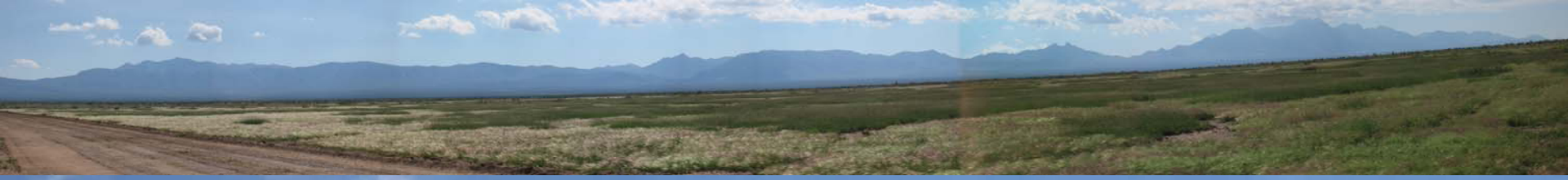

Correlation of Object-based Texture Measures at Multiple Scales in Sub-decimeter Resolution Aerial Photography

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Background

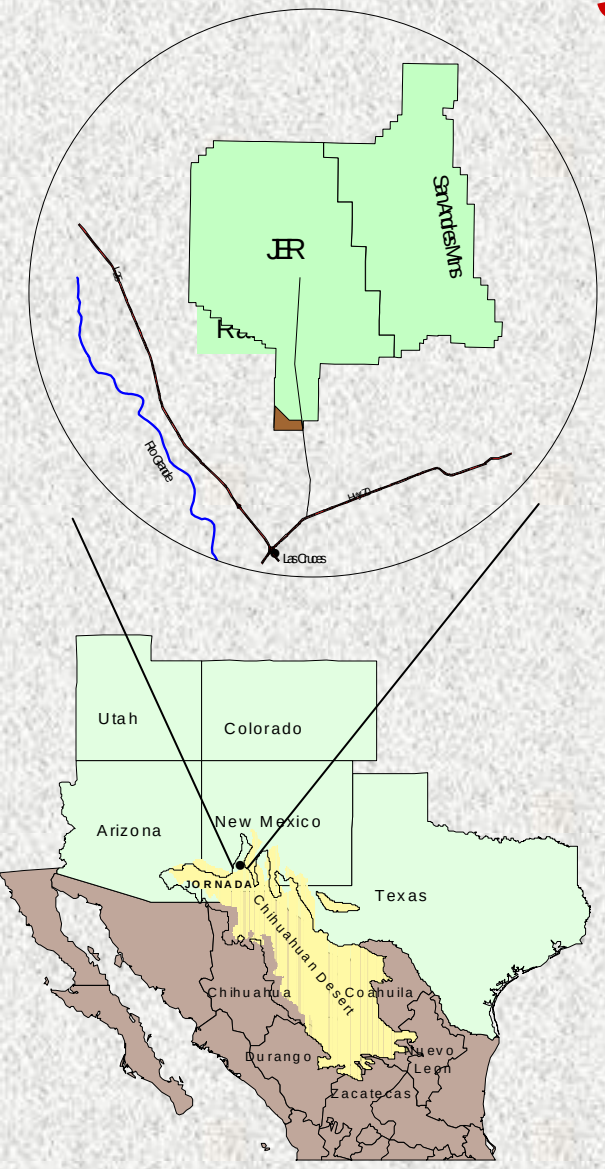
- Texture measures commonly used to increase information content and improve classification accuracy
- Useful with high resolution imagery and/or compensate for few spectral bands
- Well documented in pixel-based image analysis, not so in OBIA; more time consuming
- 2 main issues in OBIA:
  - Optimal segmentation scale
    - Sensitivity of texture to scale
  - Most suitable features
    - Knowledge of correlation between texture features reduces input variables

Objectives

- Determine optimal texture features
- Determine optimal image analysis scale
- Assess correlations between texture features as function of segmentation scale

for mapping of broad rangeland vegetation structure groups (bare ground, grasses, shrubs) in arid rangelands using sub-decimeter aerial photography

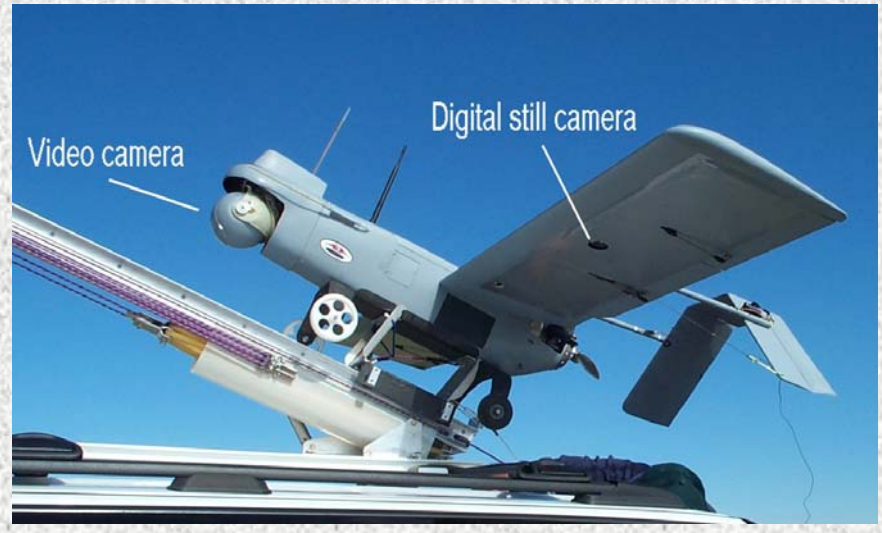
Study Area and Imagery



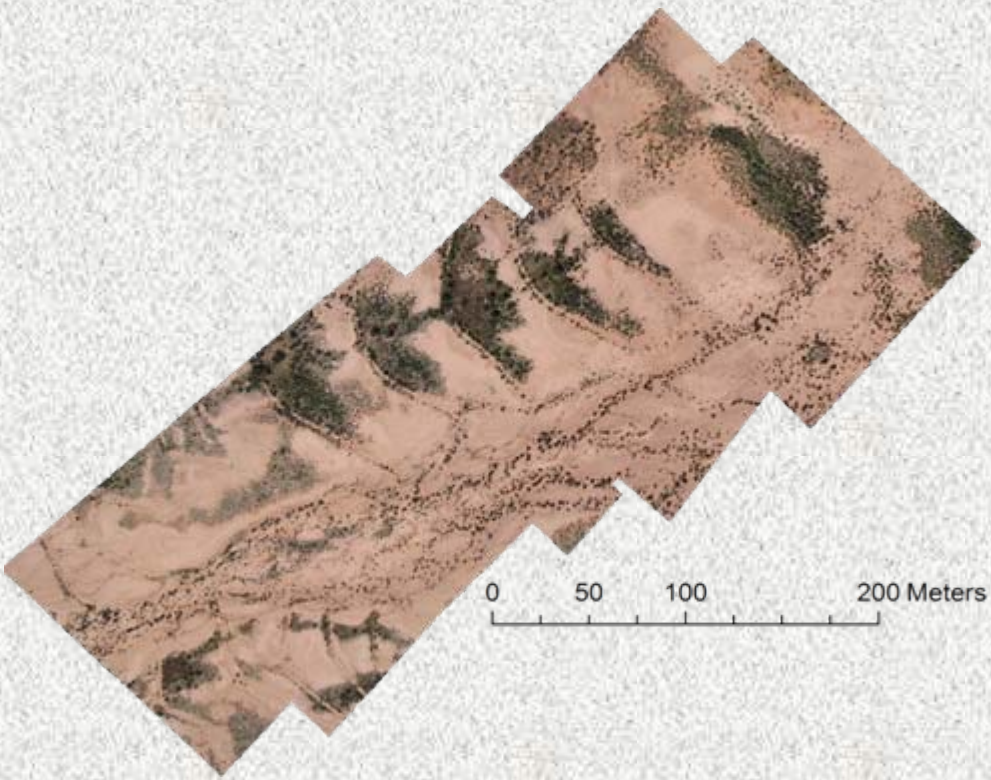
- Jornada Experimental Range, 780 km^2 - USDA ARS
- 5-cm resolution aerial photos acquired with unmanned aerial vehicle (UAV)
- Low-cost digital camera, RGB imagery
- Research into utility of UAVs for rangeland mapping/monitoring and developing workflow for acquiring, processing, and analyzing UAV imagery for use by BLM, NRCS

Rangeland Monitoring with a UAV

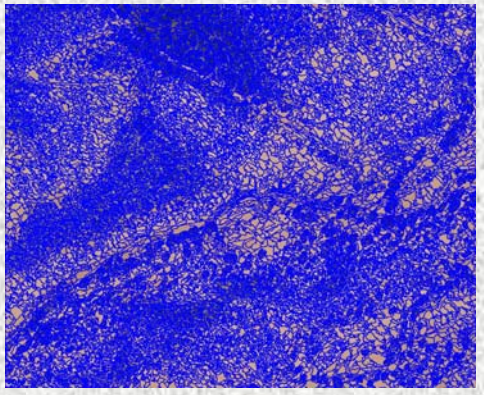
- Low flying height allows for mapping individual plants, patches, gaps, and patterns at very high resolution
- Bridges gap between ground measures and aerial photos/satellite imagery
- Texture had proven useful in related study



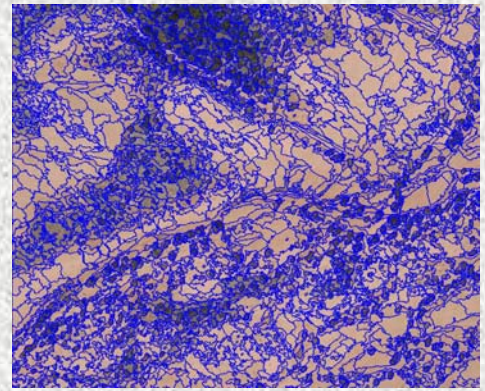
Imagery and Segmentation



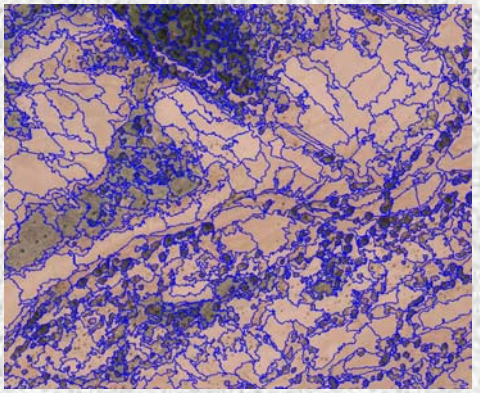
Scale 10



Scale 45



Scale 80



- 8-image mosaic, 170 m x 500 m
- Segmented at 15 scales (10-80), using Definiens Professional 5
- Upper scale limited by need to retain individual shrubs

Texture features

Texture Feature	Abbreviation
GLCM Homogeneity	MHOM
GLCM Contrast	MCON
GLCM Dissimilarity	MDIS
GLCM Entropy	MENT
GLCM Angular 2nd moment	MASM
GLCM Mean	MMEAN
GLCM Standard Deviation	MSTD
GLCM Correlation	MCOR
GLDV Angular 2nd moment	VASM
GLDV Entropy	VENT

Texture calculated on all 3 bands and average of all directions

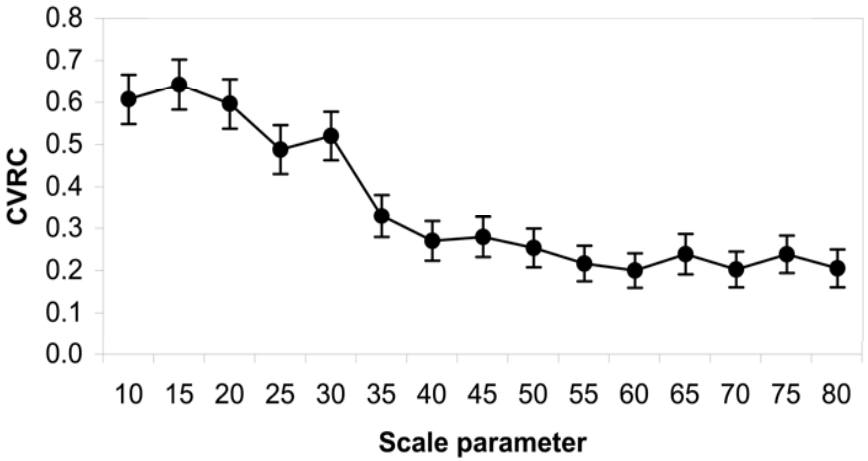
Analysis

- Used decision tree to determine optimal texture features for each scale
- 300 samples, ½ for creating map, ½ for accuracy assessment
- Spearman's rank correlation analysis

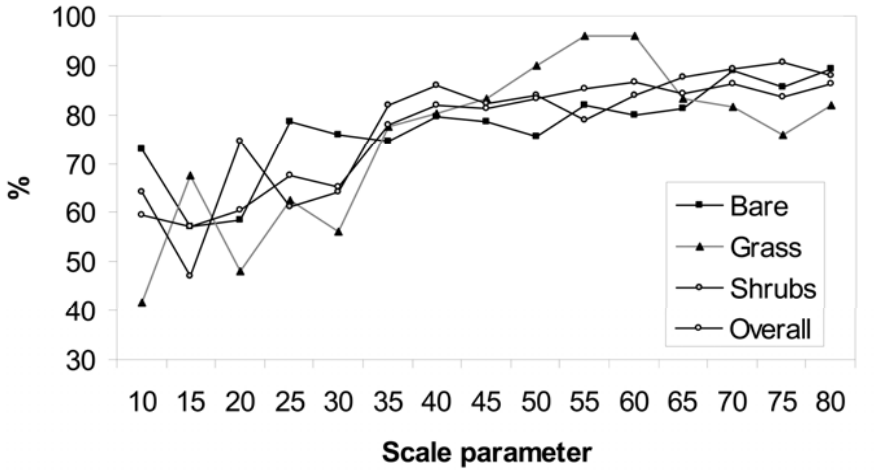
Order of texture features chosen by DT

SP	MENT	MEAN	MCOR	MCON	MHOM	MDIS	MSTD	VENT
10	3	4	5	6	7		1	2
15	2		4		5	1		3
20	2			1				
25	2	3	5	1			4	6
30	2	5	6			1	4	3
35	2	4		5		3	1	
40	2			3			1	
45	1	4	5	2	6	7	3	
50	2					1		
55	1					2		
60	1					2		
65	1	4		2			3	
70	1			2		4	3	
75	1			2			3	
80	1			2			3	

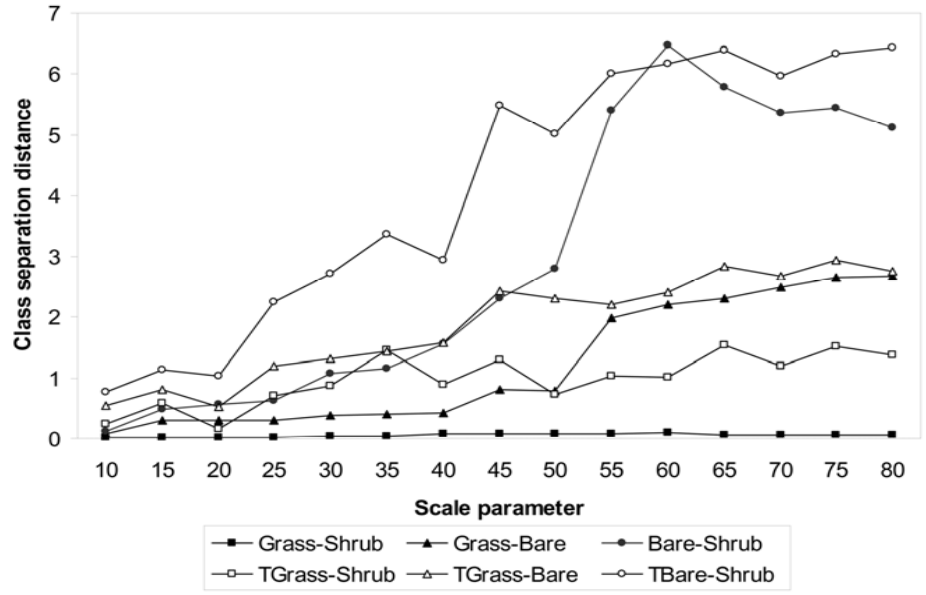
Accuracy vs. segmentation scale



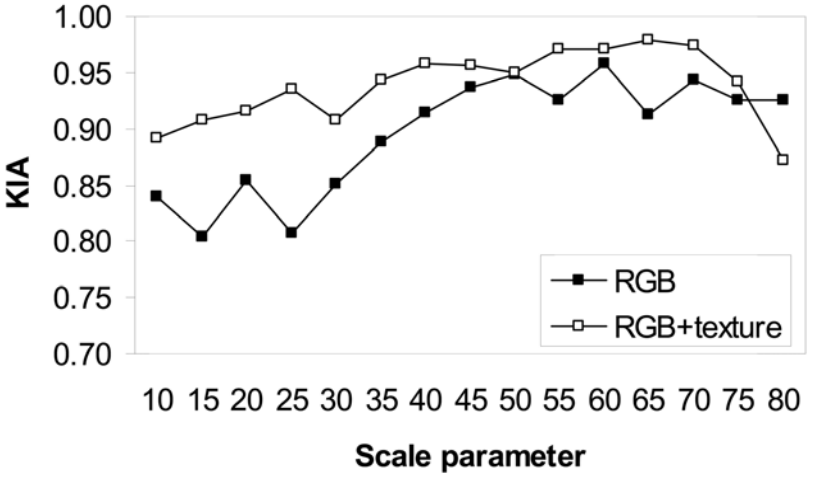
Cross-validated relative cost



Prediction success

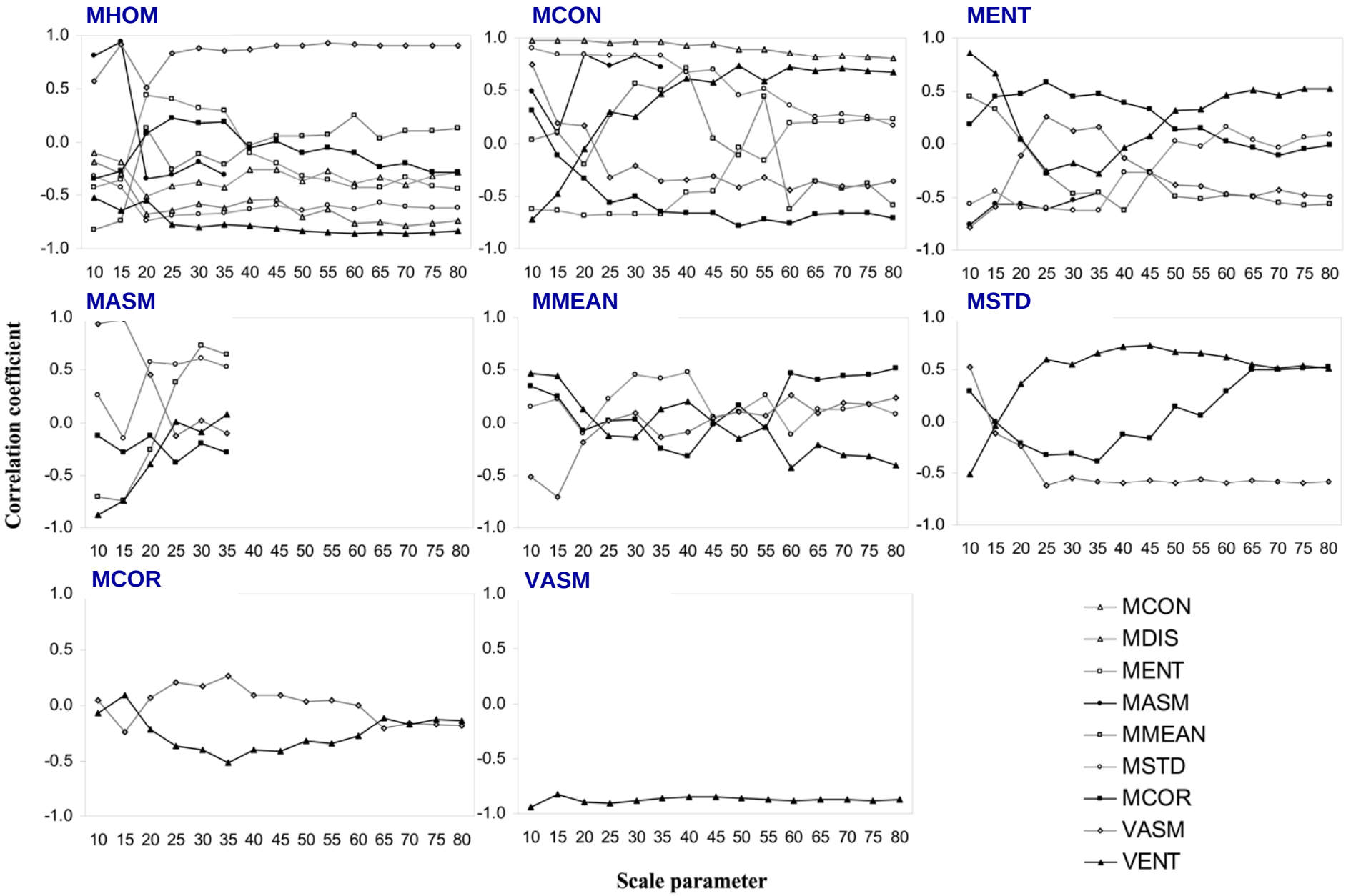


Class separability



Kappa statistic

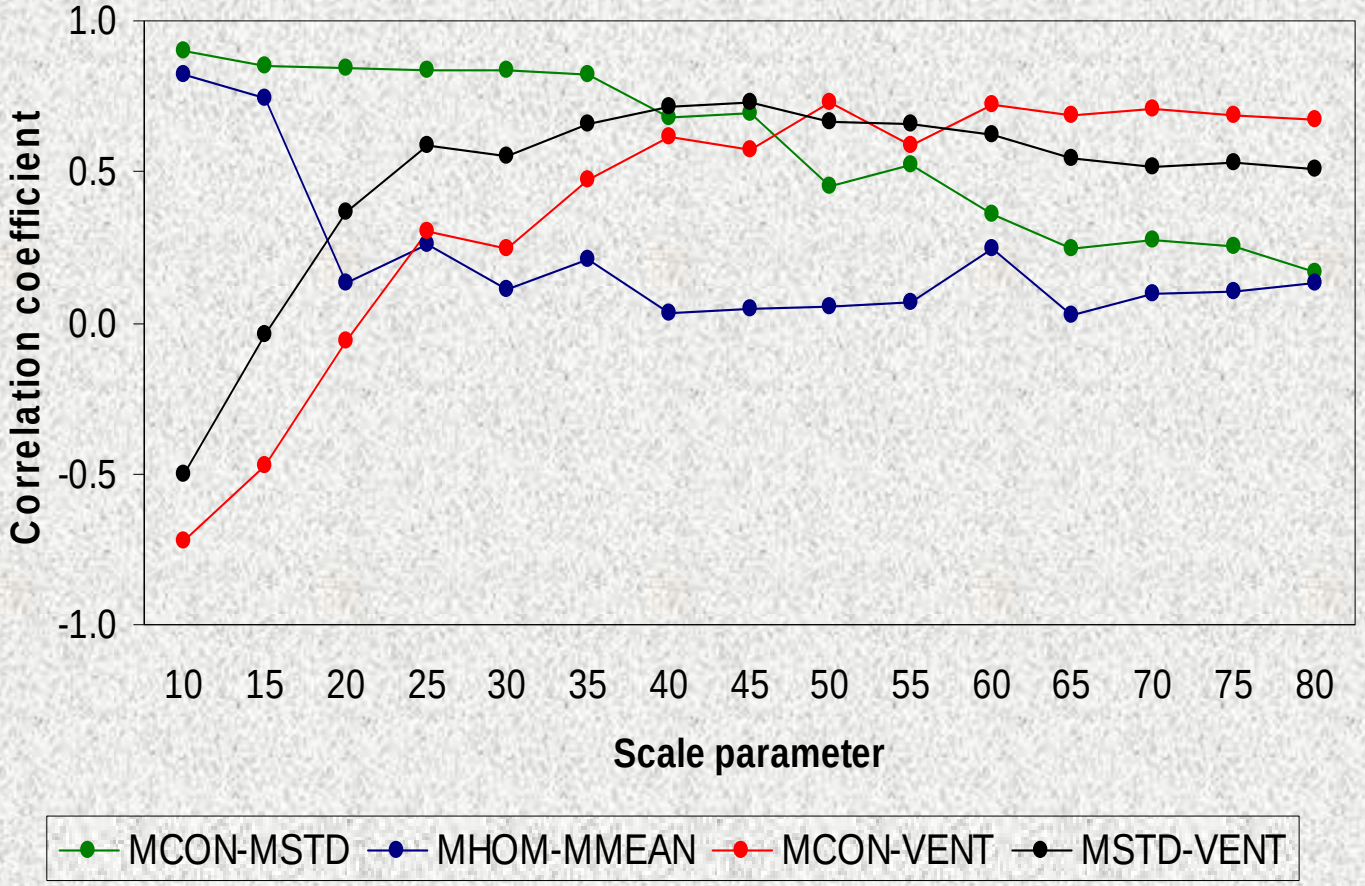
Correlations



Correlations

- MCON-MDIS and VASM-VENT were most highly correlated and had stable correlation across scales (>0.8)
- MCOR, MMEAN, MENT had least correlation with other texture features (<0.5)
- Decreasing correlation with increasing scale
  - MCON-MSTD, MHOM-MMEAN
- Increasing correlation with increasing scale
  - MCON-VENT, MSTD-VENT

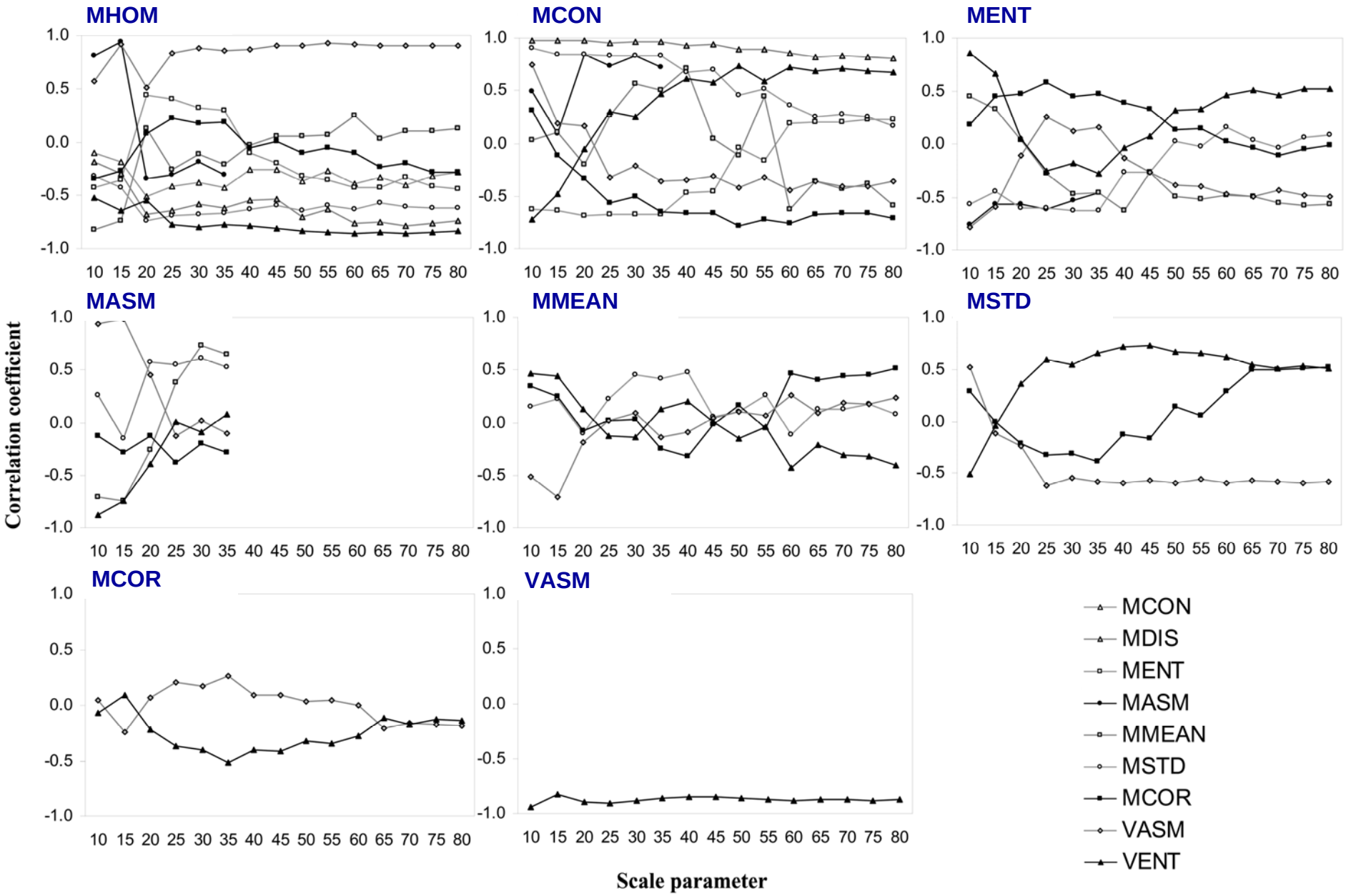
Increasing and decreasing correlation coefficients



Calculation of texture in OBIA at multiple scales

- At fine scales, the ratio of edge pixels to interior pixels is larger than at coarser scales
- Texture may not be meaningful at very fine scales
- As scale increases, adjacent image objects are less homogenous than at finer scales and differ more in terms of texture
- More variability in correlations from one scale to next at fine scale; more consistency at coarser scales – an indication of suitable scale?

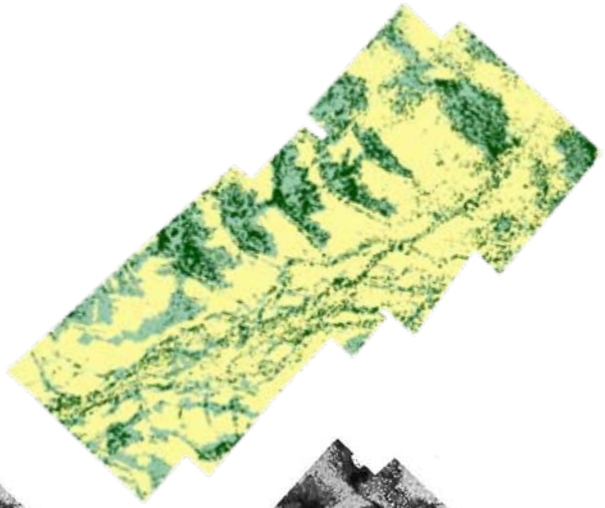
Correlations



Texture features selected by DT

- At fine scales, more correlated variables were selected
- Variables selected at coarse scales had little correlation
- At scales 65-80, DT selected MENT, MCON, MSTD
- MENT (Orderliness group), MCON (Contrast group), MSTD (Statistics group)

Entropy at eight segmentation scales



Grass
Shrubs
Bare

10

20

30

40

0 50 100 200 Meters

50

60

70

80

Conclusions and Future Research

- Changing correlation with segmentation scale related to accuracy
  - Higher accuracy, lower error rate of DT – “stability” of correlation coefficient between adjacent scales
- May be a good indicator of appropriate scale when using texture, in conjunction with accuracy
- Combination of using DT and correlation analysis in OBIA advantageous for:
  - Finding most suitable and uncorrelated texture features
  - Determining optimal analysis scale
  - Reducing computation times
- Fewer variables are preferred, if texture is used

Conclusions and Future Research

- Use of texture for classifying imagery from low-cost digital camera from a UAV resulted in high classification accuracies
- Trade-off between highest accuracy and computation times for texture
- Approach has be tested in other vegetation communities and to the species level

Acknowledgments

- The Jornada field and UAV team
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  - Amy Slaughter
  - Dave Thatcher
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