UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

RECENT ACTIVITIES REFLECTING THE MAPPING CAPABILITIES OF LANDSAT

By Alden P. Colvocoresses

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GEOLOGICAL SURVEY
RESTON, VA. 22092

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February 2, 1982

Memorandum for the Record (EC-80-Landsat/Mapsat)

By: EROS Coordinator, National Mapping Division

Subject: Recent Activities Reflecting the Mapping Capabilities of Landsat

During the past 2 years a large number of Landsat mosaics and image maps have been produced by various agencies worldwide. In fact it would appear that Landsat image products may soon be available for most of the land masses of the Earth. These products vary greatly as to form, scale, and positional accuracy, and many are little more than pictures of the Earth and can hardly be classified as maps. However, several serious efforts are being made to incorporate Landsat data into existing mapping programs. In addition to line and image mapping, Landsat data is being transformed into a wide variety of thematic products principally associated with land use and land cover. This memo does not cover such products (except for reference to one thematic portrayal of Bangladesh), but they are recognized as valuable cartographic products which warrant a separate status report. Listed below are selected mapping efforts which have been reported to the undersigned and which are considered significant to the mapping community.

1. The World Bank has prepared 1:500,000-scale color image maps of Nepal and Bangladesh which were printed during 1981. The Nepal project consists of two sheets, each printed in two versions, one ungridded and the other with a full Universal Transverse Mercator (UTM) grid. Since only a few widely scattered and poorly identified control points were available, these maps do not meet accepted accuracy standards and the rms positional error is estimated at about 1 km. However, since this was a basically unmapped area the products are significant.

The Bangladesh project resulted in two ungridded image maps, one portraying land cover, soil, and water conditions; and the other, land use. Both maps are based on the same imagery and each covers the entire country. Their positional accuracy has not been tested, as they are referenced only by 30-minute geographic edge ticks and do not carry a full grid.

Both the Nepal and Bangladesh products exhibit very fine image enhancement and reproduction. They contain considerable cartographic data in the form of names, communication routes, and boundaries; and, in one case (Bangladesh), land use categories. A second printing of these (and other) Landsat derived maps are now on sale through the World Bank. The Bank also plans to produce and sell similar type image maps of Bhutan and Peru. Further information may be obtained from:

Dr. Wolfram Drewes
Resources Planning Unit
Agriculture and Rural Development
World Bank
Washington, D.C. 20433
U.S.A.

2. Surveys and Mapping Branch of Canada has an active Landsat program aimed at map revision. Their recent work is reported in a paper "Monitoring Revision Requirements for Canadian Maps," by E. A. Fleming; a copy is enclosed. It is believed that the use of Landsat as being made by the Canadians is also applicable to many other regions of the world where conditions and requirements are similar. The implied economic benefits to the Canadian mapping program at scales of 1:50,000 and 1:250,000 are particularly significant. Further information is available from:

Surveys and Mapping Branch
Energy, Mines, and Resources
615 Booth Street, Ottawa
Ontario KIA 0E9, Canada

3. Division of National Mapping, Australia has been utilizing Landsat for various map-related projects. A short paper by Klaus Leppert summarizes this use and a copy is enclosed. Use of Landsat in heretofore unmapped areas and the discovery of an uncharted reef, now reportedly known as Landsat Reef, are significant. Although not specifically reported, the various States of Australia, which conduct the larger scale mapping, are also using Landsat for a variety of cartographic applications. Further information is available from:

Director
Division of National Mapping
(NM 81/392), P. O. Box 31
Belconnen ACT 2616, Australia

4. Papua New Guinea (PNG) - University of Technology - A shallow-sea pilot mapping project involving the extensive unmapped coral reef areas east of the New Guinea island has been initiated. These areas have a large fisheries potential but are basically inaccessible because of their unmapped status. The University of Technology (Lae) is obtaining support from the PNG Departments of Transportation and Fisheries which, in turn receives Australian support. The area has considerable cloud cover and will be beyond the Australian Landsat Station's range with the demise of Landsat 3. However, existing and projected Landsat 3 coverage provides a data base which should permit the delineation of the coral reefs and provide considerable water depth information. Further information is available from:

R. J. Lyons
Department of Surveying
University of Technology
Lae, Papua New Guinea

5. British Royal Aircraft Establishment has developed a Landsat mosaic of the United Kingdom. This mosaic has been updated in the June 1981 issue of the Chartered Surveyor. It involves 43 Landsat images and was digitally enhanced and controlled to 1200 ground points. It is cast on the projection of the National Grid and has a reported accuracy of 50 m. This mosaic has been published in color and is currently on public sale. Further information is available from:

National Remote Sensing Centre
Royal Aircraft Establishment
Farnborough, England

6. United States Defense Mapping Agency Hydrographic/Topographic Center (DMAH/TC) is utilizing Landsat to revise selected nautical charts of the shallow seas. James Hammack of DMAH/TC has recently confirmed the existence of a heretofore uncharted small reef at approximately 5°38' S and 118°21' E in Indonesia. Existing charts show depths of over 200 m whereas the reef actually has a minimum depth on the order of 7 m. Since this shallow reef lies midway between two large reefs in what was assumed to be an open channel, it constitutes a potential hazard to shipping. There is no question that Landsat data, when properly processed and interpreted, permits the revision and/or recompilation of some nautical charts and the actual mapping of uncharted shallow sea areas. Further information is available from:

Director
DMAH/TC
6500 Brookes Lane
Washington, D.C. 20315
U.S.A.

7. U.S. Geological Survey (USGS) has recently completed or is involved in several Landsat based mapping projects as follows:

(a) Arabian Peninsula - One sheet at 1:2,000,000 scale on a Lambert conformal projection is being printed in duotone (brown and black) which covers the whole peninsula. A portion of the Kingdom of Saudi Arabia (Precambrian Shield area) is also being covered by approximately 40, 1:250,000-scale 1° by 1.5° quadrangles on the UTM projection. They carry a line graticule, accuracy statement, and are being printed in duotone (brown and black). The entire Kingdom is also being covered by 21, 1:500,000-scale color enhanced quadrangles controlled to and cast on local Lambert conformal projections. Possible availability, through public sale, is currently being investigated.

(b) Cape Cod Area - Landsat-3 return beam vidicon (RBV) imagery is being compiled into 1:100,000-scale image maps to demonstrate the RBV cartographic capability. Current plans are to produce a 0.5° by 1.0° quadrangle (New Bedford) and a special format image map of the entire Cape Cod area east of the Cape Cod Canal. Both products will be controlled and gridded (UTM) and carry accuracy statements. They are planned as general-purpose products but will probably also serve as a base for the overprinting of geologic and other thematic data. Final form will be black and white or brown and black (duotone) with limited names data. When printed (date not set) the image maps will go on public sale.

(c) Mexico - USGS and the Mexican Secretariat of Public Works and Human Settlement have an informal agreement by which the USGS will provide technical advice on the preparation of 37 State-based Landsat color infrared mosaics at scales from 1:250,000 to 1:1,000,000. They are controlled to the U.S. Defense Mapping Agency (USDMA) 1,000,000-scale Operational Navigational Chart (ONC) series and are thus cast on local Lambert conformal projections. They will carry a graticule and selected cartographic annotations such as principal roads, urban areas, and boundaries. They are intended principally as a planning base for future development. Selected sheets will be printed by the USGS and may or may not go on public sale. First printing is expected during January 1982.

(d) Antarctica - The USGS has plans for publishing additional Landsat image maps of Antarctica. Sheets currently in work are the Ronne Ice Shelf, Berkner Island and Filchner Ice Shelf quadrangles, all at 1:1,000,000 scale. When published (date not set) these maps will go on public sale. USGS researchers (Williams, Ferrigno, Kent and Schoonmaker) have prepared a comprehensive report on the Landsat mapping of Antarctica by all nations. This report is scheduled for publication in the Annals of Glaciology during 1982.

(e) Landsat Station Coverage Map - The USGS has prepared a new index map indicating Landsat station coverage on a global basis. Once Landsat D is in orbit, hopefully by the end of July 1982, the use of Landsat 2 and 3 will be quite limited and D has no tape recorder. Therefore, coverage will basically be limited to the dashed circles indicated on the enclosed coverage map. This index map supplements a similar one which appeared in the September 1981 issue of the Landsat Data User Notes of the EROS Data Center, USGS.

(f) Landsat Index Maps - Another related product is a series of 26 index maps at 1:10,000,000 scale which indicate the paths and rows of Landsats 1, 2 and 3 on a global basis. These maps are now printed and are available through :

EROS Data Center
Sioux Falls, South Dakota 57198
U.S.A.

A second printing is planned following the successful launch of Landsat D in which case the path and row indicators for Landsat D (then known as Landsat 4) will be printed on the back of the sheets.

A study is being made relative to the addition on the front side, by overprint, of a summary status of the actual images available for each nominal scene (defined by paths and rows) as obtained by Landsats 1, 2, and 3.

Further information on the described USGS products and activities may be obtained from:

Chief, National Mapping Division
U.S. Geological Survey
Attention: Mail Stop 520
Reston, Virginia 22092
U.S.A.

Alden P. Colvocoresses

Alden P. Colvocoresses

Enclosures:
Canadian Paper
Australian Report
Landsat Receiving Station Coverage Map

MONITORING REVISION REQUIREMENTS FOR CANADIAN MAPS

E.A. Fleming

Topographical Survey Division

Department of Energy Mines and Resources

Ottawa

SUMMARY

The two principle topographic map series for Canada are the 1:250 000, for which there is complete coverage of the country and the 1:50 000 which is 66% complete. The total maps in these two series which are entered into revision cycles now numbers 9491 and is increasing at the rate of 400 maps per year. Innovative techniques using Landsat imagery are being developed which will facilitate map revision in many parts of the country. Revision of 1:250 000 maps using Landsat as the primary information source is proving operationally feasible. Change detection studies at 1:50 000 are making it possible to plan aerial photography over the areas showing most change and to re-validate those maps on which no change is detected. The geographical areas of the country where these techniques are applicable are being defined.

Prepared for the 7th Canadian Symposium on Remote Sensing, Winnipeg, September 8-11, 1981.

INTRODUCTION

Topographic maps are a form of inventory of the earth's surface, and, like any inventory, they must be kept up-to-date if they are to be useful. The map scales for which the Topographical Survey Division is responsible are the 1:50 000 and 1:250 000. The latter scale, with 918 maps, is the largest scale offering complete coverage of Canada. The 1:50 000 series is now 66% complete and total coverage is anticipated by 1992. Considering both scales there are, today, 9491 maps entered into revision cycles and the number is increasing at the rate of about 400 maps per year.

The frequency with which a map is revised is based primarily on the degree of settlement within the area. However defining revision cycles and achieving them are two different things. Although the present map production rate keeps pace with new revision requirements, a backlog of outdated maps has been inherited from earlier years. Currently there are 230 maps in the 1:250 000 series and 885 maps in the 1:50 000 series in this undesirable status.

In a country as large as Canada, and with the resources for mapping limited, it is essential that these resources are used in the most effective manner. Many advances have been made in recent years to accelerate the production of new maps, but revision mapping has remained the labourious process of collecting information on change from many sources and obtaining and analyzing new aerial photography. Because of the inability to predict how many changes will be required on a map sheet before all the data are collected, production planning of revision work is difficult.

However radical changes in approach are now on the horizon, as the impact of Landsat imagery analysis on revision planning is being studied in an operational mode for both the revision and the monitoring of revision requirements of Canada's two principal topographic map scales.

REVISION REQUIREMENTS: 1:250 000

The 1:250 000 map series for Canada was completed in 1970 with an up-dating program already in effect. The rate of up-dating maps has never kept pace with the rate prescribed by revision cycles for urban (10-yr), rural (15-yr) or remote (30-yr) areas. The rate of revision in each of the regions during the past 10 years is shown in figure 1. The current back-log of maps which are now off-cycle and the rate at which these will increase is shown by the break in the graph line.

Part of the slowness in revision of this series was due to tying it to the completion of all the 1:50 000 maps comprising each 1:250 000 sheet then deriving from these an up-dated 1:250 000 map. This still remains the most desirable approach to a high quality 1:250 000, however it has been recognized that other means must be used if the entire series is to remain at a useful level of currency.

In remote areas where the bulk of the maps lie (685 maps) changes will tend to be limited to the development of settlements and the construction of roads, pipelines, power lines or reservoirs. Many sheets will show no change whatever in a 30-year interval. It is in this area that the use of Landsat imagery can have its greatest impact.

OPERATIONAL DEVELOPMENTS IN THE USE OF LANDSAT FOR 1:250 000 MAP REVISION

Early studies of the application of Landsat to mapping showed the potential for the extraction of revision information (Fleming, 1976). In 1979 a comprehensive test that compared the extraction of revision information from Landsat with that obtained from aerial photography was carried out by Topographical Survey (Fleming, 1980). The results of this test showed that in areas of low population density and a vegetative land cover, change detection was complete and in fact the major changes, which at this map scale were linear features, could be plotted from the imagery for direct revision of the map base.

In 1980, a two-year development contract was awarded to Gregory Geoscience Ltd. who had done the Landsat interpretation on the initial test (Moore, Gregory 1979). The purpose of this contract, which is being carried out in close cooperation with the staff of Topographical Survey, is to develop operational techniques leading to the revision of 1:250 000 maps from Landsat data.

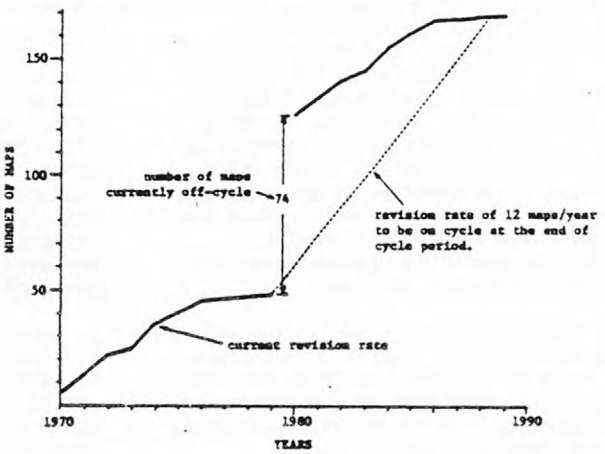
To move from feasibility studies to operational techniques means that many things aside from the interpretation of the

Figure 1

MAP REVISION WORK-LOAD FOR 1:250 000 TOPOGRAPHIC SERIES IN EACH CYCLIC AREA

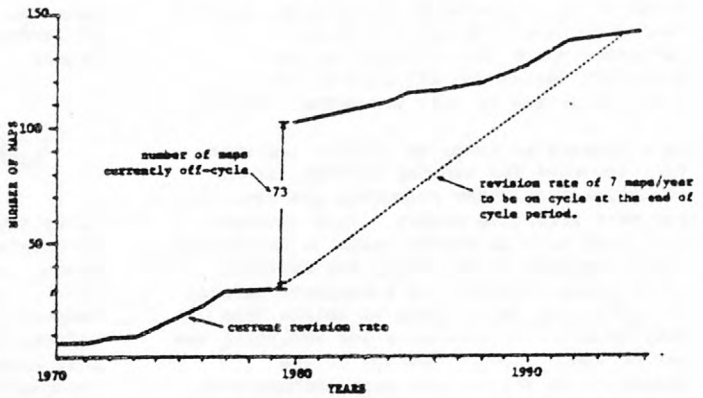
(a) URBAN AREAS

123 MAPS ON A 10-YEAR CYCLE



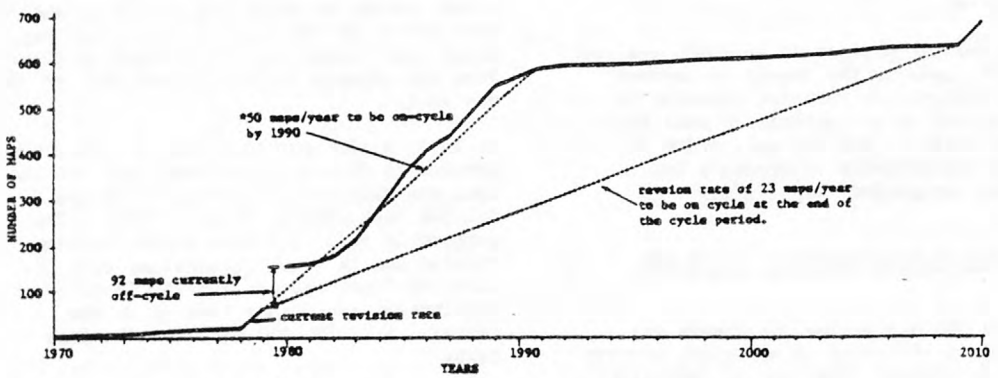
(b) RURAL AREAS

110 MAPS ON A 15-YEAR CYCLE



(c) REMOTE AREAS

685 MAPS ON A 30-YEAR CYCLE



* The heaviest revision load occurs during the next 10 years, reflecting the concentrated effort made in 1950-60 to complete the 1:250 000 series.

Landsat imagery must be considered, although this also requires extended consideration. It is known for example that change detection is reliable where some type of forest cover exists, but as the vegetative cover diminishes it seems likely that the reliability of Landsat as the primary source of revision information will also diminish. It is therefore necessary to classify the terrain areas of Canada where Landsat is effective before it is possible to incorporate these techniques in revision programs on a long term basis.

The information extracted from Landsat must be coded in a consistent manner that is meaningful to the map compiler. Innovative approaches must be used because the information and the extraction of the information is not precisely the same as when using conventional aerial photographs. For the 1:250 000 scale, position information of linear features can be more easily obtained from Landsat than from trying to piece together larger scale aerial photographs or construction plans, but it is more difficult to say whether the linear feature is a new road, railroad or pipeline from the Landsat image alone. Supplementary information is required.

The completeness and accuracy of the final revision must be verified. Although this is a routine process for 1:50 000 mapping, techniques for carrying out such work over the area of a 1:250 000 map have not been considered in the past. Again, new standards and effective procedures must be evolved before this change in revision method can be considered operational.

Landsat Revision Techniques, 1:250 000

During 1980 two 1:250 000 maps were revised using Landsat data as the primary source of information.

The first step in this process was to obtain the latest and best imagery of the area, both MSS and RBV, black and white and colour. These were interpreted by optical projection of the imagery on to the map base to detect and delineate change. Simultaneously all published 1:50 000 maps were examined for changes that could be derived for the 1:250 000 map. Combining the data from both sources lead to a composite revision overlay of new roads, power lines and clearings. The information from the rather spotty coverage of the 1:50 000 maps confirmed the Landsat interpretations and helped identify features.

The revision overlays were field checked by an interpretation team from both Gregory Geoscience and Topographical Survey. The check was carried out primarily by light aircraft. Since the test sheets were in the coastal area of British Columbia it was found that the full-time attention one interpreter was required to keep track of the exact location of the aircraft in the mountain valleys and to guide the pilot, while the other interpreter checked the completeness of the revision and identified features where necessary. The flying was done at 1500 ft above ground, this being a reasonable compromise between having enough time to see things and still being close enough to verify their identity. From this on-the-spot verification road classes could be determined, uncertainties of interpretation resolved, and any more recent changes incorporated in the revision.

With the experience gained from these two maps, the application of the technique is being tested in other regions having different geographic characteristics. These include coastal areas, interior rangeland, mountains, precambrian shield country and forested lowlands. In all, revision is being attempted on 58 additional maps during 1981. Eleven of these are within the 15-year cyclic revision area and 47 are in a 30-year cycle.

REVISION REQUIREMENTS - 1:50 000

At present there are in the neighbourhood of 900 maps in the 1:50 000 map series that are passed their scheduled revision date. The current rate of map revision is sufficient to prevent this number from increasing but not sufficient to reduce the back-log and bring the total series on-cycle. The development and operational application of Landsat change detection techniques will enable Topographical Survey to markedly increase the number of maps revised each year, to such an extent that it is expected to have the series on-cycle within 5 years.

MAP REVISION APPROACH USING LANDSAT - 1:50 000

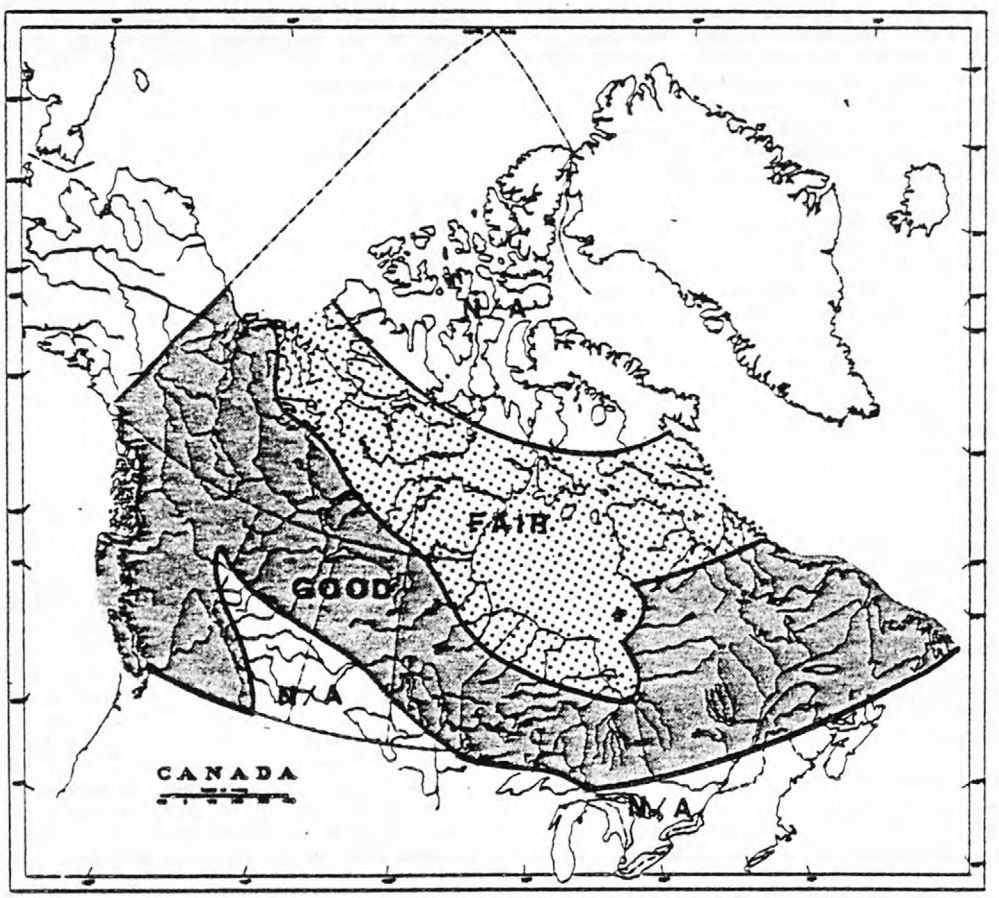
In the change detection study carried out in 1979 it was found that although 1:50 000 maps could not be fully revised from Landsat data, the change detection was complete for this scale. This information alone can provide those planning map revision programs

with a powerful two-pronged tool. It is immediately possible to separate those maps which require new aerial photography for revision from those maps in which no change has taken place and where new photography would serve no useful mapping purpose. Additionally, since change detection was complete in the test area, it is possible to re-validate the maps to the date of the Landsat imagery on which no change was detected.

As with the use of Landsat for 1:250 000 mapping the completeness of the change detection will vary with the geographical area, and those areas where change detection will be most profitably carried out must be delineated for 1:50 000 mapping. Figure 2 shows the present assessment of the areas in Canada where Landsat can be used for revision mapping purposes.

Figure 2

SUITABILITY OF LANDSAT IMAGERY TO REVISION MAPPING



N/A : Landsat techniques are either not applicable or are questionable.

Revision Planning Techniques - 1:50 000

To study the impact that Landsat change detection could have on 1:50 000 map revision planning, Gregory Geoscience undertook to carry out change detection analysis of 535 maps in 1980 prior to their inclusion in the 1981 revision program. This analysis (Moore et al, 1980) was completed in 4 months, including the time required to obtain Landsat imagery. Forty-four maps were dropped from the project because of delays in obtaining imagery, but of the remaining 491 sheets, it was found that 222 evidenced no change whatever, 70 maps had localized or linear changes for which revision information could be obtained by strip photography and only the remaining 199 maps evidenced enough change to warrant full photographic coverage.

By using this information in planning the 1981 photographic requirements it is possible to concentrate efforts where the photography is most needed. This is particularly important since many of these maps lie in an area of notoriously poor photographic weather where in the normal course of events it takes several years to complete block coverage.

The areas selected for this evaluation were those where change detection was known to be effective due to the vegetative or forest cover. The maps that evidenced no change are therefore justified in having their validity dates changed to the date of the Landsat images used in the study.

There are inevitable compromises that must be made in this approach to re-validation. One of these is the mapping of isolated habitations - cabins, houses or buildings. Changes in these features would never be detected on Landsat imagery and perhaps not even on aerial photography. Thus the correctness of these features after re-validation cannot be relied on, and marginal map notes will acknowledge this fact.

During the current year, a further 514 maps are scheduled for change detection studies. These maps are in diverse geographic areas in order to further determine the extent to which this technique can be used as a planning tool.

Interim Revision, 1:50 000

In the remote areas of the country where the major cultural change to affect a map could be the building of a road, Landsat provides a means of getting its location mapped rapidly. A revision overprint on existing map stocks to show the location of the road can be made at any time, regardless of the nominal scheduled revision date for the map. This then becomes a practical approach to keeping northern maps current between lengthy revision cycles.

CONCLUSIONS

Operational methods for the effective use of Landsat imagery in the map revision programs of Canada's two major topographic map series are being successfully developed.

The 1:250 000 scale map series can now be revised independently of the 1:50 000 series for many parts of the country. The planning of aerial photography can be optimized so that those 1:50 000 maps showing most change are given the highest priority, and by reducing the total amount of photography in any one area, the probability of completing it in a single photo season increases.

The supply of imagery during these development stages has not always been what one might desire for an operational system. Obtaining recent imagery has been hampered by delays in cataloguing and delays in reproduction. Catalogue searches for suitable images are at best a hit-and-miss proposition.

The establishment of a library of high quality Landsat images that was continuously up-dated would provide not only mappers with a rapid response source of data, but many others as well who are concerned with the earth monitoring capabilities of Landsat. When one claims to be monitoring environmental changes one likes the information to be current, and the present system does not make this easy. If one is also embarking on an operational program, it is desirable to be assured of a continuing supply of similar imagery. Unfortunately the horizon is not without its clouds of uncertainty in this respect either.

REFERENCES

Fleming, E.A., The use of Satellite Photography in the National Topographic Mapping Program of Canada. Commission IV W.G.2 of the proceedings of the XIII Congress of the International Society

for Photogrammetry, Helsinki, July 1976.

Fleming, E.A., Change Detection by Landsat as a Guide to Planning Aerial Photography for Revision Mapping. Commission IV W.G.4 of the proceedings. 14th Congress of the International Society for Photogrammetry, Hamburg, July 1980.

Moore, H.D., Gregory, A.F., The Use of Landsat Images for Revising Topographic Maps. Prepared under EMR Contract OSQ79-00018. December 1979, Ottawa.

Moore, H.D., Jeffery, C., Turner, A., and Thirlwall, S. Change Detection with Landsat Images as a Guide for Acquiring Aerial Photography to Revise 1:50 000 Topographic Maps. Prepared under EMR contract OSQ80-00060, December 1980, Ottawa.

Received from Klaus Leppert of Australian Division of National Mapping by Letter, Dated 11/2/81.

NM 77/250 KL:ded

USE OF SATELLITE IMAGERY IN NATIONAL MAPPING

1. Presently available LANDSAT imagery

Australia is completely covered by two series of topographic maps at scales of 1:250 000 and 1:1 000 000. About half of Australia is covered by topographic maps at a scale of 1:100 000.

The application of available LANDSAT imagery to mapping is limited due to the size of the smallest picture element, called pixel, that the Multispectral Scanner (MSS) on board the satellites can record. On the ground it represents an area of about 80 m x 80 m.

Another limitation of available LANDSAT imagery is that it has insufficient forward and side overlap to allow three dimensional viewing in a stereoscope.

National Mapping (Natmap) has applied satellite imagery to mapping where no maps existed and no other imagery was available or for special purpose mapping.

Some of the major applications are:

Great Barrier Reef Reconnaissance Series

Forty-eight sheets at a scale of 1:250 000 with shapes and relative positions of reefs revised from uncontrolled LANDSAT images.

Antaractica 1:500 000 ERTS Imagery Series

Thirty-three photomaps derived from enlarged LANDSAT images positioned to existing ground control as closely as possible and assembled into mosaics.

Antarctica 1:250 000 ERTS Imagery Series

Sixty photomaps derived from enlarged LANDSAT images similarly to the 1:500 000 series.

South Australia 1:500 000 LANDSAT Imagery Series

This series, completed in late 1977 covers the whole of South Australia in 18 photomaps.

These maps were compiled from rectifications of enhanced LANDSAT imagery of MSS Band 7. The enhancement of the imagery was done by the Division of Mineral Physics of CSIRO at a scale of 1:1 000 000.

The rectification and enlargement was done by Natmap who also prepared the rectified mosaics.

LANDSAT imagery of the Great Barrier Reef inspected recently revealed a possible uncharted shoal later confirmed by soundings.

Use is made of LANDSAT imagery in the compilation of maps at a scale of 1:1 M depicting land cover and land use in conjunction with air photographs and other maps.

2. Development of new Satellite imagery systems and their impact on mapping

LANDSAT D (Launch date: late 1982)

Will have besides MSS system the Thematic Mapper with a pixel size of 30 m x 30 m. No allowance for sufficient forward and side overlap hence on stereo viewing. This is not a disdvantage for Australian mapping as we have complete cover of aerial photography. Heights of natural features of an area hardly ever change other than by human activity of natural disaster.

This type of imagery would lend itself to detect changes in the cultural detail of a map (i.e., roads, dams, landing strips, etc.) hence could be useful in revising maps thereby cutting costs of inspection flights and rephotography.

SPOT (Launch date: late 1983)

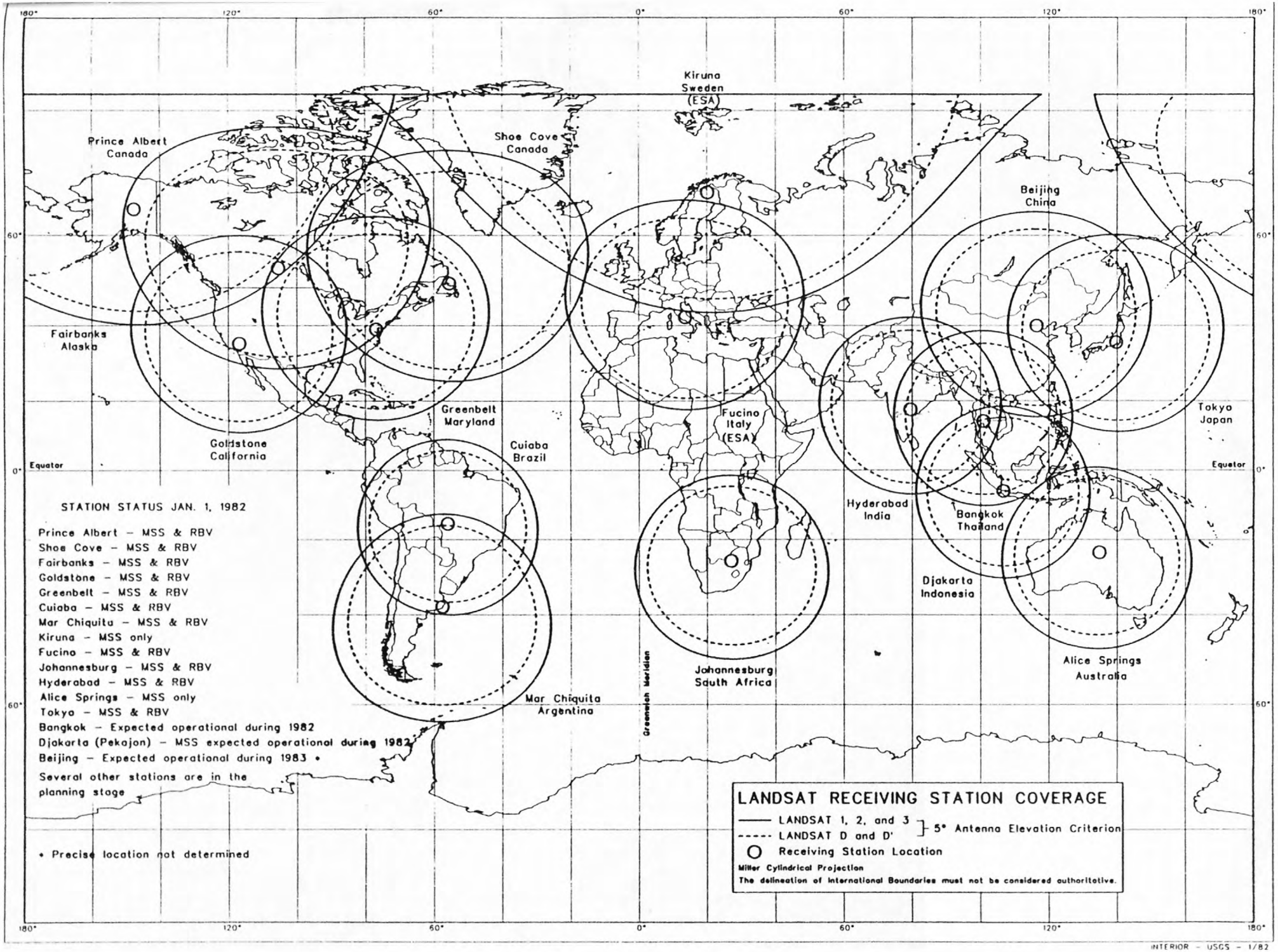
A French satellite with an MSS pixel size of 20 x 20 m or on request of 10 x 10 m. It has stereo capability.

This satellite would be very useful for map revision to detect changes in the cultural detail of a map and perhaps also changes in the coastline and of rivers.

MAPSAT (Launch date: not known)

A U.S. satellite specifically designed for mapping in the stereoscopic mode will have a pixel size of 10 x 10 m and would be very useful for map revision of our 1:100 000 topographic map series.

MAPSAT, SPOT and LANDSAT D imagery in that order would be very useful in recording the topography of Australia at selected intervals. Revision of maps of 1:100 000 scale or smaller could become more cost effective using this imagery.


Kiruna
Sweden
(ESA)
Prince Albert
Canada
Shoe Cove
Canada
Beijing
China
Fairbanks
Alaska
Greenbelt
Maryland
Fucino
Italy
(ESA)
Tokyo
Japan
Goldstone
California
Cuiaba
Brazil
Equator
Equator
Hyderabad
India
Bangkok
Thailand
Djakarta
Indonesia
Alice Springs
Australia
Johannesburg
South Africa
Mar Chiquita
Argentina
Greenwich Meridian
STATION STATUS JAN. 1, 1982
Prince Albert – MSS & RBV
Shoe Cove – MSS & RBV
Fairbanks – MSS & RBV
Goldstone – MSS & RBV
Greenbelt – MSS & RBV
Cuiaba – MSS & RBV
Mar Chiquita – MSS & RBV
Kiruna – MSS only
Fucino – MSS & RBV
Johannesburg – MSS & RBV
Hyderabad – MSS & RBV
Alice Springs – MSS only
Tokyo – MSS & RBV
Bangkok – Expected operational during 1982
Djakarta (Pekajon) – MSS expected operational during 1982
Beijing – Expected operational during 1983 •
Several other stations are in the planning stage
• Precise location not determined
LANDSAT RECEIVING STATION COVERAGE
LANDSAT 1, 2, and 3
LANDSAT D and D'
5° Antenna Elevation Criterion
Receiving Station Location
Miller Cylindrical Projection
The delineation of international Boundaries must not be considered authoritative.
INTERIOR – USGS – 1/82