresters the following questions should be answered. Is this technology really needed? How valuable is it? Who should get it? Are there not other alternatives? More simply put: is the technology appropriate for the given situation?

8.2.2 An Application of Landsat Technology by the Forest Fire Research Institute

Maps showing broad forest cover types that have similar burning properties can be made by manually grouping and colouring timber types on existing forest inventory maps. Such maps provide valuable information concerning the likely behaviour of fires and correspondingly, information to formulate the best control strategies. However, prohibitively high labour costs prevent the general production and use of these maps. Consequently a key set of information is unavailable for decision makers. Fire researchers working in conjunction with CCRS, by 1973, recognized that, through the use of Landsat digital classifications, maps surprisingly similar to the desired fuel maps could be produced for relatively little cost. The technology seemed to be appropriate and so we began the job of trying to apply the method in the field.

It is interesting to note that we played the role of a middleman in the transfer process having some knowledge of both the technology side and the provincial fire control operations side. Our provincial working arrangements and good field contacts permitted us access to provincial fire control operations. Our co-operative arrangements with CCRS ensured that their specialists and hardware were readily available for the project. A key factor in the transfer process centers around the Institute's policy of having researchers deal directly with provincial field personnel. This contact continues until application is ensured. This middleman approach to applications coupled with persistent followup may represent a model approach for future remote sensing applications.

Three phases can be identified in the application process. First, the potential Landsat user has to be made aware of the likely usefulness, limitations costs and benefits of the technology in his or her field of interest - the education phase. Here, CCRS and the Canadian Forestry Service, through their seminars, publications, demonstrations and personal contacts have played an important role in introducing foresters to the Landsat system. There still is a lot of work yet to be done. For example, many forestry field personnel are extremely sceptical of anything new, especially if it envolves computers. I believe that the reasons for this attitude are very personal and are related to perceived threats to their job security coupled with a lack of education necessary for even partial technical understanding. Regardless of the reasons for this distrust, if the final users cannot be convinced that technology may be appropriate, any application attempts can be sabotaged at the lowest user levels. Closely related to the education phase, is the motivation phase where the technologists and the users interact to conduct trials within the "near operational"

environment. Here, the necessary prerequisites are a field organization willing to permit such trials, technologists willing to babysit the user through the trials and incorporate the changes necessary to make it work, and finally a user group interested in conducting such trials. The third phase, the operational phase, involves expanding the trial approach into an operational system. For Landsat applications this phase may involve purchasing digital image processing equipment for inhouse processing, or alternatively, a commercial supplier will have to be found. Strong support, even in this phase, will be required from the research and development groups such as CCRS.

Early demonstration field trials of fire fuel maps using supervised and unsupervised classifications pointed out another problem in technology transfer. Field personnel, many experienced in photo interpretation, were interested in participating in the classification process. Computer produced classifications had little credibility. This difficulty was not overcome until the Taylor* enhancement was introduced. Enhancements represented a compromise between the technically advanced digital image classification and conventional aerial photography and were a product to which the user was easily able to relate. Success was achieved only when we introduced an "intermediate" technology that fell somewhere between the traditional and technologically advanced approaches.

The importance of the intermediate technology approach can be seen in the favourable response to the CCRS-ISIS "standard" product set. What is required now are more options for the user in the form of simple enhancements and better choices of scale. For example, the fire control community is most interested in obtaining photographic quality output, maybe 50 centimeters square or larger in size, that gives contrast stretched band 5, designed for road and logged area enhancement, at a scale of about 1:80,000.

Our attempts to apply part of the Landsat technology for fuel mapping appear to be paying off. The Outaouais fire control organization has used Landsat enhancements spanning a 9 million hectare area for operational decisions over the past two fire seasons. Currently we are redoing the area using updated imagery, improved quality output and a larger scale. This winter, enhancements were completed that cover 15 million hectares in North Central Ontario. We hope that these will be used in an operational trial this summer by the North Central Regional Fire Center and 6 fire control districts of the Ontario Ministry of Natural Resources.

8.2.3 Bottlenecks in Technology Transfer

In spite of our progress, applications are proceeding at a snail's pace. Several major stumbling blocks are in our way.

In the old days, new developments and corresponding applications, say in the aerial photography-timber inventory field, came about by the determination of a few highly motivated users who could see how to improve existing methods and procedures. However today, the complexity of digital processing insures that the developers and users are two distinct groups.

The challenge that confronts us is to develop appropriate remote sensing tools and, at the same time, ensure that the tools are used effectively. This requires communication and cooperation between the user and developer.

It would be relatively easy to solve the communication and cooperation problem if it were not for restrictive government mandates and policies. The federal government is a major developer of remote sensing technology while most of the users are the provincial governments and industry. The federal government sees the Canadian Forestry Service's role as limited mainly to researching and developing the forestry remote sensing tools and precious little to do with provincial or industry applications. Certainly any activity resembling a service to provinces or industry must be avoided and no encouragement is given to follow-up application attempts; although in fire research's case limited provincial application assistance is tolerated. Clearly no operational involvement is possible but it is a very thin line separating research application attempts and provincial operations.

What is required fy the federal government is a recognition that successful applications of remote sensing, at least in the Forestry sector, requires persistent followup by the developers and that this often requires close working arrangements between federal and provincial employees, often within an operational environment. Mandates must be broadened to permit and encourage followup applications.

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General policy guidelines under which federal agencies operate have a major bearing on technology transfer. Universities are not encouraged to compete for federal research dollars thus reducing the incentives for remote sensing educational opportunities.

The cost recovery policy discourages the inquisitive, yet poorly financed, potential user from becoming involved. The contracting out policy coupled with sometimes unrealistic financing procedures may prematurely encourage private industry to become involved before a user market demand has built up or may encourage over-competition for scarce federal and provincial dollars. I believe that it is the role of CCRS and the CFS to introduce the technology to the users and to take the large development and applications risks. Only when users approach the operations phase should industry be encourated to take over. In the Landsat case, even today, a company would find it difficult to earn a living without federal government contracts - not because the federal government is still supplying free or near free support to those wishing to experiment but because the potential users are, as yet, unwilling to pay the true costs. Only after the government agencies generate the demand will there exist a viable market for private industry.

8.2.4 Conclusions

In conclusion, there is an important need for a technology transfer program aimed at getting remote sensing technology out of Ottawa and into the hands of the users. I have outlined fire research's middleman approach involving considerations of how appropriate the technology is for various tasks, intermediate technology lying somewhere between the most advanced and the existing procedures, and perhaps most important, the persistent follow through on applications by the technologists.

Attempts must be made to broaden federal mandates to permit agencies such as CCRS and CFS to carry out active applications programs within provincially controlled resource fields. Policies to encourage vigorous university remote sensing programs must be developed. Educational support in this area now should significantly speed up the applications process in the future as well as reduce future costs.

While we still have the opportunity a development policy for a remote sensing industry should be laid out. Consideration should be given to the number and ownerships of companies encouraged to participate, the function and allocation of federal research and subsidy funds, a distribution policy for software that avoids wasteful competition, reasonable national standards in hardware to avoid reinventing the software wheel, and encouragement and assistance for foreign marketing activities.

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8.3 A SUGGESTED APPROACH TO ENVIRONMENTAL MONITORING CENTRES

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8.3.1 The Need for an Environmental Accounting System

Before discussing environmental monitoring centres, I'd like to discuss environmental monitoring and before discussing environmental monitoring, I'd like to present an analogy: I'd like you to visualize the savings department of a bank. Even in these days of inflation most people still have savings accounts. For each account there is a card on which the transactions are listed. When I worked for the Royal Bank 40 years ago we didn't have cards, we had ledgers - great heavy ones - and one of my duties was to heave these into the vault at night and out in the morning. However, now there are cards, usually backed up by computer files.

One of the time-consuming tasks in a Savings Department used to be computing the half-yearly interest on the minimum balance. This had to be done as of the last day of June and the last day of December. We planned ahead for weeks and if we finished by midnight we were lucky - and no overtime. I'm not current on bank procedures but I'm sure that is done by computer batch processing nowadays. Now, imagine a situation where all the interest calculations would be made, and totalled but not added to the individual accounts. They'll all be listed; any clerk would be able to look up the interest that Dr. Morley's account had earned for any particular quarter but no entry would be made to his account. Imagine then the confusion whenever Larry wanted his pass book up-dated. Chaos! Information pollution!

To elaborate on the analogy it is as if we fed the bank's computer a list of all the Savings Account balances and nothing else, as of a certain date. The bank's computer could list the interest but it might or might not be computed on the minimum balance and the only way to find which account it went to would be to count down the sequence and conclude that the 57th interest credit belonged to the 57th balance listed.

Now, how does this relate to remote sensing? What is the point in this analogy? LANDSAT and its associated hardware and software are comparable to the computer that could quickly work out and add the changes to our environmental accounts - but the problem is that we don't have any environmental accounts to add them to.

Why haven't we got a system of account numbers for the basic units of our renewable resources? The reason, very briefly, is that until recently no one cared. Canada was a country with unlimited forests and unlimited agricultural land; why bother? All that decision-makers wanted to know was where the exploitable resources were located. It's less than a decade ago that the Assistant Deputy Minister responsible for New Brunswick forests assured me that the province was growing four times as much wood as it could sell and that their only problem was harvesting and marketing. That ADM didn't know what he was talking about! Now a shortage of wood is predicted within a very few years.

We haven't got account numbers because until recently decision-makers didn't want to be confused by facts. Let's face it, it's a lot easier to make a political decision without facts than it is with facts. But times are changing, and some of the intuitive decision-making is beginning to boomerang. When this happens facts can provide a very welcome cover. The possibility that Reye's syndrome may be caused by budworm spray solvent is one of the most important discoveries of the past decade for remote sensing. Our decision-makers could live with the spruce budworm but they can't live with irate parents' groups. In other words, the consequences of managing resources with limited information are beginning to hurt.

Dr. Gordon Baskerville headed a task force for the province of New Brunswick on alternatives for combatting the budworm. His conclusion, briefly, is that intensive management is the best solution. To demonstrate his point he developed a modelling program with the acronym WOSFOP (Wood Supply and Forest Production) to predict annual allowable cuts for the next few decades. WOSFOP (and similar programs in Nova Scotia, Québec and elsewhere) have created an instant demand for a forest information system.

Almost at the same time, a task force on agricultural resources discovered the obvious fact that the Maritimes are heavy importers of agricultural products. The recommendation: Double the agricultural out-

put by improving existing farmland and by bringing additional land into production. This recommendation has been converted into a $35 million GDA (General Development Agreement); this, in turn has raised countless questions about where the money should be spent.

Both of the above cases are discussed in some detail in a study completed last fall entitled "Remote Sensing for Renewable Resource Monitoring in the Maritime Provinces". For that study I assembled a flow chart showing the main elements and the flow of information to meet the needs for renewable resource management in the Maritimes. This was critiqued at a one-week workshop in Moncton in January - a summary of which was prepared by Josef Cihlar and distributed before CACRS. The flow chart is attached.

8.3.2 Centres

As part of my study last year I visited the Ontario Remote Sensing Centre and the Alberta Remote Sensing Center and after considerable reflection recommended against the creation of a Maritime centre similar to either of these. As an alternative I recommended that projects be identified for joint action by those groups where either the need or the capability existed. In other words, I recommended a strategy of building on strength. Specifically:

In each province I can see the rationale for:

1. An agriculture data base to which there would be an input of LANDSAT data on a scheduled basis. To be effective this data base must be proprietary with the provincial departments of agriculture.

2. A forestry data base to which there would be an input of LANDSAT data on a scheduled basis. To be effective this data base must be proprietary with the provincial departments of forestry.

3. A continuing education effort at each university and technical institute where there are programs or courses on remote sensing (e.g. forestry, agriculture, surveying) and where there is at least one specialist with appropriate equipment, etc. to give courses as part of the regular program and to offer (or arrange for) extension courses as required.

In essence the question of one centre versus an overall improvement in facilities is another version of the classic military debate between the merits of having one small elite unit such as a Commando Force at the expense of weakening regular army units, or of strengthening all the units. There was a time a few years ago when elite Centres were needed. In my view that time is past. In fact, in New Brunswick, I'm sure it would be counter-productive.

In Nova Scotia there are two foci for remote sensing (excluding the federal agencies in Halifax):

i) The Nova Scotia Land Survey Institute in Lawrencetown;

ii) The Department of Lands and Forests in Truro.

There is close cooperation between these two and recently John Wightman at the Institute has made a giant leap forward by initiating a two-year remote sensing technician course and by getting a Canada Works project for land identification in the Annapolis Valley.

The Department of Lands and Forests have conducted tests over the Cape Breton Highlands and are recognized as the most advanced group in remote sensing applications to forestry in the Maritimes.

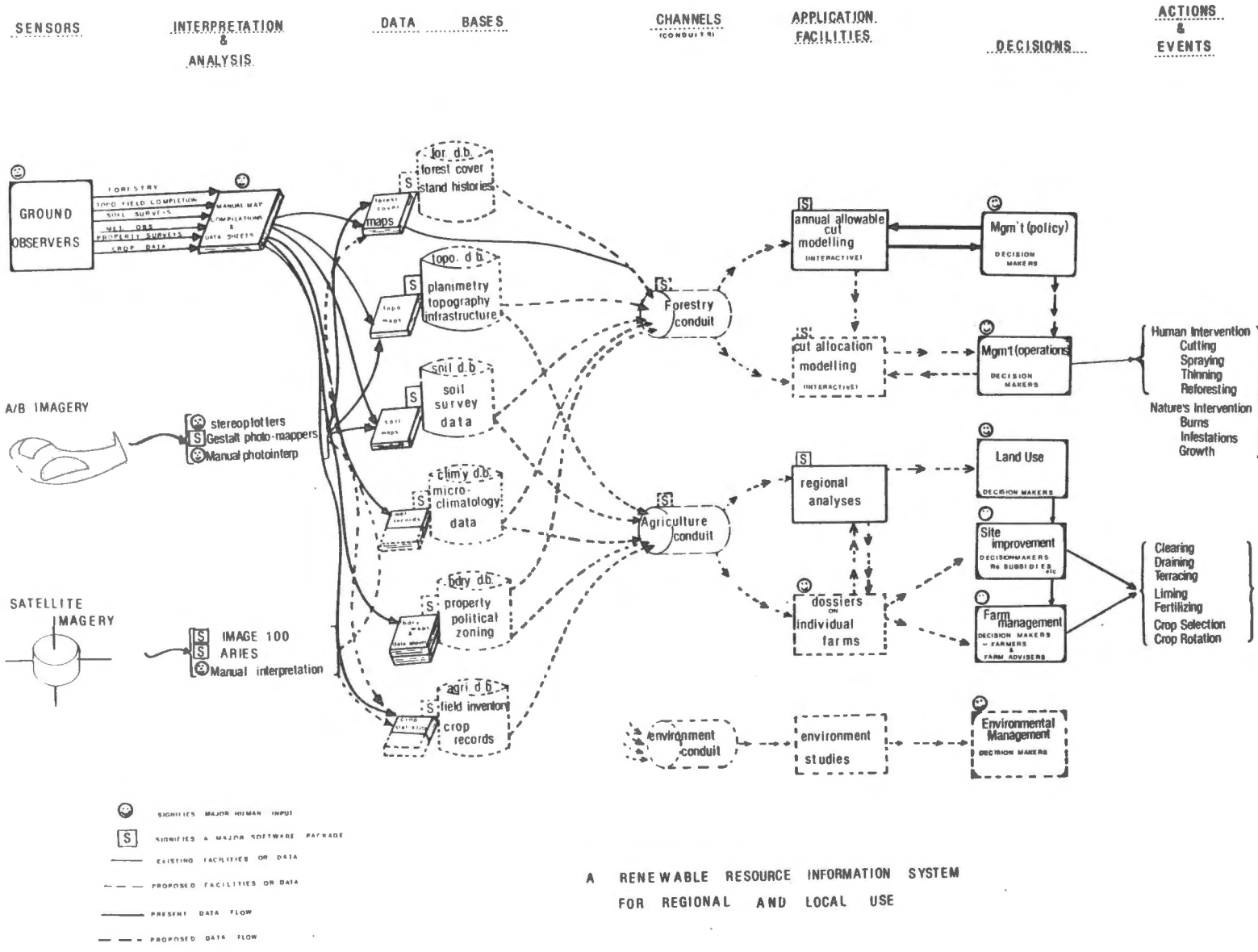
In New Brunswick remote sensing courses are offered in the forestry and in the surveying engineering programs at U.N.B. The Department of Agriculture has co-operated with CCRS in a project to identify potato acreage and currently the Department of Agriculture has received confirmation of a Canada Works project to do a field inventory of all farmland in New Brunswick. This data will be compiled at the Surveying Engineering Department at U.N.B. and will provide the ground truth for a research project by a Ph.D student on development and updating of a farmland data base.

The situation in P.E.I. is less clear but it is obvious that both the Department of Agriculture and the Land Use Service Centre should be involved.

The conclusions then are:

i) To use existing educational centres for promotion and for general dissemination of information on remote sensing.

ii) To develop a renewable resource information system by linking data sources and decision-makers in an integrated network.



A RENEWABLE RESOURCE INFORMATION SYSTEM FOR REGIONAL AND LOCAL USE

Figure 1

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9.0 UPDATE TO THE REPORT OF THE ACTION TAKEN BY CCRS AS A RESULT OF THE 1977 CACRS RECOMMENDATIONS

In the 1977 CACRS Report, all the recommendations made were compiled in Section 3 and comments by CCRS followed each recommendation. Most of the comments made at that time are still valid, but the following additional comments are published now, based on new facts and actions. The numbers cross-reference to the 1977 CACRS Report.

3.4.3 We are presently modifying the Shoe Cove Station in order to receive, process, and distribute TIROS-N and VHRR data.

3.7.3 See response to 3.7.5.

3.7.9 Experimenters have not yet received SURSAT data in adequate quantities for us to judge the validity of the concern which gave rise to this recommendation. We still believe that SURSAT will not unduly strain image analysis support facilities.

3.7.10 SURSAT includes several experiments which provide access to international sources of ground truth.

3.7.11 Two current projects make use of Canadian experience in water colour measurements to estimate various water quality parameters. NIMBUS-7 coastal zone colour scanner data will be an integral part of these studies. Preliminary results are expected to be available in early 1980.

3.7.12 Access by Canadian researchers to NIMBUS-7 coastal zone colour scanner data is being coordinated by Dr. Harold Zwick of CCRS. A wide spectrum of digital and analogue image analysis devices are available for the study of CZCS image products, at the Applications Division Laboratories.

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11.0 TABLE OF ACRONYMS USED IN THIS REPORT

AES	Atmospheric Environment Service, DFE
AMOP	Arctic Marine Oilspills Program (Canada)
ANIK-B	DOC communications satellite
APT	Automatic Picture Transmission
ARIES	Interactive remote sensing interpretation system (FMI)
ARS	Airborne remote sensing
ARSC	Alberta Remote Sensing Center
ART	Airborne Radiation Thermometry
CACRS	The Canadian Advisory Committee on Remote Sensing
CCIW	Canada Centre for Inland Waters, DFE
C-CORE	Centre for Cold Ocean Research Engineering, Newfoundland
CCRS	Canada Centre for Remote Sensing, EMR
CCT	Computer-compatible tape
CFS	Canadian Forestry Service, DFE
CHS	Canadian Hydrographic Service, DFE
CIAS	CCRS Image Analysis System
CIDA	Canadian International Development Agency
CIR	Colour Image Recorder (CCRS)
CLDS	Canada Land Data System (DFE)
CLI	Canada Land Inventory (DFE)
CNES	Centre national d'études spatiales (France)
COMSS	Coastal Ocean Monitoring Satellite System, a proposed ESA program
CQCT	Centre québecois de coordinateur de la télédétection
CRC	Communications Research Centre, DOC
CRESS	Centre for Research in Experimental Space Science (York University)
CZCS	Coastal zone colour scanner
DCIEM	Defence and Civil Institute of Environmental Medicine, DND
DCP	Data Collection Platform
DFE	Department of Fisheries and the Environment
DICS	Digital Image Correction System
DND	Department of National Defence
DOC	Department of Communications
DOE	Department of the Environment (see DFE)
DPD	Data Processing Division, CCRS
DREO	Defence Research Establishment Organization, DND
DSS	Department of Supply and Services
EB(I)R	Electron beam (image) recorder
EMR	Department of Energy, Mines and Resources
ERIM	Environmental Research Institute of Michigan
ERTS	Earth Resources Technology Satellite (U.S.) (Name changed to LANDSAT January/75)
ESA	European Space Agency
ESMR	Electronically scanned microwave radiometry
FCIR	False colour infra-red
FFRI	Forest Fire Research Institute, DFE
FMI	Forest Management Institute, DFE
GEOS	Geodetic Satellite (NASA)
GOES	Geostationary Operational Environmental Satellites (2/5) SMS - Synchronous Meteorological Satellite
IACRS	The Inter-Agency Committee on Remote Sensing
IAP	Image Analysis Processor
ICAS	Interdepartmental Committee on Aerial Surveys
IISS	Image Inventory Search and Summary (CCRS)
IMAGE-100	Interactive Multispectral Image Analysis System (CCRS)
INRS-EAU	Institut national de la recherche scientifique sur l'eau (Université du Québec)
IPTASC	Interprovincial/Territorial Advisory Subcommittee to CACRS
IR	Infra-red

ISIS	Integrated Satellite Imaging Systems Ltd.
ISISFICHE	Daily LANDSAT coverage of Canada produced on microfilm by ISIS
ISP	International Society for Photogrammetry
JSC	Johnson Space Center (NASA)
LACIE	Large Area Crop Inventory Experiment (US)
LANDSAT	US Remote Sensing Satellite (Formerly ERST)
LASS	Land Applications Satellite System, a proposed ESA program.
LS-D	LANDSAT-D
MAD	Bendix Multispectral Analyzer Display (CCRS)
MDA	Macdonald, Dettwiler and Associates Ltd., Vancouver
MEIS	Multispectral Electro-optical Imaging System (CCRS)
MIPS	Multi Image Processing System (PASS)
MMS	Multimission Modular Spacecraft
MSS	Multispectral scanner
MUN	Memorial University of Newfoundland
NAPL(RC)	National Air Photo Library (Reproduction Centre), EMR
NASA	National Aeronautics and Space Administration (US)
NIMBUS	Weather and Earth Atmosphere Satellites (US)
NOAA	National Oceanographic and Atmospheric Administration (US). Also a series of environmental satellites operated for that Administration.
NORDCO	Newfoundland Oceans Research and Development Corporation
NRC	National Research Council (Canada). Now Natural Sciences and Engineering Research Council.
NSRSC	Nova Scotia Remote Sensing Centre
NSLSI	Nova Scotia Land Survey Institute
NTS	National Topographic System
OAS	Ocean and Aquatic Sciences, DFE
OCRS	Ontario Centre for Remote Sensing
OMNR	Ontario Ministry of Natural Resources
PASS	Prince Albert Satellite Station
PFRC	Pacific Forest Research Centre, DFE
PNFI	Petawawa National Forestry Institute, DFE (a merging of several forestry institutes including FMI and FFRI).
QL	Quick-look
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
SEASAT	Ocean parameter observing satellite (USA) (1978)
SKYLAB	Manned space station (US)
SLAR	Side-Looking Airborne Radar
SMMR	Scanning Multifrequency Microwave Radiometer
SPOT	Satellite pour l'observation de la Terre (France)
SURSAT	Surveillance Satellite Program (Canada)
SYDOSAT	Système de documentation sélective automatique sur la télédétection
TIROS-N	U.S. meteorological satellite
TM	Thematic Mapper, a sensor on LANDSAT-D
UAMU	User Assistance and Marketing Unit (CCRS)
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UTM	Universal Transverse Mercator System
VHRR	Very High Resolution Radiometer (AES instrument)
VISSR	Visual Infrared Spin Scan Radiometer (a sensor on the GOES Satellite)
WIPS	Weather Information Processor System (AES)
WMO	World Meteorological Organization

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