

THE EFFECT OF THE LANDSAT CLOUD COVER DOMAIN
ON WINTER WHEAT ACREAGE ESTIMATION IN KANSAS DURING 1976

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A preliminary analysis was done to determine the effect of a cloud cover domain on winter wheat acreage estimation utilizing LANDSAT data in Kansas during 1976. The objective of the analysis was to see the effect of domain estimation^{1/} in arriving at unbiased estimates of wheat acreage. Thus, the extent and location of cloud cover on LANDSAT imagery in relation to wheat acreage recorded on SRS ground surveys was examined.

For the state of Kansas in 1976, two mosaics were constructed. Both mosaics were constructed using the best quality and most cloud free imagery from the entire months of April and May in 1976. The first mosaic uses only LANDSAT-I imagery and the second mosaic uses only LANDSAT-II imagery. SRS sample segments were manually located on the imagery. Each segment was classified as cloud covered or cloud free. Segments that were partially cloud covered or in cloud shadows were classified into the cloud covered domain.

A composite of the best imagery from both satellites was constructed algebraically. The intersection of the segments that were cloud covered on LANDSAT-I and LANDSAT-II was used to define the cloud cover domain for a composite of LANDSAT-I and II.

The results of the relationship between wheat acreage and the cloud cover domain for this experiment is presented in Appendix I. Significant differences were found for average wheat acres per segment using ground survey data in the two domains (cloud covered vs. cloud free) for LANDSAT-I, LANDSAT-II, and the

^{1/} Hanuschak, George A., LANDSAT Estimation With Cloud Cover, Laboratory for Applications of Remote Sensing, Symposium Proceeding, IEEE Catalog No. 76, June 29 - July 1, 1976.

composite of LANDSATS I and II. Two types of estimates were made for each of LANDSAT-I, LANDSAT-II and the composite of LANDSATS I and II. The first estimate uses only cloud free segment data and the second estimate uses all segment data. The ratio of the cloud free segment estimate to the all segment estimate for LANDSAT-I, LANDSAT-II, and LANDSATS I and II is also included in Appendix I.

The conclusion of the author, based upon a random sample of area segments for which wheat acreage was acquired by ground enumeration for the cloud covered and cloud free domains, is that biased estimates would have resulted if data for both were not available. This analysis would indicate that effects of cloud cover must be adjusted for using auxiliary data, if unbiased estimates are to be obtained when clouds are present.

APPENDIX I

KANSAS LANDSAT PROJECT 1976

LAND USE STRATA

<u>Stratum</u>	<u>Definition</u>
11	More than 75 percent cultivated.
12	50-75 percent cultivated
20	15-49 percent cultivated

Notation:

- n = number of segments in the sample.
- n_h = number of segments in the sample in the h'th land use stratum.
- $n_{h\ cc}$ = number of segments in the sample in the h'th land use stratum that are cloud covered.
- $n_{h\ cf}$ = number of segments in the sample in the h'th land use stratum that are cloud free.
- N_h = number of segments in the population in the h'th land use stratum.
- \bar{X}_{cc} = average acres of wheat per segment in the sample (stratified) for the cloud covered segments.
- \bar{X}_{cf} = average acres of wheat per segment in the sample (stratified) for the cloud free segments.

APPENDIX I

LANDSAT I

Domain	Number of Sample Segments	Average Acres of Wheat Per Segment (Stratified Sample Mean)
Cloud Covered	$45 = \sum_{h=1}^3 h^{n_{cc}}$	$275.4 = \bar{X}_{cc}$
Cloud Free	$111 = \sum_{h=1}^3 h^{n_{cf}}$	$165.0 = \bar{X}_{cf}$

Null Hypothesis: $U_{cc} = U_{cf}$

Alternative Hypothesis: $U_{cc} \neq U_{cf}$

Test Statistic: t

t - calculated = 4.79*

State Acreage Estimates
(Strata 11, 12, 20)

Data	Form of Estimate	Ratio of Cloud Free Segment Estimate To All Segment Estimate
Cloud Free Segments	$\hat{Y}_{cf} = \sum_{h=1}^3 N_h (\bar{X}_{cf})$	$\frac{\hat{Y}_{cf}}{\hat{Y}_a} \times 100 = 84.5\%$
All Segments	$\hat{Y}_a = \sum_{h=1}^3 N_h \cdot \left[\frac{h^{n_{cc}} (\bar{X}_{cc}) + h^{n_{cf}} (\bar{X}_{cf})}{h^{n_{cc}} + h^{n_{cf}}} \right]$	

*Significant difference between domain means (cloud free vs. cloud covered) at the $\alpha = .01$ level.

APPENDIX I

LANDSAT II

Domain	Number of Sample Segments	Average Acres of Wheat Per Segment (Stratified Sample Mean)
Cloud Covered	$14 = \sum_{h=1}^2 h^{n_{cc}}$	$357.3 = \bar{X}_{cc}$
Cloud Free	$102 = \sum_{h=1}^2 h^{n_{cf}}$	$214.8 = \bar{X}_{cf}$

Null Hypothesis: $U_{cc} = U_{cf}$

Alternative Hypothesis: $U_{cc} \neq U_{cf}$

Test Statistic: Behrins-Fisher t

t - calculated = 4.15*

State Acreage Estimates
(Strata 11, 12)

Data	Form of Estimate	Ratio of Cloud Free Segment Estimate To All Segment Estimate
Cloud Free Segments	$\hat{Y}_{cf} = \sum_{h=1}^2 N_h (\bar{X}_{cf})$	$\frac{\hat{Y}_{cf}}{\hat{Y}_a} \times 100 = 92.7\%$
All Segments	$\hat{Y}_a = \sum_{h=1}^2 N_h \cdot \left[\frac{h^{n_{cc}} (\bar{X}_{cc}) + h^{n_{cf}} (\bar{X}_{cf})}{h^{n_{cc}} + h^{n_{cf}}} \right]$	

*Significant difference between domain means (cloud free vs. cloud covered) at the $\alpha = .01$ level. Since there were no cloud covered sample segments in stratum 20, it was not included.