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TECHNICAL MEMORANDUM

ANALYSIS OF THE CLASSIFICATION OF U.S. AND CANADIAN INTENSIVE TEST SITES USING THE IMAGE 100 HYBRID CLASSIFICATION SYSTEM

By

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1. INTRODUCTION

During Phase III of the Large Area Crop Inventory Experiment (LACIE), 24 U.S. and 10 Canadian intensive test sites were scheduled for processing on the Interactive Multispectral Image Analysis System, Model 100 (Image 100) using the Procedure 1 hybrid classification system. This report describes an evaluation of the results obtained.

In this study the only segments analyzed were those with (1) satisfactory classifications and (2) complete classification and ground-truth data. This eliminated 22 of the 34 segments: 4 segments were not classified, 6 segments were eliminated because of unsatisfactory classifications, and 12 segments were eliminated because of inadequate classification or ground-truth data. This left 12 segments with 13 estimates. (Segment 1968 is a mixed-wheat segment, so estimates for this segment are available for both spring and winter wheat.)

Originally, it was intended to investigate both labeling accuracy and proportion estimation accuracy. However, there were not enough dot-labeling data available, so this part of the investigation was abandoned.

2. METHOD

In the procedures used on the Image 100, the analyst could give proportion estimates for winter wheat, winter grains, spring wheat, or spring grains. However, these could not be compared directly with a corresponding ground-truth proportion, since the ground truth did not cover the whole segment. Therefore, an analyst estimate of the proportion in the ground-truth area was obtained and compared with the ground-truth value. This was done in the following manner.

The image, classification map, and a map of the ground-truth area were read into the Image 100. Using existing hardware and software, the number of pixels within the ground-truth area and the number of these pixels which were

classified as wheat or grains were counted. These pixel counts, after deleting those which had been designated other (00) pixels, were used to calculate the "uncorrected" proportion estimate for the ground-truth area. The bias correction alpha table, as stored in the Image 100, was then used to obtain a bias-corrected estimate for the ground-truth area.

3. RESULTS

The results of the evaluation are shown in table 1. Each segment is identified in the table together with the acquisition used for the estimate, the type of estimate (i.e., spring wheat, winter wheat, spring grains, and winter grains), and the Robertson biostage as determined from the adjustable crop calendar for the latest imagery used. In each case, the uncorrected proportion estimate, $\hat{\lambda}$, and the bias-corrected proportion estimate, $\hat{\lambda}_C$, which are expressed as percentages, are given for the entire segment. The corresponding quantities \hat{Y} and \hat{Y}_C for the ground-truth area within the segment are given in the next two columns. Since some of the estimates passed to the Crop Assessment Subsystem (CAS) were not corrected for bias, each estimate passed is identified by a superscript b. The ground-truth proportion, Y , which was determined from field reports, is also given, along with the difference, $D = \hat{Y}_C - Y$, which is the proportion error for the ground-truth area.

LACIE segment 1973 (Whitman County, Washington) had the largest difference value, $D = -33.8$. Labeling data were available for this classification, and they showed that all labeling errors were for wheat called nonwheat. Out of 98 labeled type 1 and type 2 dots, approximately 25 percent were wheat dots which were labeled nonwheat. Note that 90 percent of the cultivated crops within the ground-truth area (excluding pasture and summer fallow) were winter wheat.*

*Ground truth was available for approximately one-third of this segment. This area contained 53.5 percent winter wheat, 3.9 percent spring barley, 2.4 percent dry peas, and 40.1 percent fallow and pasture.

TABLE 1.— LACIE PHASE III CLASSIFICATION OF U.S. AND CANADIAN INTENSIVE TEST SITES USING THE IMAGE 100 HYBRID SYSTEM

Number	Location	Segment				Segment estimate, percent			Ground-truth area estimate, percent		Ground-truth (Y), percent	Bias-corrected estimate minus ground-truth ($\hat{Y}_C - Y$), percent
		Number of acquisitions used	Latest acquisition used	Type of estimate ^a	Robertson biostage	Uncorrected (\hat{X})	Bias corrected (\hat{Y}_C)	Uncorrected (\hat{Y})	Bias corrected (\hat{Y}_C)			
United States												
1963	Kansas	1	77101	WM	3.4	b35.2	41.1	30.8	37.0	34.3	2.7	
1964	Kansas	3	77193	WM	6.5	29.8	b33.6	37.4	37.8	48.6	-10.8	
1965	North Dakota	1	77143	SM	2.7	b27.4	21.9	26.7	22.1	43.1	-21.0	
1973	Washington	1	77118	MG	2.8	18.5	b18.3	22.2	19.7	53.5	-33.8	
1975	Idaho	1	77112	MG	2.2	b9.3	13.9	7.3	13.8	7.0	6.8	
1976	Idaho	1	77166	WM	4.0	12.8	b8.0	20.4	12.6	6.8	5.8	
1983	Indiana	2	77130	WM	3.8	10.5	b14.5	13.2	16.2	2.8	13.5	
1986	South Dakota	3	77194	WM	5.9	b2.5	5.5	2.3	4.6	.5	4.1	
												SM
1988	Kansas	3	77211	WM	7.0	46.8	b42.8	46.1	42.3	41.5	.8	
Canada												
1958	Saskatchewan	2	77182	SM	4.0	47.8	b34.8	40.6	29.6	15.3	14.3	
1991	Manitoba	3	77230	SG	6.9	58.0	b49.5	50.0	44.0	61.3	-17.3	
1992	Alberta	1	77170	SM	3.4	32.4	b18.5	34.2	19.5	2.3	17.2	

^a SM - spring wheat
 WM - winter wheat
 SG - spring grains
 MG - winter grains

^b Estimate reported to CAS

The largest overestimate (17.2 percent) occurred for LACIE segment 1992. This segment had only 2.3 percent spring wheat within the ground-truth area, but the large amount of barley raised the total spring grains to 40 percent. The high wheat estimate was caused primarily by the inclusion of a large portion of barley in the wheat estimate. It is particularly difficult to separate spring wheat and spring barley without an acquisition showing a difference in crop development such as occurs near the ripe stage of barley.

The estimate for LACIE segment 1975 probably is better than is indicated by the table 1 data. Examination of the imagery and the classification map indicates that the wheat proportion probably was much higher in the area outside rather than inside the ground-truth area. The bias correction factors, which were calculated for the entire segment, probably are valid for the segment; however, because the wheat proportions are significantly different in the ground-truth area, these bias correction factors are not appropriate. Even so, the bias correction was applied to the ground-truth area for consistency. (See table 1.)

Figure 1 shows a plot of the proportion errors as a function of the ground-truth proportions for all 13 estimates. It will be seen that the errors are overestimates for segments with low wheat proportions and that the errors are underestimates for segments with high wheat proportions. This behavior is similar to that observed for blind sites (ref. 1) during LACIE Phase I and Phase II.

With the exception of LACIE segment 1973, which was discussed earlier, figure 1 shows that the largest proportion errors occurred in spring wheat and spring grains. Of the five spring wheat and spring grains estimates, two (segments 1958 and 1992) had very large overestimates of spring wheat in segments with very large proportions of barley and oats (46.0 and 38.6 percent, respectively).

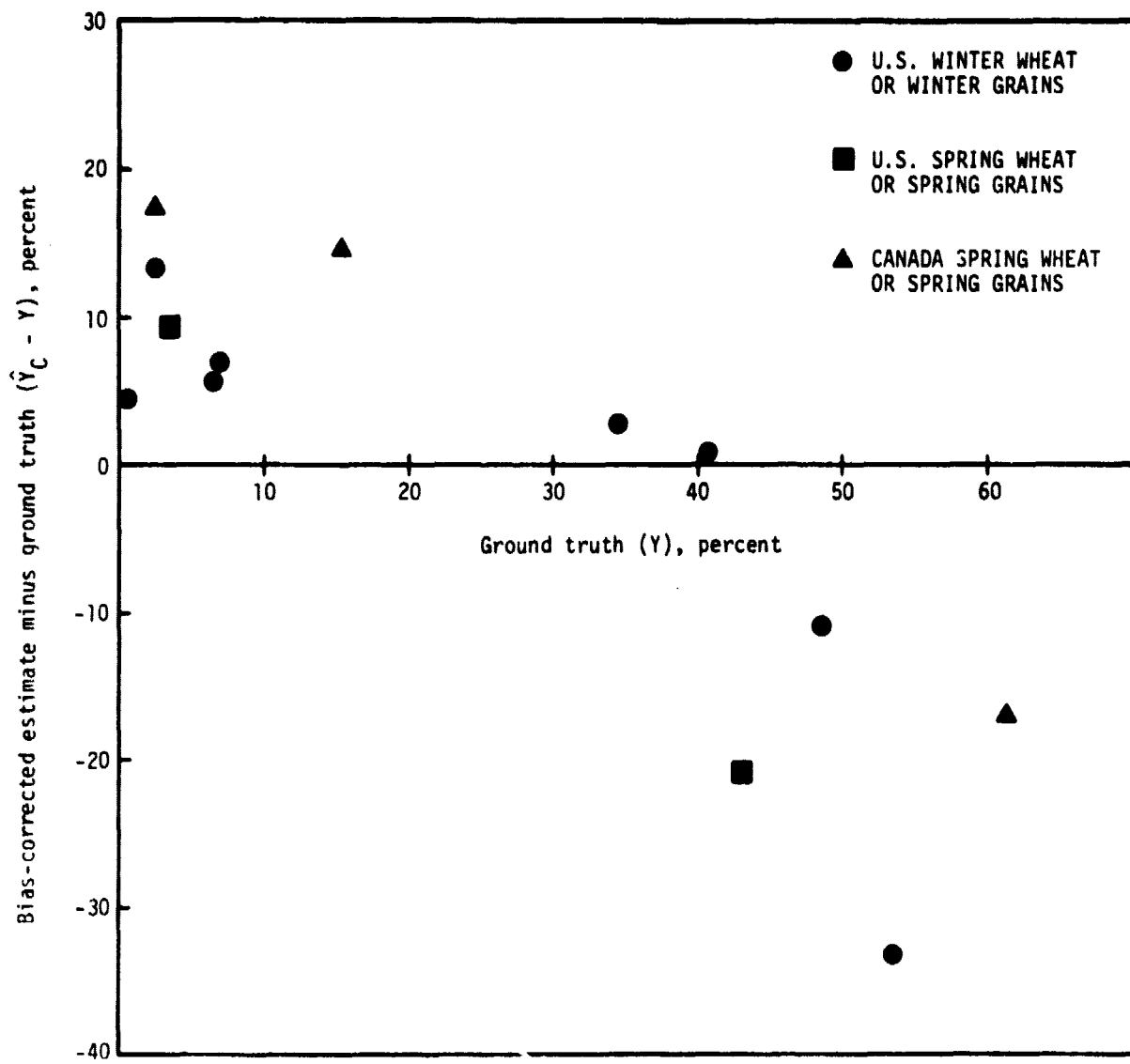


Figure 1.— Plot of proportion errors as a function of ground-truth proportions.

4. CONCLUSIONS

Insufficient data are available to provide a clear picture of the accuracy of the Image 100 classifications, but some specific observations are valid.

- a. Labeling of wheat rather than total grains, particularly with only one acquisition, led to significant overestimates in some segments.
- b. The Image 100 software and procedures were written to facilitate classification of the LACIE segments but were not designed to record data for later accuracy assessment. A much better evaluation would have been possible if accuracy assessment data had been collected following each satisfactory classification.
- c. A more thorough quality assurance check on the Image 100 analysis probably would have prevented reporting to CAS some of the segments (such as 1973 and 1992) which had large estimation errors.

5. REFERENCE

1. LACIE Phase I and Phase II Accuracy Assessment Final Report. LACIE-00450 (JSC-13736), April 1978.