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EVALUATE ERTS IMAGERY FOR MAPPING AND DETECTION OF CHANGES OF SNOWCOVER
ON LAND AND ON GLACIERS

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Type I Progress Report for Period 1 January - 28 February 1974

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Goddard Space Flight Center
Greenbelt, Maryland 20771

Type I Progress Report
ERTS-1

a. Title: Evaluate ERTS imagery for mapping and detection of changes of snowcover on land and on glaciers.

ERTS-A Proposal No.: 342-7

b. GSFC ID No. of P.I.: IN 045

c. Statement and explanation of any problems that are impeding the progress of the investigation:

No official word has been received on the status of our Data Analysis Plan dated 1 May 1973, which requested additional funds to study 1973 summer images; nor has any preliminary information been forthcoming on the status of these funds. Thus work has only proceeded at a low level of effort, in order to save enough money to prepare the final reports.

Acquisition of images taken prior to the 30 November cutoff date is still not complete. For some passes with acceptable cloud cover no data have been received; for some other passes the full set of frames or the full set of spectral bands has not been received. Data analysis has been hampered by this spotty receipt of primary information.

d. Discussion of the accomplishments during the reporting period and those planned for the next reporting period:

Snow covered area (in km² and percent) has been measured for 10 individual drainage basins in the North Cascades, Washington, all or some of which were measured with the Stanford ESIAC during 12 ERTS cycles. These data are now being analyzed in terms of a hydrologic model, and 4 additional basins and one additional cycle are being measured.

Experiments have been conducted on the ESIAC utilizing masks cut according to topographic contours. By cycling through a registered set of these masks on the display monitor, one can match the snowline to the best-fitting contour. This "variable contour overlay" promises to be another useful procedure for obtaining snow-covered area or snowline altitude.

Some preliminary work has been done on all-digital processing to measure snow. It appears that rules can be defined for identification of snow in images which do not include clouds. This technique will receive further investigation, especially in regard to separating snow from vegetation.

Intensive study continues on the problem of defining the errors in various analysis techniques and as a function of forest cover and shadowing.

High altitude (U-2) and low altitude aircraft data on snowlines are being analyzed as "ground truth" for the ERTS imagery. This is an extremely tedious process due to the complexity of the snowline, the problems with vegetation cover, and the relief distortion in photographs. Thus attempts will be made in the next reporting period to use statistical sampling and other techniques for streamlining the procedures.

Work on glaciers includes study of glacier motion, identification of surge-type glaciers, and the monitoring of tidal glacier termini and iceberg discharge plumes.

e. Discussion of significant scientific results and their relationship to practical applications or operational problems including estimates of the cost benefits of any significant results.

The area of snowcover on 10 individual drainage basins in the North Cascades, Washington, has been determined for 29 July, 2 September, and 8 October 1972, and 30 May and 12 September 1973. In addition, snowcover on many of these basins has been measured on 14 November 1972 and 6 January, 12 February, 7 April, 25 April, 12 May, and 11 August 1973. A semi-automatic radiance threshold technique was employed. The result is a unique record of the changing water storage as snow in these important hydrologic units, the runoff of which is utilized for hydroelectric power, dilution of wastes and heat, support of salmon migration, and irrigation. These data will now allow a new type of hydrologic modelling to proceed which should permit more accurate forecasts of streamflow.

A new technique has been developed for measuring snow-covered area or snowline altitude semi-automatically. This variable contour overlay method involves superimposing an ERTS image on a monitor with a registered series of contour masks which are rapidly cycled, thus permitting the snowcover to be matched efficiently to the best fit contour of altitude. Repeatability of 60 m in altitude is readily obtained.

Although it is not yet possible to measure snowcover on an ERTS image by a fully automatic (digital processing) technique, progress has been made in distinguishing snow from other terrain materials in the absence of clouds. The band 7/band 5 radiance ratio is typically 0.5 for dry snow and less than 0.48 for wet snow; other typical terrain radiances show appreciably higher ratios. This technique may be of great value in identifying snow in deep shadows, a severe problem with other techniques.

The motion of the Yentna Glacier during the concluding phase of its surge was successfully measured by a "flicker" technique using images of two dates. It appears that displacements as small as 100 to 200 m can be measured, which is very close to the resolution limit for a single ERTS image.

Motion of the Tweedsmuir Glacier was measured using ERTS images enlarged to 1:50,000, using the facilities of the Geophysical Institute, University of Alaska. Changes detected included a shock wave moving down the glacier, the margin expanding, the moraine pattern deforming, and the marginal valley deepening. Velocities measured at 9 places in time and space ranged from 2 to 88 m per day; these clearly show the increase and then decrease in speed as the surge wave passed. These data have been confirmed by independent measurements made at the site by a Canadian glaciologist. Tweedsmuir Glacier is now damming the large Alsek River, and the future release of this glacier dammed lake imperils settlements and a small industry at Dry Bay, Alaska.

f. A listing of published articles, and/or papers, preprints, in-house reports, abstracts of talks, that were released during the reporting period:

Colloquium "Remote Sensing of Snow and Ice" given at the University of Washington, 14 February.

g. Recommendation concerning practical changes in operations, additional investigative effort, correlation of effort and/or results as related to a maximum utilization of the ERTS system:

None.

h. A listing by date of any changes in Standing Order Forms:

7 November 1972

1 May 1973

i. ERTS Image Descriptor forms:

In preparation.

j. Listing by date of any changed Data Request forms submitted to Goddard Space Flight Center/NDPF during the reporting period:

29 October 1973.

k. Status of Data Collection Platforms:

N/A