

"Made available under NASA sponsorship  
in the interest of early and wide dis-  
semination of Earth Resources Survey  
Program information and without liability  
for any use made thereof."

E73-10254

TMX-68941

WATER RESOURCES

Charles Calvert Room

Chairman, V. V. Salomonson, (GSFC)

Co-chairman, A. Rango, (GSFC)

E 73-10255

Paper W 1

## HYDROGEOLOGY OF CLOSED BASINS AND DESERTS OF SOUTH AMERICA, ERTS-1 INTERPRETATIONS\*

George E. Stoertz and William D. Carter, *U. S. Geological Survey, Washington, D.C. 20242*

### ABSTRACT

Images from the Earth Resources Technology Satellite (ERTS-1) contain data useful in studies of hydrogeology, geomorphology, and paleoclimatology. Sixteen Return Beam Vidicon (RBV) images and 15 Multi-Spectral Scanner (MSS) images were studied. These covered deserts and semidesert areas in southwestern Bolivia, northwestern Argentina, northern Chile, and southeastern Peru from July 30 to November 17, 1972. The study area is bounded by latitudes  $16^{\circ}30'$  and  $27^{\circ}30'$  South and by longitudes  $66^{\circ}30'$  and  $70^{\circ}30'$  West. During the first 4 months after launching, high-quality cloud-free imagery was obtained over approximately 90 percent of the region of interior drainage, or a total area of about 170,000 square miles.

Features interpreted from the images include: (1) principal types of salt crusts on major salars (salt-encrusted playas), some of which are subject to modification by seasonal floodwaters; (2) extent of floodwaters and lakes on the floors of more than 120 closed basins, thus providing a basis for more accurate mapping of hydrologic features in the central Andes; (3) prominent former lake shores of Pleistocene lakes; (4) mid-winter snow cover in the high Andes, data essential to the appraisal of water resources and runoff; (5) volcanoes and volcanic craters numbering more than 500 in the study area, of which 13 are reportedly active and many believed to be associated with playa-type borate deposits and sulfur deposits; and (6) major faults such as the Atacama fault and other prominent geologic structures.

No single source of data previously has permitted identification of all of these features, and observation on synoptic snow cover was not possible prior to ERTS. ERTS thus provides an invaluable data base for earth resources surveys and development in this large and relatively undeveloped area.

---

\* Publication authorized by Director, U.S. Geological Survey.

E 73-10256

Paper W 2

**DETECTION OF MAJOR RIVER BED CHANGES IN THE RIVER EBRO  
(NORTH-EASTERN SPAIN)**

R. Espejo, J. Torrent and C. Roquero, *E. T. S. de Ingenieros Agrónomos Universidad Politécnica de Madrid*

**ABSTRACT**

The River Ebro is the most important water course in Spain crossing the Iberian Peninsula in a south-eastern direction from – Central North to the Mediterranean Sea.

A study has been undertaken to evaluate major river bed – changes over a distance of 30 km. either side of the city of Zaragoza. Data, as far back as 1.890, have been used showing that – meanders are fairly active thus causing a noticeable repercussion on the use of the nearly agricultural lands.

Results make it possible to estimate future trends in meander evolution.

E 73-10257

Paper W 3

APPLICATIONS OF MULTISPECTRAL PHOTOGRAPHY TO WATER RESOURCES  
DEVELOPMENT PLANNING IN THE LOWER MEKONG BASIN (KHMER  
REPUBLIC, LAOS, THAILAND AND VIET-NAM)

Willem J. van Liere, *Mekong Committee Secretariat, Bangkok, Thailand*

ABSTRACT

The use of ERTS photography for water resources planning in the lower Mekong basin relates to three major issues:

- it complements data from areas, which have been inaccessible in the past because of security; this concerns mainly forest cover of the watersheds.
- it refines ground surveys; this concerns mainly land forms, and soils of existing and planned irrigation perimeters.
- it provides new information, which would be almost or entirely impossible to detect with ground surveys or conventional photography; this concerns the mechanism of flooding and drainage of the delta; siltation of the Great Lake and mapping of acidity, possibly also of salinity, in the lower delta.

Examples are given of all these major issues.

There are also other uses, not directly related to water resources planning, but still of prime importance to the holistic concept of river basin planning. These relate to the delimitation of national reserves and to the identification of antiquities. Examples of these are given too.

The satellite data are particularly valuable also because their repetitive coverage gives an insight in the gradual transformation of changing features such as the extent of flooding and moisture retention in various soil types. Furthermore the availability of satellite imagery is most timely as it fills gaps in basic data necessary for completion of development plans for the Mekong basin. These, in turn, are urgently needed, in order to finalize a realistic post-war development program for the Basin.

E73-10258

Paper W 4

**PRELIMINARY TEST OF ERTS-1 IMAGERY FOR IMPROVING DEFINITION OF  
NATURAL STREAMFLOW**

Este F. Hollyday, *Water Resources Division, U. S. Geological Survey, Nashville, Tennessee*

**ABSTRACT**

Historical streamflow data, which were routinely collected at gaging stations, have been transferred to ungaged sites with varying degrees of success by relating statistical flow parameters to physiographic characteristics of a drainage basin. The basin characteristics that are most easily extracted by automated techniques from ERTS-1 imagery include open water, infrared-reflecting vegetation, snow, and massed works of man. In preliminary tests, using two small basins in the Chesapeake Bay area of Maryland and Delaware, the percent of basin areas occupied by open water and infrared-reflecting vegetation was determined from ERTS imagery and checked by aerial photography. The two basins, which were selected from a group of about 20, represent extremes in their hydrologic response to precipitation. The percent of basin areas was correlated with the residuals of multiple-regression equations that were developed to relate streamflow characteristics to basin characteristics that, in part, were measured from topographic maps. Results of this correlation were encouraging; however, a more thorough test is needed.

E 73-10259

## APPLICATION OF ERTS-1 IMAGERY TO FLOOD INUNDATION MAPPING\*

George R. Hallberg and Bernard E. Hoyer, *Iowa Geological Survey Remote Sensing Laboratory* and Albert Rango, *National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.*

### ABSTRACT

In September, 1972, heavy rains initiated major flooding in southwestern Iowa, concentrated in the East and West Nishnabotna basins. The flood crest moved downstream between September 11-15. A cooperative program to evaluate the possibility of mapping flood inundation using remote sensing techniques was initiated jointly by the Iowa Geological Survey, Remote Sensing Laboratory (IGSRSL), and the U. S. Geological Survey, Water Resources Division. Ground data and a variety of low altitude multispectral imagery was acquired for the East Nishnabotna River on September 14-15. This successful effort concluded that a near-visible infrared sensor could map inundated areas in late summer for at least two days after flood recession. ERTS-1 imagery of the area was obtained on September 18-19. Analysis of MSS imagery by IGSRSL, USGS, and NASA reinforced the conclusions of the low altitude study while increasing the time period critical for imagery acquisition to at least seven days following flood recession. The capability of satellite imagery to map late summer flooding at a scale of 1:250,000 is exhibited by the agreement of interpreted flood boundaries obtained from ERTS-1 imagery to boundaries mapped by low altitude imagery and ground methods. The synoptic coverage of ERTS-1 allowed extension of the flood mapping to the West Nishnabotna River. Satellite imagery allows rapid appraisal of the areal extent of flood inundation for the entire river systems. This satellite flood mapping should prove valuable to federal and state agencies involved in regional floodplain management and planning.

---

\*Publication authorized by the Director of the Iowa Geological Survey.

E73-10260

## ASSESSMENT OF FLOOD DAMAGE IN ARIZONA BY MEANS OF ERTS-1 IMAGERY

Roger B. Morrison, *U. S. Geological Survey, Denver, Colorado*

### ABSTRACT

ERTS-1 MSS images clearly show two important effects of a large flood in southeastern Arizona - the extent of inundation and the areas affected by severe sediment deposition and erosion - although the images were made a week and a half after the flood. On October 20 and 21, 1972, the upper Gila River had its second-largest flood on record. Peak flows attained about 42,000 and 82,000 cubic feet a second at Duncan and Safford, Arizona, respectively. Six lives were lost, hundreds of people made homeless, and more than 10,000 acres of cropland inundated.

The first ERTS-1 images after the flood were made on November 1 and 2. The inundated area is best displayed on the infrared bands, particularly on band 7, where it appears as a belt along the river that is distinctly darker than the adjoining flood plain. This dark belt does not appear on ERTS images that pre-date the flood. Presumably the low infrared reflectance of this belt is caused by still-moist soil. Inundation limits mapped from the ERTS imagery agree well with those obtained by aerial photography during the flood and by ground surveys. Areas of severe sand and gravel deposition and of local strong erosion show on band 5. By comparing before-and-after-flood images on this band, a quick assessment can be made of the severely flood-ravaged land.

E73-10261

USE OF THE SRI SATELLITE IMAGE ANALYZER CONSOLE FOR MAPPING SOUTHERN ARIZONA PLANT COMMUNITIES FROM ERTS-1 IMAGERY

Raymond M. Turner, U. S. Geological Survey, Tucson, Arizona

ABSTRACT

Cloud-free imagery covering the Tucson, Arizona, region for the period from August 22 to November 2, 1972, was used to show the utility of ERTS-1 data for discriminating boundaries between plant communities.

The following studies were made from imagery analyzed by Stanford Research Institute's Image Analyzer Console:

(I) Console-generated color composites from MSS-5 and MSS-6 bands were recorded photographically from the console color monitor. The color photographs were then used to compare with short-term changes in vegetative cover observed on the ground.

(II) Microdensitometric traces were made by the console along selected traverses to quantify changes in scene brightness across the image field. MSS-6 minus MSS-5 densitometry values were employed as a relative measure of plant cover in the wide range of vegetative zones covered by the traverses.

(III) Quantitative plant coverage data, recorded at ground-truth stations along the traverses, were compared with the densitometric values.



E73-10262

Paper W 8

## MONITORING OF STREAMFLOW IN THE VERDE RIVER BY ERTS-1 DATA COLLECTION SYSTEM (DCS)

Herbert H. Schumann, *U. S. Geological Survey, Water Resources Division, Phoenix, Arizona*

### ABSTRACT

The Verde River watershed of central Arizona furnishes municipal, industrial and agricultural water to the Salt River Valley - an area that contains more than half of Arizona's population and about one-fourth of the State's irrigated land. Water management decisions related to the operation of large multiple-use reservoirs require accurate and continuous monitoring of moisture conditions over large remote areas.

The U. S. Geological Survey in cooperation with the Salt River Project installed a specially designed gaging station on the Verde River near the town of Camp Verde to evaluate near-real time streamflow data furnished by the ERTS-1 Data Collection System (DCS). On November 3, 1972, this installation was equipped with a Stevens digital water-level recorder, modified for telemetry, and an ERTS-1 data collection platform operating in the digital-parallel mode. During the 43-day period between November 3 and December 15, 1972, the DCS relayed 552 transmissions during 193 data passes. The DCS system transmitted stream stage information 4.5 times per day on the average. The amount of data received far exceeded the expected single high quality transmission rate of once per 12-hour period from the DCS system.

The digital-parallel ERTS-1 Data Collection System has furnished data sufficient to accurately compute mean daily gage heights. These, in turn, are used to compute the average daily streamflow rates during stable or slowly changing flow conditions. The digital-parallel DCS data has also furnished useful information during peak flow periods. However, the serial-digital DCS capability, currently under development for transmitting streamflow data, should provide data of greater utility for determining times of flood peaks.

E73-10263

PRELIMINARY ANALYSIS OF ERTS RELAYED WATER RESOURCES DATA IN  
THE DELAWARE RIVER BASIN\*

Richard W. Paulson, *U.S. Geological Survey, Harrisburg, Pa.*

ABSTRACT

Preliminary analysis of ERTS-DCS data from water resources stations in the Delaware River basin indicates that the Data Collection System is performing well. Data Collection Platforms have been successfully interfaced with five stream-gaging stations, three ground water observation wells and are being interfaced with 12 water-quality monitors in the basin. Data are being relayed during four or five ERTS orbital passes per day, which is within the design specifications of the ERTS-DCS.

---

\*Abstract approved by the Director, U. S. Geological Survey.

E73-10264

Paper W 10

## MODELING SUBTROPICAL WATER-LEVEL DYNAMICS DISTRIBUTION

A. L. Higer, E. A. Cordes and A. E. Coker, *U. S. Geological Survey, Miami, Florida*

### ABSTRACT

ERTS MSS Imagery coupled with Data Collection Platforms (DCP's) relaying virtual real time data provides the potential for optimum water-resource conservation and utilization in south Florida. Limited information gained from ERTS-1 suggests implementation of a prototype Water Resource Model capable of: (1) Disseminating data to the agencies responsible for maintaining an adequate water supply to the 2 million coastal ridge inhabitants; (2) Delineating the distribution of existing waters stored in the 1,400-square-mile Central and Southern Florida Flood Control District; (3) Quantifying the essential elements in the hydrologic cycle; and (4) Providing the basis for preserving the diverse but delicate Everglades aquatic communities.

New and existing DCP's relaying rainfall, water-levels, wind velocity and specific electrical conductance of water to the USGS via ERTS-1 will allow determination of south Florida water, and weather, and ecologic model feasibilities. Dissemination of data will provide the Central and Southern Florida Flood Control District with an opportunity for daily water-management capability decisions. Sophistication of an experimental Water Resource Management Model up to an annual prototype operational water management budget will allow Federal (National Park Service, Fish and Wildlife Service and U. S. Army Corps of Engineers), State (Central and Southern Florida Flood Control District, Fish and Game, Department of Natural Resources), and County (Dade and Broward public water supply) agencies to avert crisis negotiation for the seasonally limited water resources. A more accurate water resource model is the critical planning need in south Florida with choice of alternative storage techniques hinging on the exact quantity and duration of the seasonal surplus. Preservation of sensitive hydrobiological communities in the Everglades National Park is a primary concern.

E 73-10265

Paper W 11

AN EVALUATION OF SPACE ACQUIRED DATA AS A TOOL FOR  
MANAGEMENT OF WILDLIFE HABITAT IN THE STATE OF ALASKA

Bill J. Van Tries, EROS Coordinator, *Bureau of Sport Fisheries and Wildlife, Washington, D. C.*

ABSTRACT

ERTS data was analyzed and interpreted using color coded densitometric displays and digital processes to provide information on floristic phenology, vegetation zone mapping, and surface hydrology of the Yukon-Kuskokwim Delta.

The ERTS acquired data on vegetation and hydrology were compared with existing vegetation and surface water maps covering 70 percent of one ERTS frame. Multispectral (I<sup>2</sup>S) photographic data were acquired in an adjunctive effort, and subjected to the same analyses and interpretation as ERTS data.

It was concluded that ERTS data, with adequate verification from quadrat in situ sampling, could be extrapolated to describe accurately the vegetative characteristics of scenes far removed from the sample site.

Hydrologic data - surface acres of water - were immediately obtainable for a delta area containing thousands of small ponds important to wildlife and the production of waterfowl. Minimum pond size measurable from ERTS data was approximately 5 acres.

The application of the two techniques has great potential for developing accurate vegetation and hydrologic maps for millions of square miles in Alaska.

Multispectral photography (I<sup>2</sup>S) has not yet been compared with ground data to ascertain its adequacy as a substitute for the ground acquired data now considered essential to interpretation of ERTS data.

E73-10266

Paper W 12

## PRELIMINARY EVALUATION OF ERTS-1 FOR DETERMINING NUMBERS AND DISTRIBUTION OF PRAIRIE PONDS AND LAKES

David S. Gilmer and Albert T. Klett, *Bureau of Sport Fisheries and Wildlife, Northern Prairie Wildlife Research Center, Jamestown, North Dakota*, and Edward A. Work, Jr., *Environmental Research Institute of Michigan, Ann Arbor, Michigan*

### ABSTRACT

Management of waterfowl is a major responsibility of the Bureau of Sport Fisheries and Wildlife. Numbers and distribution of wetlands (prairie ponds and lakes) in the primary breeding areas during the spring and summer provides an index to waterfowl production. The Bureau conducts annual surveys to determine waterfowl habitat conditions and makes periodic regional wetland inventories to assess the long-term changes in this resource. To improve the accuracy and speed of these inventories the use of satellite borne sensors and associated data processing techniques are being investigated. ERTS-1 and aircraft multispectral data collected over a North Dakota test site during July 1972 are compared to evaluate the capability of the satellite sensors to detect numbers and distribution of wetlands of various sizes. Digital maps of wetlands processed from satellite and aircraft scanner imagery and photographic products are presented.

E 73-10267

Paper W 13

## DYNAMICS OF PLAYA LAKES IN THE TEXAS HIGH PLAINS

C. C. Reeves, Jr., *Department of Geosciences, Texas Tech University, Lubbock, Texas*

### ABSTRACT

This study shows that satellite imagery can be used for a census of the thousands of lake basins which commonly exist in semi-arid areas, and which sporadically contain water at various times of the year. Storm paths and runoff collected by such lake basins can also be closely monitored, the accuracy dependent on periodicity of the orbits. Study of the relationships between spectral differences (obtained from ERTS-1 imagery) and the water balance ecosystem of the lake basins is in a preliminary stage. However, examination of ERTS-1 MSS frames show that Band 4 has the poorest tonal contrast in semi-arid area West Texas, Band 5 is best for definition of vegetation, Band 6 is best for defining large water areas, and Band 7 is best for counting small lake basins with water.

Ground-truth studies reveal significant differences between the test sites, the relative importance of which will be reflected by the hydrologic balance of each lake basin.

E73-10268

Paper W 14

## HYDROLOGIC STUDIES IN THE LAKE ONTARIO BASIN USING HIGH ALTITUDE AND ERTS-1 IMAGERY

A. Falconer, *University of Guelph, Guelph, Ontario*

### ABSTRACT

The Lake Ontario Test Site includes areas of both land and water. Studies of high altitude and ERTS-1 imagery show that inflow from the Niagara River and underwater discharge from effluent pipes can be delineated. Because these features are dynamic, the collection of adequate ground data for interpretative studies is very difficult. The imagery provides synoptic data of ephemeral features and the high altitude imagery is being used to define some surface movements of the lake. Sun glint on the RB-57 imagery has been used to define upwelling along the northern shore and the sequential photography resulting from successive flight paths allows the calculation of rates of movement in such features. Study of internal wave patterns revealed on RB-57 imagery is continuing but no internal waves have been detected on available ERTS imagery.

Over the land area of the test site, attempts to model the behavior of river basins have defined a requirement for soil moisture measurements and a definition of vegetation cover. RB-57 imagery has been used for vegetation mapping and measurements of soil moisture status appears possible. Soil moisture measurement is complicated by the effect of land use and soil type. Variability of the high altitude imagery is a further complicating factor. Correction of image density over the area of the test site has been achieved by fitting smoothing functions. Studies of soil types in the laboratory and in the field using various sensors and scales of resolution have defined the role played by soil parent material and landforms. High altitude data are being used to define land use, soil type, and landform regions. In a limited test area the corrected image density values have been correlated with moisture status and the regional scale use of this is being examined with reference to ERTS-1 data. As a bi-product from hydrologic studies the interpretation procedure gives regional scale land use data, soil maps, and physiographic information.

E73-10269

Paper W 15

## PROGRESS OF AN ERTS-1 PROGRAM FOR LAKE ONTARIO AND ITS BASIN

Fabian C. Polcyn and Thomas W. Wagner, *Environmental Research Institute of Michigan, Ann Arbor, Michigan*

### ABSTRACT

A multidisciplinary team of scientists from Canada and the United States are currently studying the use of ERTS-1 data for application to hydrological and limnological problems of Lake Ontario and its Basin. The results of this research are contributing to the objectives of the International Field Year for the Great Lakes (IFYGL)—an intensive synoptic study of the 32,000 sq mile Lake Ontario Basin designed to increase our understanding of a major lake system and the techniques required to manage it.

In addition to conventional image interpretation of the MSS data, eight contiguous ERTS frames, obtained in mid-August 1972, are being processed for enhancement and classification of significant hydrological and limnological features. Processing to date includes level slicing, ratioing of spectral bands, and classification of features. The additional information available from processed data, are being primarily directed to the evaluation of elements of the terrestrial water balance, but important sedimentation and water movement properties may also be observed and charted from these data.

Rapid processing of ERTS data by analog computer techniques are expected to make the periodic enhancement and classification of the large amount of ERTS data (8 frames) economically feasible.



E 73-10270

Paper W 16

## REMOTE SENSING OF TURBIDITY PLUMES IN LAKE ONTARIO

Edward J. Pluhowski, *U. S. Geological Survey, Water Resources Division, Arlington, Virginia*

### ABSTRACT

Preliminary analyses of ERTS-1 imagery demonstrate the utility of the satellite to monitor turbidity plumes generated by the Welland Canal, and the Genesee and Oswego rivers. Although visible in high altitude photographs, the Niagara River plume is not readily identifiable from satellite imagery.

E73-10271

## ERTS-1 VIEWS THE GREAT LAKES AREA

Walter A. Lyons and Steven R. Pease, *College of Engineering and Applied Science, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201*

### ABSTRACT

With the launching of Earth Resources Technology Satellite (ERTS-1) in July 1972, a powerful new tool for studying mesoscale atmospheric phenomena associated with the Great Lakes has come on the scene.

It has been found possible to discriminate air pollution patterns from large sources of suspended particulates. Plumes from major steel mill operations in the Chicago-Gary-Hammond area can be seen spreading in southwest flow over Lake Michigan for over 50 nm. The excellent background provided by water in the near infrared makes for optimum viewing. Conversely, over land even very dense smoke plumes become difficult to distinguish from terrain.

Comparison of same area viewed at different portions of the spectrum allows the detection and identification of cirriform clouds. At shorter wavelengths (0.5-0.6 micrometers) cirrostratus layers might appear a total undercast. Yet in the near infrared (0.8-1.1) almost complete penetration to the underlying features is found. Denser clouds, such as altocumulus, stratus, cumulus, etc., do not exhibit this characteristic at all.

In a similar manner, views of the Toronto area under cloudless but hazy conditions, reveal the marked haze penetrating characteristics of the near infrared. Reconstructed color infrared views (made by combination of the three longer wavelength bands) reveal sharp ground features almost totally obscured by haze and pollutants in the "green" band (0.5-0.6 micrometers).

Snow cover is readily apparent in ERTS images. A localized record early season (October 18) lake snow squall in the south-Chicago and Hammond, Indiana region produced a well defined path through the metropolitan Chicago area. Though depth determination is difficult (maximum 4" in this case), such images can clearly reveal freshly deposited lake snow squall swaths as soon as the skies clear.

Aircraft condensation trails also appear in several photographs, including one with a peculiar circular shape.

Summer lake phenomena, such as lake breeze fronts are ideally studied. Even the smallest cumulus elements are resolved. During an all-shore lake breeze over Lakes Erie and Ontario, the cloud-free zone extended almost uniformly inland around the perimeter of the lakes. Smaller lakes and reservoirs also show marked cloud suppression. Cloud streets on downwind shorelines show great similarity to laboratory studies of cold fluids advecting over heated plates, including Benard cell type patterns.

Several sets of simultaneous views of cloud patterns from ERTS and all-sky cloud cameras are compared. These are helpful in showing the extremely high resolution of the satellite, as well as the horizontal viewing range with the lens filter combination used.

E73-10272

## USE OF ERTS DATA FOR MAPPING SNOW COVER IN THE WESTERN UNITED STATES

James C. Barnes, *Environmental Research and Technology, Inc., Lexington, Massachusetts 02173*

### ABSTRACT

The purpose of this investigation is to evaluate the application of ERTS data for mapping snow cover, primarily in the mountainous areas of the western United States. The specific objectives are to determine the spectral interval most suitable for snow detection, to determine the accuracy with which snow lines can be mapped in comparison with the accuracies attainable from other types of measurements, and to develop techniques to differentiate reliably between snow and clouds and to understand the effects of terrain and forest cover on snow detection. Snow cover is a water resource for which spacecraft observation holds great promise. The results of this study will provide the hydrologist with interpretive techniques that will enable data from future operational satellite systems to be used to map snow on a more cost effective basis.

Preliminary results of the analysis of ERTS-1 data indicate that snow cover can be detected in the MSS-4 (0.5 to 0.6  $\mu\text{m}$ ) bands by its high reflectance compared to that of the surrounding snow-free terrain. Snow can generally be distinguished from clouds because of well-defined boundaries as compared with the less-distinct cloud edges, the lack of shadows characteristic of clouds and pattern configurations that fit closely with higher elevations and terrain features. At higher latitudes where repetitive ERTS coverage occurs, snow can also be identified by the day-to-day continuity of the patterns. In the longer wavelengths, particularly the MSS-7 (0.8 to 1.1  $\mu\text{m}$ ) band, the contrast between snow and snow-free terrain is much lower, and, thus, snow is more difficult to detect.

In several mountain areas, including the Southern Sierra Nevada, the White Mountains, the Olympic Mountains, the Mt. Rainier area, and the central Arizona Mountains, snow lines have been mapped from ERTS pictures from the fall and early winter. Changes in snow line elevation are clearly evident in data collected on different dates. In ERTS data from the Arctic, considerable detail is evident in glaciers located along the east and west coasts of Greenland. Detectable features include imbedded sediment trails (medial moraines) and crevassed areas. Significant differences are also apparent in the various spectral bands. Several glaciers exhibit a uniform reflectance in the MSS-4 band, whereas in the MSS-7 band, the lower elevation portions appear much darker than the upper portions. This difference in reflectance is believed to be due to the existence of meltwater on the surface of the glacier at lower elevations in contrast to snow cover at the higher elevations.

E73-10273

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

Mark F. Meier, *U. S. Geological Survey, Tacoma, Washington*

### ABSTRACT

The percentage of snowcover area on specific drainage basins was measured from ERTS imagery with the Stanford Research Institute console. Basin outlines were electronically superimposed on imagery, and video density slicing used to measure areas. For a basin with 22.6 percent snowcover, results were repeatable to within 4 percent of the snow-covered area. Data from five ERTS and U-2 images of the melt season snowcover in the Thunder Creek drainage basin in the North Cascade Range were combined with existing hydrologic and meteorologic observations to enable calculation of the space and time distribution of the water stored in this mountain snowpack. Knowledge gained from this model can then be used in subsequent years to forecast meltwater runoff during the critical late summer period. Similar data could be used for frequent updating of expected inflow to reservoirs if similar satellite data were available in the future.

Snow-covered area and snowline altitudes were also determined by enlarging ERTS imagery to 1:250,000 and using a transparent map overlay. Under favorable conditions, snowline altitude was determined to an accuracy of about 60 $\mu$ m. Ability to map snowcover or to determine snowline altitude depends primarily on cloud cover and vegetation and secondarily on slope, terrain roughness, sun angle, radiometric fidelity, and amount of spectral information available.

Glacier accumulation area ratios were determined from ERTS imagery. Also, subtle flow structures, undetected on aerial photographs, were visible. Surging glaciers were identified, and the changes resulting from the surge of a large glacier were measured. Marked changes in tidal glacier termini were discovered between successive ERTS passes.

E 73-10274

Paper W 20

**DETECTION OF TURBIDITY DYNAMICS IN TAMPA BAY, FLORIDA USING  
MULTISPECTRAL IMAGERY FROM ERTS-1**

A. E. Coker, Aaron Higer and Carl R. Goodwin, *U. S. Geological Survey, Miami, Florida*

**ABSTRACT**

In 1970, Congress authorized the deepening of the Tampa Bay channel (Rivers and Harbors Act of 1970) from 34 to 44 feet. In order to determine the effects of this deepening on circulation, water quality, and biota, during and after the construction, the U. S. Geological Survey, in cooperation with the Tampa Port Authority, has collected data and developed a digital simulation model of the bay.

In addition to data collected using conventional tools, use is being made of data collected from ERTS-1. Return-Beam Vidicon (RBV) multispectral data were collected, while a shell dredging barge was operating in the bay, and used for turbidity recognition and unique spectral signatures representative of type and amount of material in suspension. The processed data integrated with other modeled parameters provide an overview of the dynamics of turbid material during dredging periods. A three-dimensional concept of the dynamics of the plume was achieved by superimposing the parts of the plume recognized in each RBV band. This provides a background for automatic computer processing of ERTS data and three-dimensional modeling of turbidity plumes.