SDSU-RSI-73-07

MONITORING FLOOD DAMAGE WITH SATELLITE IMAGERY

Remote Sensing Institute
South Dakota State University
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by

L.A. Benson and F.A. Waltz

Interim Report

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ABSTRACT

During analysis of ERTS-1 imagery for land use patterns a large impoundment of water was observed in a location that was normally farmland. Subsequent investigation revealed that the satellite had recorded the remaining floodwaters from a severe local rainstorm that had occurred four days prior to the overpass. The inundated area was measured using the automatic planimeter associated with the Signal Analysis and Dissemination Equipment located at the Remote Sensing Institute. The area measurement coupled with estimates of the land use and productivity of the region permitted an estimate of the crop damage loss for the inundated area.

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INTRODUCTION

The synoptic view and repetitive coverage of the ERTS-1 satellite have made it a very useful monitoring device for numerous disciplines. The satellites usefulness in the assessment of damage due to natural disasters would likely be considered a bonus since the probability of the satellite passing over at the time of the disaster is necessarily very low. However, on its first orbit over eastern South Dakota on July 29, 1972, the ERTS-1 satellite recorded the effect of a severe local cloudburst that occurred on July 25, 1972.

The cloudburst dumped an average of 7 to 8 inches of rain and caused heavy crop damage over a 70 square mile area according to a survey by the Farmers Home Administration. The small community of Ferney (population 74), located southeast of Aberdeen, South Dakota was nearly inundated by the floodwaters. Due to a wet spring, the grain harvest was late and most of the grain was either standing or in windrows in the field awaiting harvest at the time of the storm. Corn which is the main row crop in the area was approximately knee high.

The primary objectives of the analysis of the ERTS imagery were to measure the areal extent of the inundated area and to estimate the damage in that area.

PRESENTATION AND DISCUSSION OF DATA

The ERTS-1 imagery from July 29 was evaluated to determine the multispectral scanner band which provided the greatest contrast. The flooded area was most prominent on channel #7 which records in the infrared (.8 - 1.1μm). The area was easily distinguished on channel #6 (.7 -.8μm) and with some difficulty on channel #4 (.5 - .6μm), but was barely discernible on channel #5 (.6 - .7μm). Figure 1 shows the ERTS image from channel #7 for the July 29, 1972 overpass. Figure 2 is an ERTS image of the same area and from the same scanner channel taken on September 21, 1972 to show the area after the floodwaters had receded.

AREA MEASUREMENT

A determination of the areal extent of the inundated area on July 29 required two basic assumptions. It was assumed that the white tones on the black and white negative print* corresponded to open water and that there was no open water of appreciable extent prior to the storm. The first assumption seems valid since the only natural features on the image having the unique white tone are perennial lakes or marshes. The second assumption is difficult to verify since no imagery was available prior to the storm, but topographic maps did not portray any lakes or marshes in the flooded

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* Negative prints were used because the transparencies received from the EROS Data Center are positives and contact printing produces a negative.

areas. A check with the county extension agent confirmed the absence of ponding before the storm.

To determine the areal extent of the unique white tones corresponding to the ponded water, the image was enlarged to a scale of 1:250,000 and the inundated area was delineated. The size of the delineated area was measured with the automatic planimeter associated with the Signal Analysis and Dissemination Equipment located at the Remote Sensing Institute. The result was a 15 square mile area or 9600 acres that was still under water four days after the storm. Figures 3 and 4 show the enlarged imagery and Figure 5 shows the delineated area and the Signal Analysis and Dissemination Equipment used for the area measurement.

DAMAGE ESTIMATE

The inundated area lies in a poorly-drained, level to undulating plain that contains several large shallow depressions. The soils are typical of the Lake Dakota Plain and consist of the Exline, Aberdeen, Harmony, Beotia, and Great Bend soil series (1). The land is worth approximately $130 per acre based on land sale figures (2). The principal crops grown in the area are wheat, rye, oats, corn and sorghum. The crop yields in surrounding fields that were not flooded were above average and based on increased grain prices an average return of $50 per acre was estimated for the cropland portion of the inundated area.

Computation of crop damage based on an average return of $50 per acre and assuming that 50 percent of the inundated area (9600 A.) was cropland, produced a figure of $240,000. The estimate assumed a 100% loss on cropland because ponding for a four-day period will normally kill growing agricultural crops during a period of high respiration and destroy or ruin mature grain in the field.

A method suggested by the county agent, used a value of $35 per acre for the entire inundated area. This method yielded a crop damage loss of $336,000 for the area and would likely be considered a maximum estimate.

Using a formula based on figures from the Crop Reporting Service (3) which indicates the average annual return from all land in Brown County to be $11 per acre, the crop damage amounted to $105,600. This figure would seem to be a minimum in estimating crop damage loss.

In regard to the damage to houses, bridges and businesses, about all that could be determined, due to the small scale of the imagery, was that any houses or business in the inundated area had water in their basements and their foundations were weakened by the flooding.

CONCLUSIONS

Imagery from ERTS-1 has been shown to be a useful tool in estimating crop damage from flooding. By determining the areal extent of the inundated land after a severe cloudburst, an estimate can be obtained based upon the expected yield of the crop, the land

use of the area, and statistics available from several sources. Although the areal extent of the inundated land on the day the image was taken was determined, no estimate could be made of the flooded area prior to that time or the damage to crops that were flattened by the rain or otherwise damaged but not inundated. A crop damage value in the neighborhood of $250,000 seems to be a realistic estimate for the inundated area.

The usefulness of this approach to damage assessment would appear to lie in the realm of rapid and gross assessment for purposes of obtaining federal aid or relief as opposed to adjusting insurance claims, civil suits, etc. The satellite image should also be valuable to anyone interested in flood prevention or land use planning for the area.

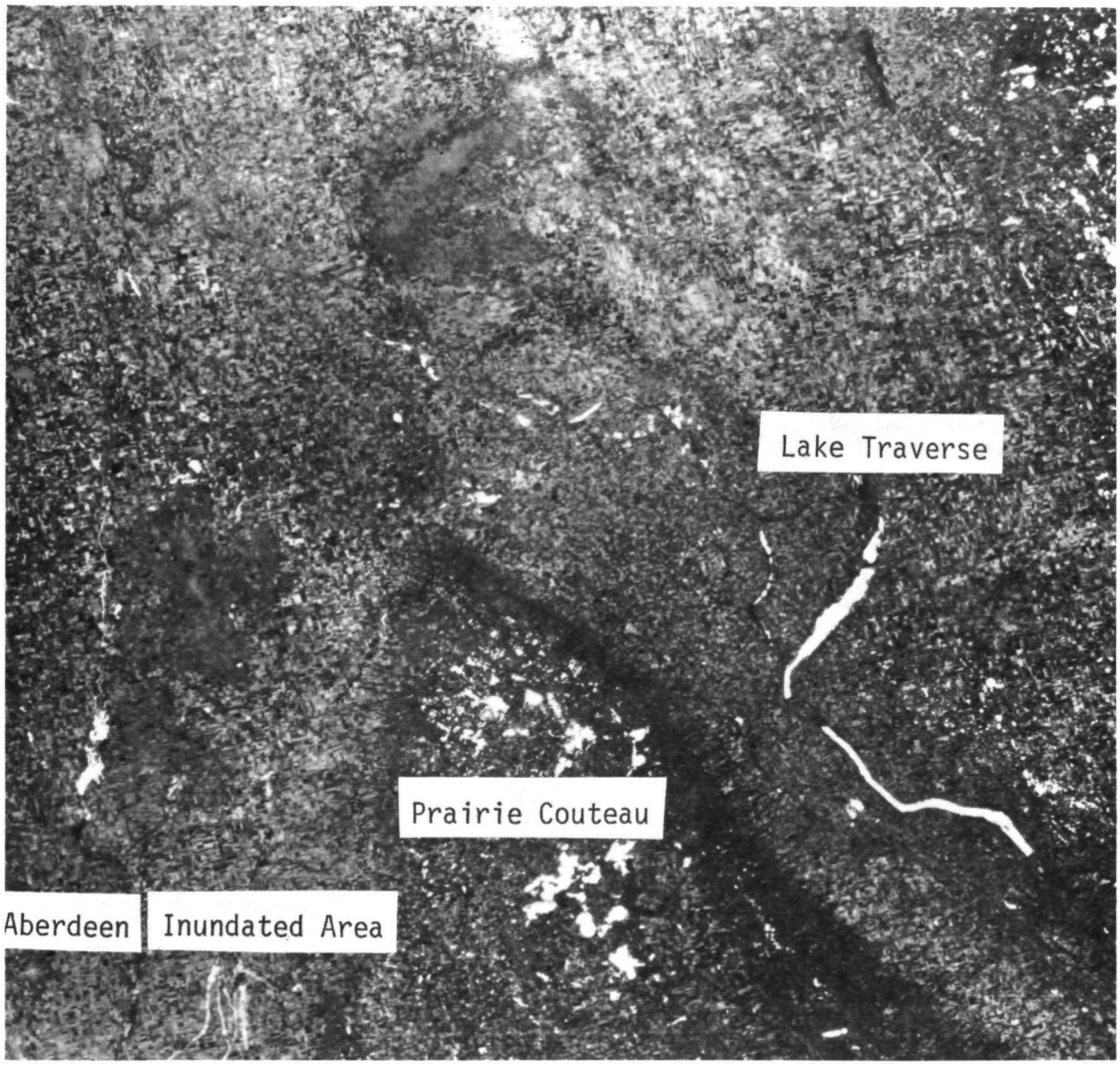


Figure 1. Negative print of ERTS-1 image for infrared band (MSS 7) taken July 29, 1972. Scale = 1:1,000,000.

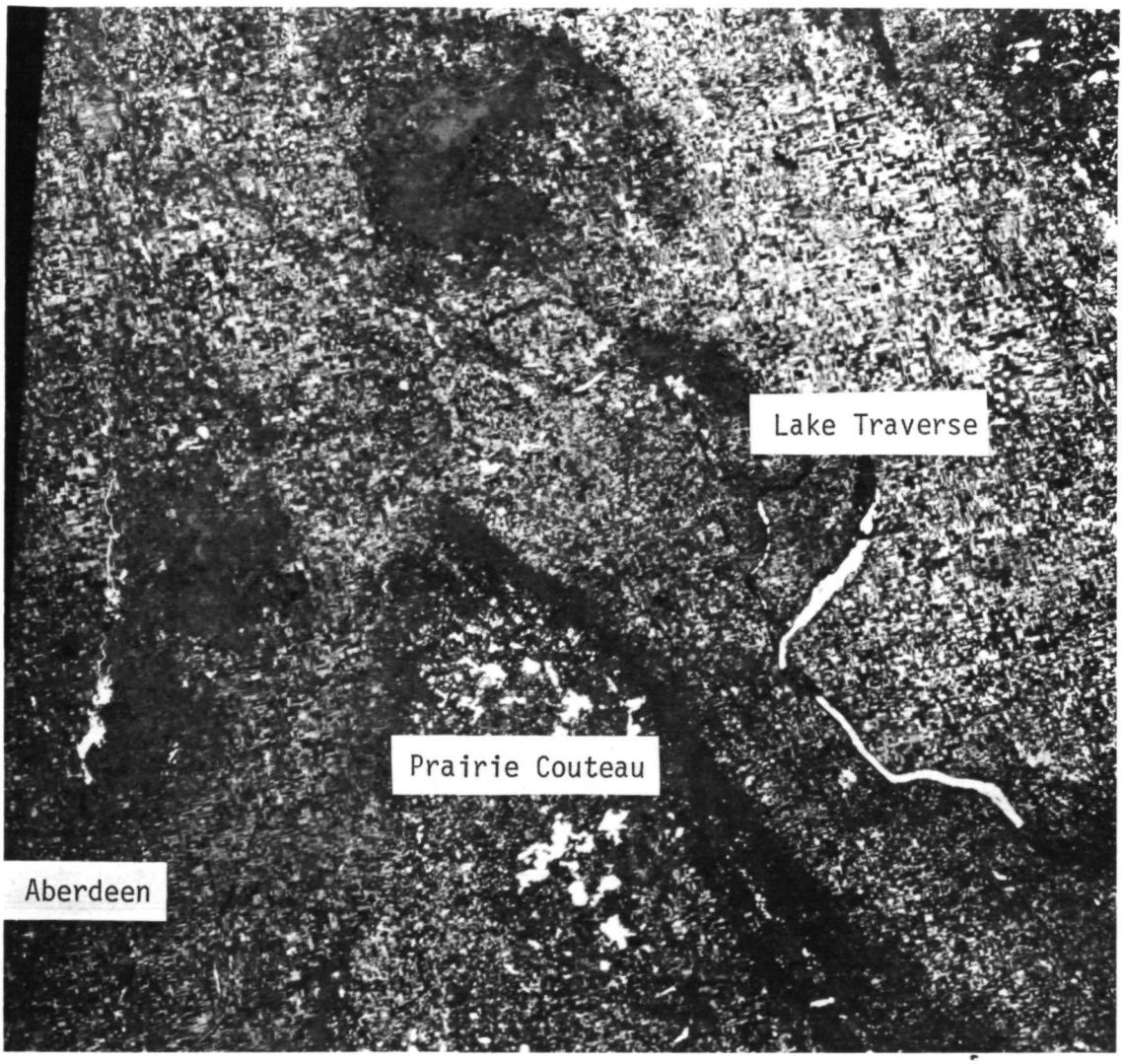


Figure 2. Negative print of ERTS-1 image for infrared band (MSS 7) taken September 21, 1972. Scale = 1:1,000,000.

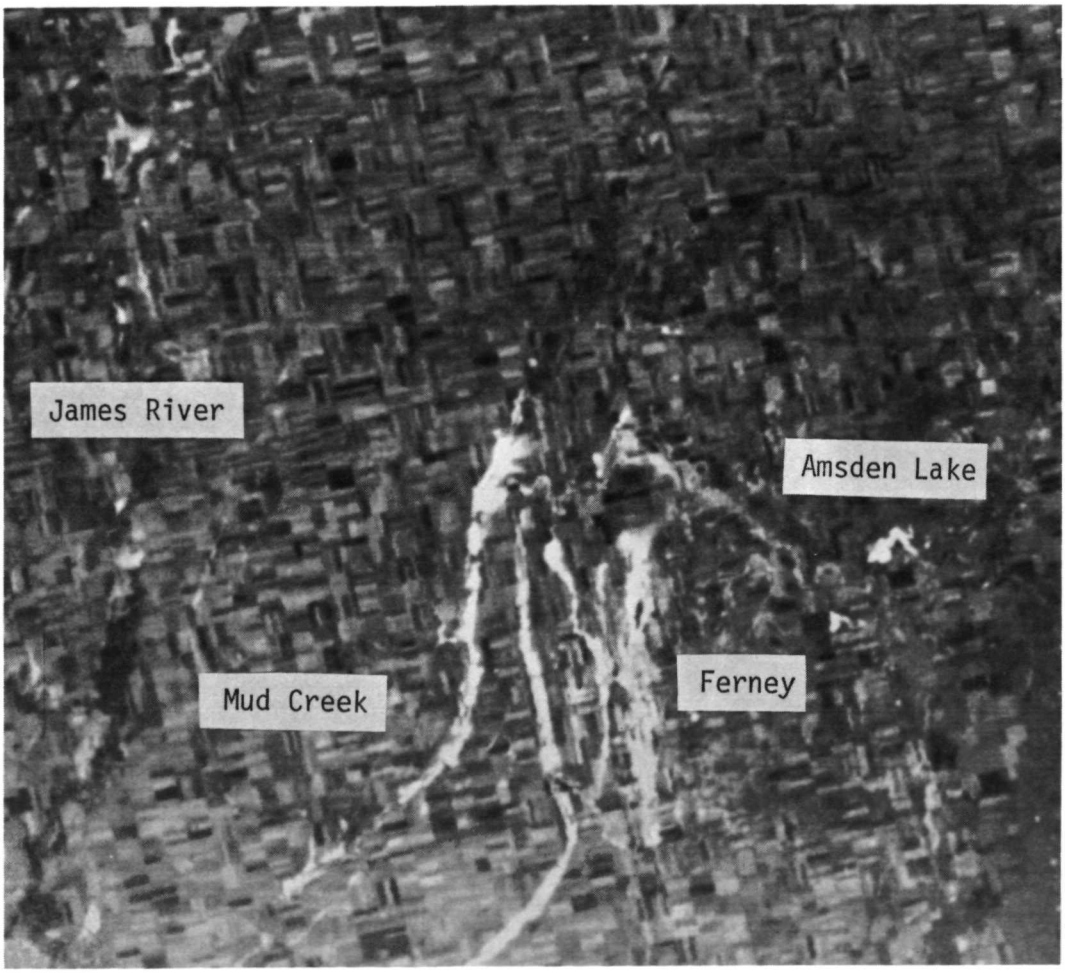


Figure 3. Enlarged negative print of ERTS-1 image for July 29, 1972 showing the inundated area near Ferney, S. D. Scale = 1:250,000.

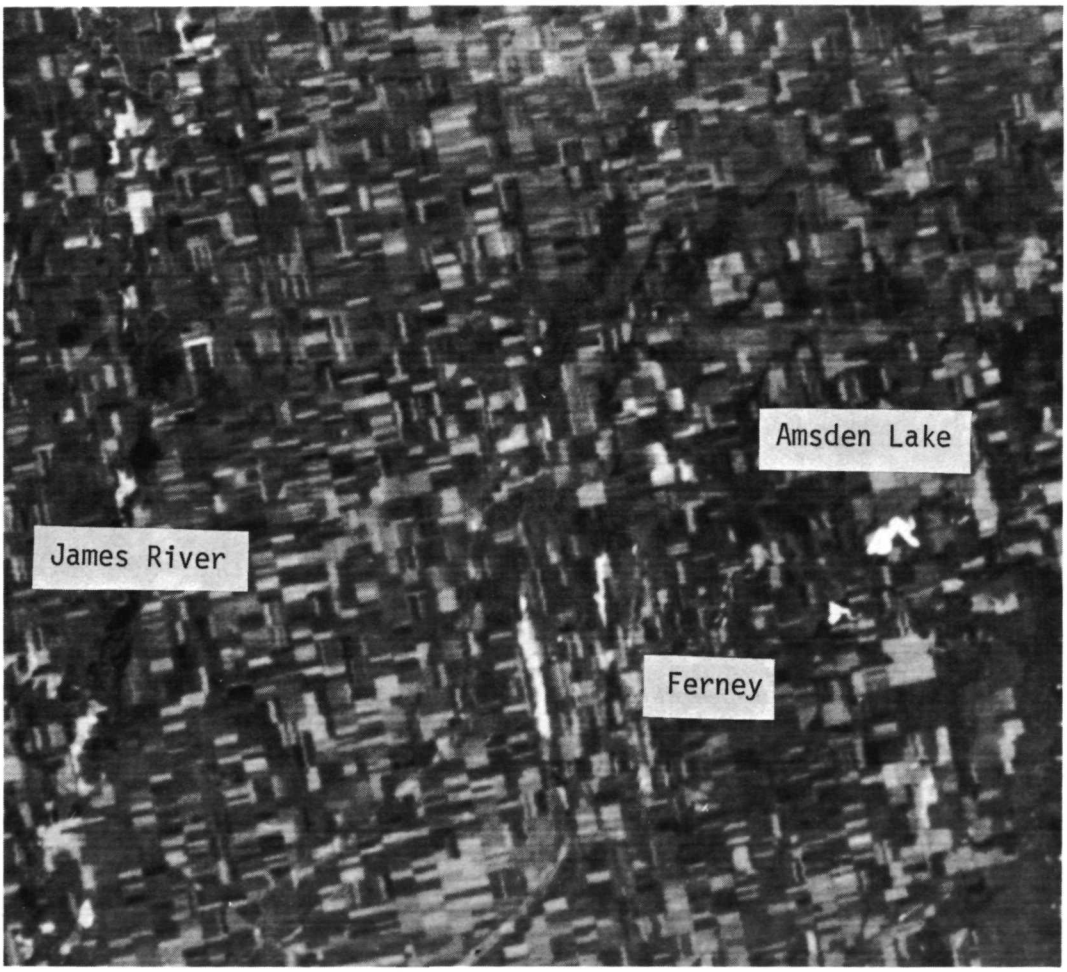
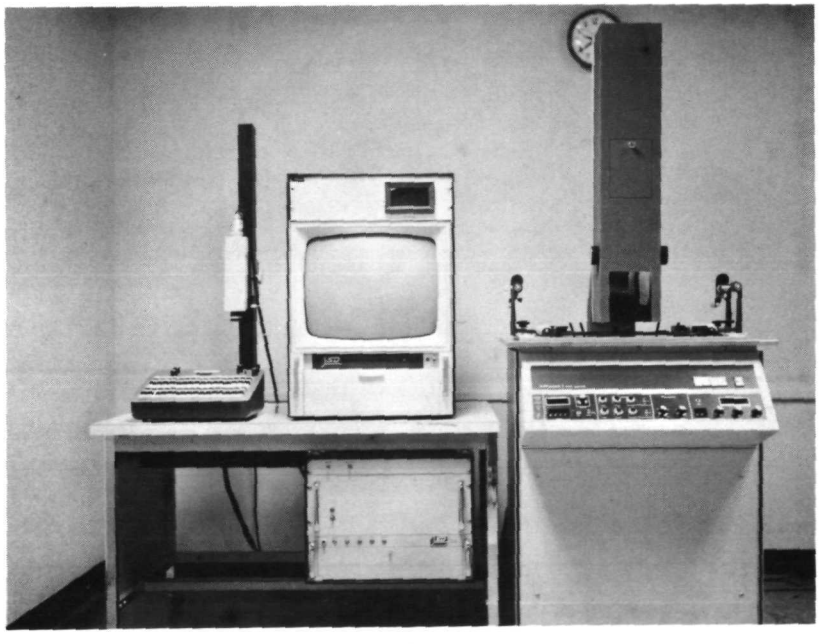


Figure 4. Enlarged negative print of ERTS-1 image for September 21, 1972 showing the area near Ferney after most of the floodwaters had receded. Scale = 1:250,000.

(a)



(b)

Figure 5. (a) Areal extent of inundated area, and (b) Signal Analysis and Dissemination Equipment used for area measurement.

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