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ANCILLARY DATA INTERFACE TO VICAR/IBIS

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I. ABSTRACT

To produce data in machine-readable form defining the extent of irrigated land by water source within the Snake River Plain of Idaho, a digital land-use classification map derived from Landsat MSS data was combined with irrigation district maps. The procedures developed at the Idaho Image Analysis Facility (IIAF) to link ancillary cartographic information with the VICAR/IBIS image processing environment in a production mode were an effective means of optimizing the analysis procedure.

II. INTRODUCTION

The purpose of this paper is to describe the techniques utilized at IIAF to merge spectrally derived Landsat classification data with ancillary geographic information for production of spacially registered data on the areal extent of irrigated agriculture by water source within the Snake River Plain of southern Idaho. These techniques were developed to support IBIS-GIS processing in a production mode.

The Idaho District of the U.S. Geological Survey Water Resource Division is engaged in a Regional Aquifer System Assessment (RASA) project which involves the development of a mathematical model simulating the hydrology of the Snake River Plain. The model requires information in computer-readable form on irrigation acreages referenced by water source. The Bureau of Reclamation, responsible for providing much of the irrigated water used in the state, and the Idaho Department of Water Resources, engaged in evaluating consumptive water use, also require information on irrigation within the Snake River Plain.

Under a cooperative agreement between these three agencies, the IIAF undertook a project to provide irrigated acreage statisics and crop type (by irrigation district) utilizing Landat MSS data and existing maps of the irrigation districts. A regression analysis of irrigated/nonirrigated accuracy and a contingency table analysis of crop type classification accuracy were provided. The primary digital analysis was conducted using VICAR/IBIS (Video Image Communications and Retrieval/Image Based Information System)[1] software developed by the Jet Propulsion Laboratory, supplemented by International Imaging Systems Incorporated System 511 interactive image manipulation system.

III. METHODS

A. Background

In order to understand the procedures used to introduce ancillary data into the IBIS-GIS subsystem, it is necessary to describe the operational configuration at IIAF. The VICAR/IBIS system is operational on the state of Idaho's IBM 370/168 (since replaced by a 3033). The Department of Water Resources operates a DEC PDP 11/34 minicomputer as a communications interface to the IBM, supporting remote job entry and on-line file text editing. An I^2S model 70E image display computer and the System 511 software package are also resident on the 11/34. A GTCO digitizer is also interfaced to the 11/34 utilizing in-house written software. Digitized data file management and some batch job creation is achieved using the 11/34 operating system's indirect command file capabilities. Analog information (Figure 1) from maps is interactively digitized and converted to a vector format on the minicomputer. Via a telecommunications interface, the vector data is transferred to the mainframe where it is converted to raster image format. The image data

is then returned to the minicomputer utilizing magnetic tape medium (we are having some success with small image telecommunications transmissions between the mainframe and minicomputer).

B. Classification

The techniques for classification of Landsat MSS Data have been sufficiently covered by others and are not within the scope of this paper; a brief description will suffice. The analysis procedure involved six Landsat scenes. A modified guided clustering[2] technique was used to classify the spectral data. Two-hundred (stratified random sample) unit training sites were used. Sample unit statistics were generated, and classification was performed using a Gaussian maximum likelihood classifier. The classified data were registered to a UTM projection map base by developing a triangulation network using corresponding tiepoints chosen from maps and the raw data, then geometrically transforming the classified data to the map base.

Registration of classified data to a map base allows the introduction of other ancillary map based-information into an analysis procedure. Since a composite image of the entire study area (5,000 lines x 9,000 samples) would exceed the capacity of the IBM storage medium available and would be very cumbersome to work with, an image size corresponding to a 1:100,000 scale UTM map was chosen as a basic data unit. To determine the source of irrigation water, information published on county irrigation district maps had to be digitized and interfaced with the classification results.

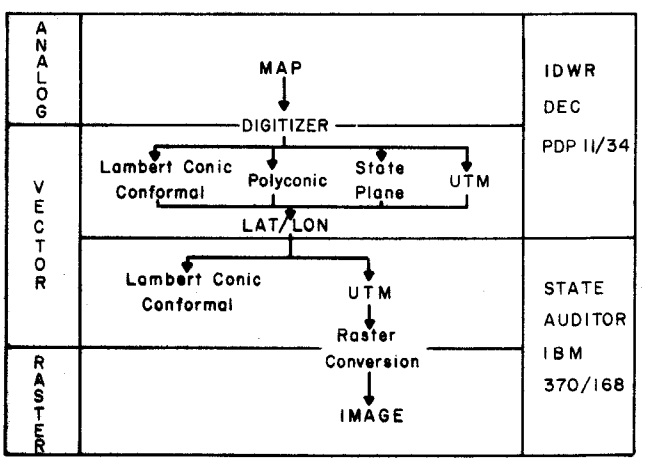

Figure 1. Data transformation flow & environment.

C. Ancillary Data Capture

The information base for irrigation source-districts was provided by county maps[3] depicting irrigation source-districts. This information was transferred by manual cartographic procedures to mylar overlays on 1:100,000 scale USGS UTM projection maps. Polygons were labeled with a four digit code to identify the district. There are over 300 irrigation districts (covering 21 map sheets at the designated scale) on the Snake River Plain, resulting in 978 digitized polygons. A minimum resolution of 40 acres was chosen as being compatible with the needs of the participating agencies (and the inherent limitations of Landsat classification). This permitted a generalization in the transfer of information to the mylar overlays, which enhanced through-put for the entire project. Once all the overlays were prepared, they were digitized under programmatic control (Figure 2). The procedure for digitizing operated at two levels. The upper level routine supervised file naming conventions, initiation of digitizing, and creation of VICAR batch language job streams. The lower level routines were the specific digitizing programs. Based on the map projection of the information to be digitized, the upper level routine initiated the appropriate lower level program for digitizing of Polyconic, UTM, or Lambert Conic Conformal maps. The individual routines operate in similar fashions. Two corners of the map were digitized and the latitude/longitude entered. This information set up the appropriate transforms. A file was also written containing tiepoints (for geographic referencing of UTM projection coordinates to raster image space) for subsequent use by VICAR.

After a map scale check was accepted by the operator, vectors were digitized, and the digitizer's output board coordinates were transformed to latitude/longitude coordinates and written to an output file. The coordinate transformation procedure was to rotate and scale a board-specific coordinate into its appropriate coordinate system and then run the inverse tranform to output a latitude/longitude coordinate. This allowed maps to be placed on the digitizing table in any orientation. As each point was digitized, it was checked against a menu for an end-of-segment or map flag and was evaluated for reliability (our digitizer is old and occasionally left truncates coordinates, creating interesting but bogus points). When all vectors were digitized, the polygon labels were digitized, creating a second output file

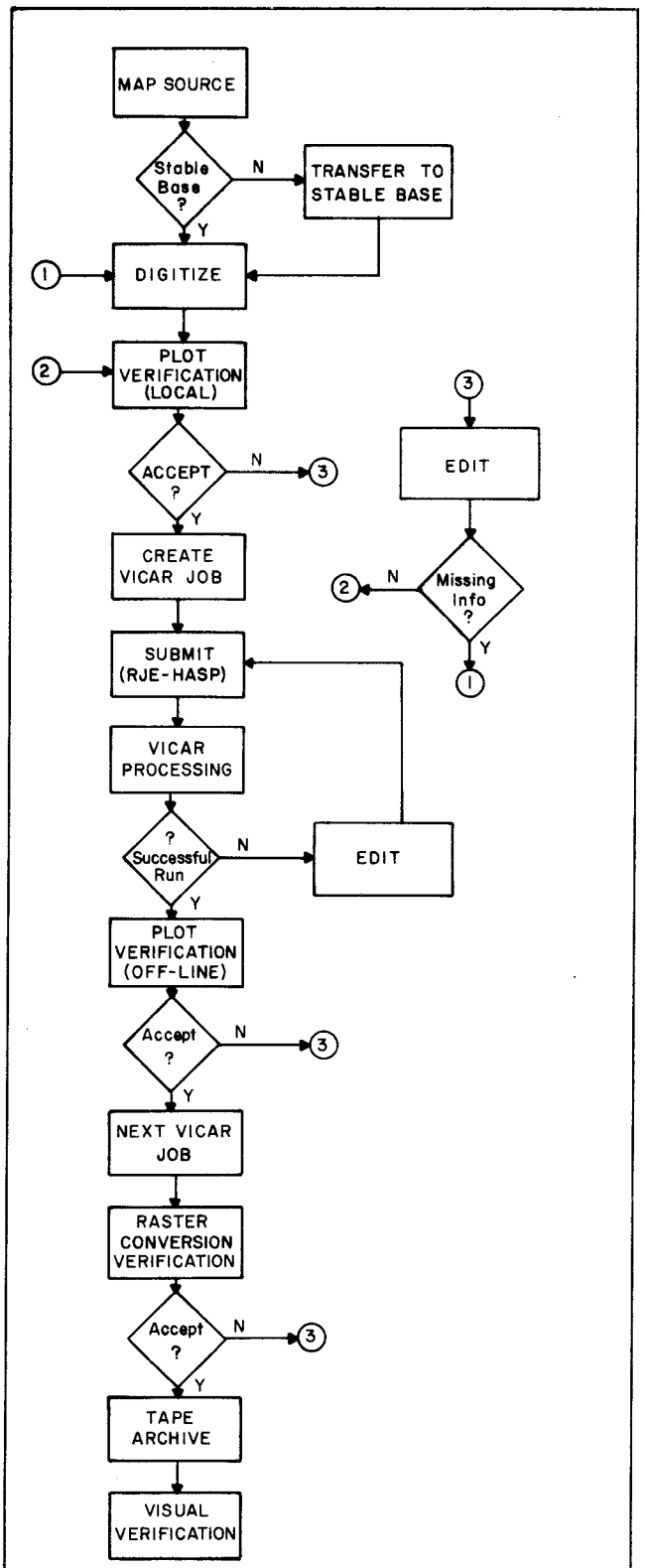

Figure 2. Ancillary information Data Capture.

of coordinate 'centroid' locations. The operator then signified the end of a digitizing session, control is reqlinquished to the upper level routine which then renamed coordinate files and created the job stream file for remote submission to the state's IBM 370/168 and VICAR batch processing.

D. Processing

The job stream created consisted of three steps. The first two utilized an IBM system's utility to create disc files on the 370 for both the vector and centroid data generated while digitizing. The third step initiates the execution of the VICAR job which created VICAR formatted files from the utility created data sets (V2POLY), converted these latitude/longitude files to UTM (POLYMAP), offset and scaled (POLYREG) data to the appropriate 1:100,000 map at a 57m resolution, (using the programmatically generated tiepoints), and produced a plotter output for verification (SCRBPLOT). Errors detected from the plot were easily rectified. Since the output of the digitizing routines is highly reproducible, the plot output was placed over the original mylar, and using the digitizer, bad points, lines, and centroids were easily located and missing information quickly redigitized. Using a line text editor (EDI) on the 11/34 the original job stream file was edited and resubmitted.

Once the individual map plots were acceptable, the vector information was converted to raster image form (POLYSCRB), the polygons were sequentially coded (PAINT), and a link was made between polygons and centroid names (CTRMATCH). The service district images were then overlaid on the classification map images to produce tabular summaries of irrigated acreages by service districts. To produce the desired output product, (a map depicting irrigation by source), the service district maps were simplified to depict only irrigation source (HSTRETCH) (surface water, groundwater, mixed). These images were merged with the classification maps (F2) to produce maps containing the desired information. These maps were then mosaicked (FASTMOS) to produce the desired output.

E. Post Processing

The secondary phase of this project was to generate regression and contingency table information on the classification in order to assess the overall classification accuracy. Again, having the classification data registered to a map base greatly aided the process of extractng the

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PAUL E. ANUTA is Associate Program Leader for Data Handling Research at the Laboratory for Applications of Remote Sensing (LARS) at Purdue University. He received a B.S., Electrical Engineering, Purdue University in 1957; M.S.E.E., University of Connecticut in 1962; and an M.S. in Computer Science, Purdue University in 1967.

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Dr. Pomalaza's most recent work at LARS involved the use of signal processing and information extraction disciplines and also research and development of advanced technology for processing remote sensing data obtained from satellite and aircraft systems.

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A native of Tehran, Iran, Mr. Davallou came to Purdue in 1979 after graduation from Azar High School where he majored in math and physics. He received his B.S.E.E. from Purdue in May 1982 and is working toward his M.S.E.E. He is a member of Phi Eta Sigma and Eta Kappa Nu.