John G. Gergen
National Geodetic Survey
National Ocean Survey, NOAA
Rockville, MD 20852

The Geodetic Basis for Precise Photogrammetric Densification

Based on a horizontal network analysis, ground control in the Ada County, Idaho project area was strengthened, for which cost figures are given.

Abstract: *Densification of horizontal control to support the large-scale mapping of Ada County, Idaho, was performed by precise photogrammetric techniques. The precision of control points used for photogrammetric interpolation is important to assure highest possible accuracy of adjusted points. Horizontal network analysis provides specifications for future surveys and geodetic field operations, as well as for office computations. Actual cost figures are quoted. The accuracy of horizontal control stations was shown to be well within expectations for this precise photogrammetric densification survey. A postmortem horizontal verification survey was performed in January 1981. Results of this survey are important for the overall assessment of the quality of such a cooperative effort between geodesy and photogrammetry.*

Introduction

Ada County, Idaho, decided to densify its horizontal control network in order to provide coordinates for section corners and to maintain a dense local control network in support of future surveying and mapping operations.

Consultations between officials of Ada County and NOAA's National Ocean Survey resulted in the recommendation that the densification should be done by a precise photogrammetric survey. The area of the survey covered the northern half of Ada County between latitudes 43°26′ and 43°50′, and longitudes 116°W and 116°30′W (see Figure 1).

Horizontal Network Analysis

This photogrammetric densification survey was based on a small number of existing horizontal control stations, between which the photogrammetrically determined points were interpolated. For this reason, it is essential that the existing horizontal control stations be positioned to the highest possible accuracy.

The accuracy of the horizontal control stations must be in harmony with the precision of the photogrammetric positioning technique. In addition, proper scale and orientation are important because these elements are generally not provided by photogrammetric surveying. Although it is possible to integrate scale and orientation into the photogrammetric process, this becomes unnecessary if the ground survey is properly scaled and oriented. For these reasons a detailed analysis of existing horizontal control is absolutely essential.

The network analysis is performed using all existing horizontal observations of direction, astronomical position and azimuth, and distance. A least-squares adjustment of all observations reveals existing distortions in the network, existing weak observations, systematic errors, and, in general, determines the overall network consistency.

This analysis revealed that additional field work was necessary to improve the scale of the network. A traverse running through the center of the area of concern showed less than adequate scale. Other distance observations were found to be necessary to provide scale for the existing triangulation.

Specifications for Ground Survey

The analysis of the existing observations provided information to plan the future survey.

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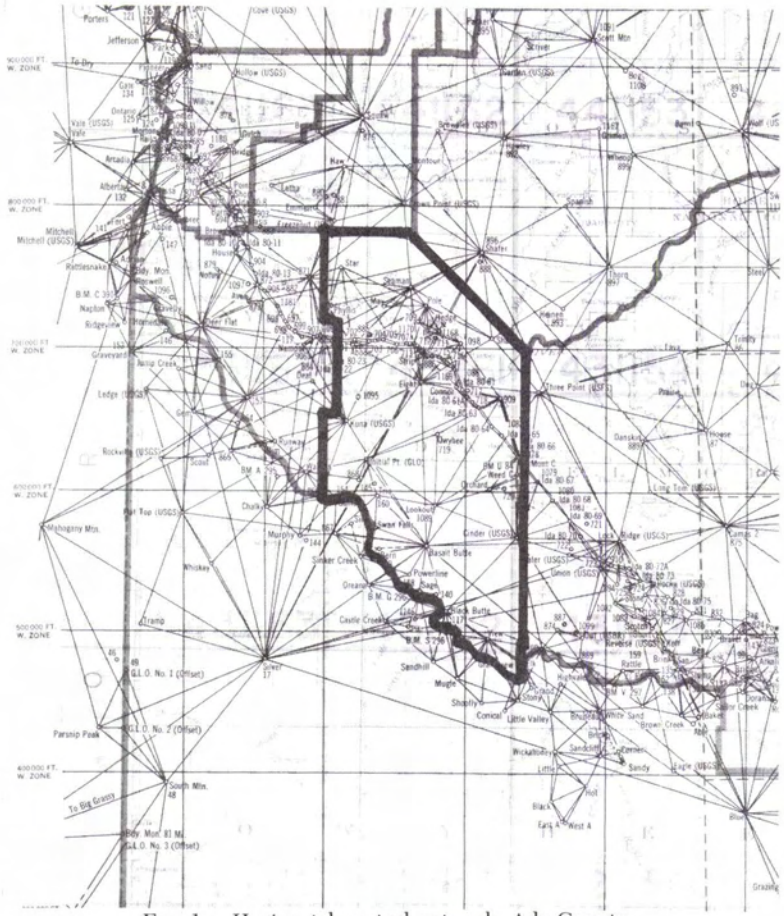

FIG. 1. Horizontal control network, Ada County.

Two considerations were considered important: the accuracy of points within the area of interest, and the consistency of the network within the triangulation of the region. These factors determined the extent of the future survey, the number of new points, and the necessary reobservations of directions and distances, as well as new observations.

Specifications for the survey also include instructions to survey new prominent objects built since the last survey, airport facilities and obstructions, and other points of interest on Federal and state property.

GEODETIC FIELD OPERATIONS

In the summer of 1978, geodetic field operations began. A total of 53 new horizontal stations were established during the period 2 October 1978 through 16 March 1979. These included 19 triangulation stations, 14 azimuth marks, and 20 landmarks and marks of other organizations. The cost of geodetic field operations was as follows:

salaries		$ 77,000
travel		42,000
supplies, rent, etc.		12,000
overhead		18,000
	Total	$149,000

The photogrammetric survey established a total of 346 points of which 161 were eccentric to the respective section corners.

The private firm of McCarter and Tuller, Inc., consulting engineers in Boise, Idaho (under contract to Ada County), tied 140 eccentric points to the actual section corners by traverse. Costs, as detailed by Don C. McCarter, were

marking		$19,000
surveying		11,000
	Total	$30,000

These observations were submitted to NOS early in 1980.

Office Computations

The office computations were carried out in two phases: the adjustment of all National Geodetic Survey observations and, subsequent to the photogrammetric adjustment, the computation of adjusted coordinates for the 140 section corners as surveyed by McCarter and Tuller, Inc.

The first phase was by far the most important, because it provided the basis for subsequent computations. A total of 1787 horizontal directions and 213 measured distances related a total of 267 stations. These stations included the following: 53 new stations, 24 temporary stations, 22 fixed stations, and 168 old stations which were readjusted. The average circular standard error for any point in the area was 45 mm. The circular standard error is the radius of a circle enclosing 39.35 percent of the estimated position variation. Relative accuracies between points averaged one part in 400,000.

The second phase was possible after coordinates for all photogrammetrically determined points were derived.

The total cost of office computations, including salaries, computer time, and overhead, was $7,000.

Conclusions

The initial network analysis is very important. Distortions in the network must be removed in order to avoid biasing subsequent photogrammetric computations.

Once the North American Datum project is concluded, all horizontal stations in the United States will have been readjusted and, consequently, all distortions will be eliminated. At that time, network analyses will concentrate on accuracy questions, in order to assure that horizontal stations will be sufficiently accurate to support photogrammetric densification surveys.

A postadjustment survey was performed to check on the relative position of two photogrammetrically determined points. Results of the survey have confirmed the assessed accuracy of the original survey.

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