# Using Remote Sensing to Identify Size and Condition of Kansas Windbreaks

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#### **Project Background**

- **38** Lack of Data on Windbreak Size, Condition and Location of Windbreaks
- Strong Windbreak Renovation Interest in SW Kansas
- 2008 Project Award 1<sup>st</sup> Year for USFS S & P Western Competitive Resource Allocation – "Redesign" (\$116,567)

#### 3 2008 - 2009 Great Plains Tree and Forest Invasives Initiative Inventory

- 2.9 million acres 84% "isolated trees" without a specific function
- 289,577 acres of windbreaks totaling 43,436 miles long
- Protects 1.2 million acres (59% field, 28% farmstead, 12% livestock)
- Condition 56% good, 44% fair to poor
- Age 59% 25-50 yrs., 21% older than 50 yrs., 20% less than 25 yrs.
- Species (in millions of trees) Osage orange 17, hackberry 15, eastern redcedar 8, American elm 5, Siberian elm 4, green ash 1



Project Timeline 2008 USFS Grant Application 2009 Mike Dulin's Thesis – Ford County 2010 Kabita Ghimire 2011 Ground Truthing

Neeravi Nepal Aug. 26, 2011

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# Major Goals

- 1. Identify the location, size and condition of field windbreaks
- 2. Identify priority areas where windbreak establishment is most effective in reducing windblown soil
- 3. Assign ecosystem service values to the windbreaks
- 4. Increase implementation of windbreak renovation practices





# Specific objectives



- Rapidly classify windbreaks using Object
   Based Classification of remote sensing images
- Develop a secondary classification to assess windbreak condition (good, fair, poor) using same criteria that NRCS uses to qualify windbreaks as an EQIP "resource concern"
- Determine the number of acres/hectares that exists in each class
- Interface landownership GIS layer with poor condition GIS layer to target promotion of windbreak renovation



# Study Area: Coronado Crossings Resource Conservation and Development Area

#### National Agriculture Imagery Program (NAIP)

- 2008 4 band color aerial imagery tiled by county in 1-meter resolution
- 2006 CIR (colored infrared imagery) tiled by county in 1-meter resolution
- The 2008 NAIP imagery was collected during the growing season during the months of June and July







#### Gray county NAIP 2008 Image



Gray county boundary overlay

# 5 Step Methodology

- Image pre-processing
- Object based classification using ENVI Zoom 4.5
- Windbreak Class extraction
- Editing of windbreak features and attributes in Arc GIS
- Assessment and area calculation



#### Image preprocessing

- Resampling of NAIP images with ArcMap
  - Using the nearest neighbor technique at a factor of 6
  - To reduce the image file size
  - Speed up computer processing
  - Resampling also transformed windbreaks into more homogeneous areas of pixels rather than isolated cells containing a single tree within a windbreak







#### Original (1 M)



Resampled (6 M)

# **Object Based Classification - ENVI Zoom 4.5**

**Feature Extraction** – IDs different objects and puts them into blocks of similar pixels.

#### **Segmentation and merging**



#### **Thresholding and Masking**



# Land Use/ Land Cover Classification

LULC Type	Description
Crops	Live row crops including center pivot irrigation land
Tree Stands	Individual stands of trees/shrubs not linear in nature and not near water features
Riparian	Long irregularly shaped stands of trees bordering water features
Windbreaks	Linear Strips of trees planted near farm houses and crop fields likely to have jagged edges conforming to the shape of outer edge trees
Manicured Landscape	Vegetative features such as Golf Courses and Lawns under apparent human management
Ditches	Extremely long linear features running parallel to roads and rail road tracks containing few trees and smooth edges

#### Training ENVI Zoom 4.5 to Identify Objects By Land Use/Cover Class

Cover Type	Number of Training Sites By County							
	Ford	Gray	Clark	Hodgeman	Haskell	Meade	Seward	Total
Crops	35	52	50	50	50	50	50	337
Ditches	15	22	38	25	25	25	25	175
Manicured Landscapes	6	10	10	5	5	5	5	46
Riparian	20	18	83	85	20	75	50	351
Tree Stands	50	63	75	50	30	50	30	348
Windbreaks	45	35	65	65	10	50	10	280
<b>Total samples</b>	171	200	321	280	140	255	170	1537





In Gray County 200 sites were used to classify 33,911 total objects

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## Classified Objects overlaid on the original Image





Counties	Number of objects
	classified
Ford	51,202
Gray	33,911
Clark	64,518
Hodgeman	33,853
Haskell	15,909
Meade	40,576
Seward	30,173

# **Classification Accuracy – Ford County**

	NWB	WB	Row Total	User Accuracy
NWB	1115	63	1178	94.65%
WB	36	119	155	76.77%
Column total	1151	182	1333	
Producer	96.87%	65.38%	Overall	92.57%
Accuracy	Accuracy			
Kappa is a static expected due to c agreement (mode	66.4% Kappa			

8 63 of 1,178 NWB objects were misclassified as windbreaks

Out of 155 objects in the WB class, 119 were actually windbreaks

# Working with ArcGIS

- Windbreak Class extraction (getting rid of NWB objects)
- Editing windbreak features and attributes in Arc GIS
- Assessment and area calculation



#### Consolidating Poor Condition Windbreaks into One Windbreak





#### Clark County Windbreak Locations

166 windbreaks729 acres1,981 acres protected55 miles30 ft. AV HT



Windbreaks
County Boundary
NAIP Image



Haskell County Windbreak Locations

22 windbreaks26 acres98 acres protected





Wind Erodibility Index of 86+

- Provides some guidance for potential new CRP practices 488 (48%) WEI 86+ (green dots)
- A total of 1,116 windbreaks covering 2,597 acres
- Total of 8,202 Acres
   Protected (3,319 Hectares)
   (10 x AV HT of 30 FT)



## Number of Windbreaks 7 counties



## Area of WB in 7 counties

County	Number of	Area covered by Windbreaks				
	Windbreaks	Acres	Hectares			
Gray	196	222.5538	90.064			
Haskell	22	26.9154	10.89			
Seward	29	26.170	10.590			
Clark	166	728.8169	294.941			
Ford	355	1011.9	409.5			
Hodgeman	109	140.538	56.8737			
Meade	239	440.451	178.244			
Total	1116	2597.3451	1051.1027			

Total of 8,202 Acres Protected (3,319 Hectares) (10 x AV HT of 30 FT)

#### Area of WB in 7 counties







# **Condition Assessment Criteria**

KANSAS FORESTRY TECHNICAL NOTE KS-11

- Less than 25 percent of the trees are dead
- Continuous barrier; no gaps
- 50 percent density or greater
- No smooth bromegrass or fescue sod
- No livestock activity in the windbreak
- Tree regeneration is present
- Windbreak will live/function another 20 years



# **Condition Classes**

- Good At least seven of the attributes describe the windbreak; (one includes less than 25 percent of the trees are dead)
- Fair At least five of the attributes describe the windbreak; (one includes less than 25 percent of the trees are dead)
- **Poor** At least four of the attributes describe the windbreak; more than 25 percent tree mortality

# **Condition Assessment**

Brightness Value (Average green reflectance value), band 2
Low BV = Lower reflectance = Good WB condition
High BV = High reflectance = Poor WB condition

#### • Texture Analysis

High textural value = Coarser feature = Poor WB condition Lower textural value = Finer feature = Good WB condition

#### • Normalized Difference Vegetation Index (NDVI)

- NDVI value ranges from 0.0 to 1.0
- High NDVI = Good Vegetation Health = Good WB condition
- Lower NDVI = Poor Vegetation Health = Poor WB condition

#### • Ground Truth Information

based on windbreak condition class evaluation guide

# **Brightness Value**

 Average green reflectance value, band 2
 Low BV = Lower reflectance =Good WB condition (nothing is being reflected from the ground – good canopy, few gaps)
 High BV = High reflectance = Poor WB condition



# **Texture Analysis**

#### High textural value = Poor WB condition

rough, patchy features, gaps

#### Lower textural value = Good WB condition finer features



Mean texture value for this windbreak = 53.65



**Normalized Difference Vegetation Index** 

NDVI is a measure of amount and vigor of vegetation using reflective spectral values of imagery

NDVI value ranges from 0.0 to 1.0

High NDVI = Good Vegetation Health = Good WB condition Lower NDVI = Poor Vegetation Health = Poor WB condition

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# **Ground Truth Information**

- Final assessment based on ground truth Information
- 12% of the windbreaks were visited to collect ground truth information



County	No of WB	GT WB
Gray	196	32
Haskell	22	4
Seward	29	3
Clark	166	24
Ford	355	43
Hodgeman	109	21
Meade	239	17
Total	1116	114

25% – 38% of the time ground truthing correlated to remote sensing condition

## **Condition Assessment**

County	Condition classes									
	Good			Fair			Poor			
	No	Acres	Hectares	No	Acres	Hectares	No	Acres	Hectares	
Gray	77	117.291	47.4660	41	34.77	14.07	78	70.490	28.526	
Haskell	15	12.511	5.0630	7	14.404	5.829	0	0	0	
Seward	20	17.442	7.058	7	5.903	2.389	2	2.824	1.142	
Clark	14	37.414	15.141	43	168.754	68.2926	109	522.647	211.508	
Ford	110	313.1	126.7	185	528.6	213.9	60	170.2	68.9	
Hodgeman	40	45.6791	18.4856	21	19.121	7.7380	48	75.737	30.650	
Meade	79	124.045	50.199	54	101.0848	40.9076	106	215.321	87.1776	
Total	355	667.4821	270.1126	358	872.6368	353.1262	403	1057.219	427.9036	

# **Condition Assessment**





Clark County Condition Assessment

14 Good – 37 AC, 15 HA 43 Fair – 168 AC, 68 HA

109 Poor – 523 AC, 211 HA





# Application, Measuring Success & Changes to Project Methodology

- Obtained landowner parcel/contact information County Assessors Offices
- County Conservation Districts direct mail letters to landowners with WB in poor condition for Cooperative Conservation Partnership Initiative(CCPI) Environmental Quality Incentives Program (EQIP) – (April 2011)
- In 2011 over 50 applications for windbreak renovation were received in the project area, none in previous yrs.
- Incorporation of LIDAR (Light Detection and Ranging) into remote sensing application (Smoky Hill Region)
- Since 2010 98 CCPI contracts for \$358,651

#### Status of LiDAR in Kansas



#### FY2012 Project Area (28,446 SqMi)

Area 1 (8,793.4 SqMi)

📕 Area 2 (9,932.4 SqMi)

Area 3 (9,720.1 SqMi)

Underway/Completed