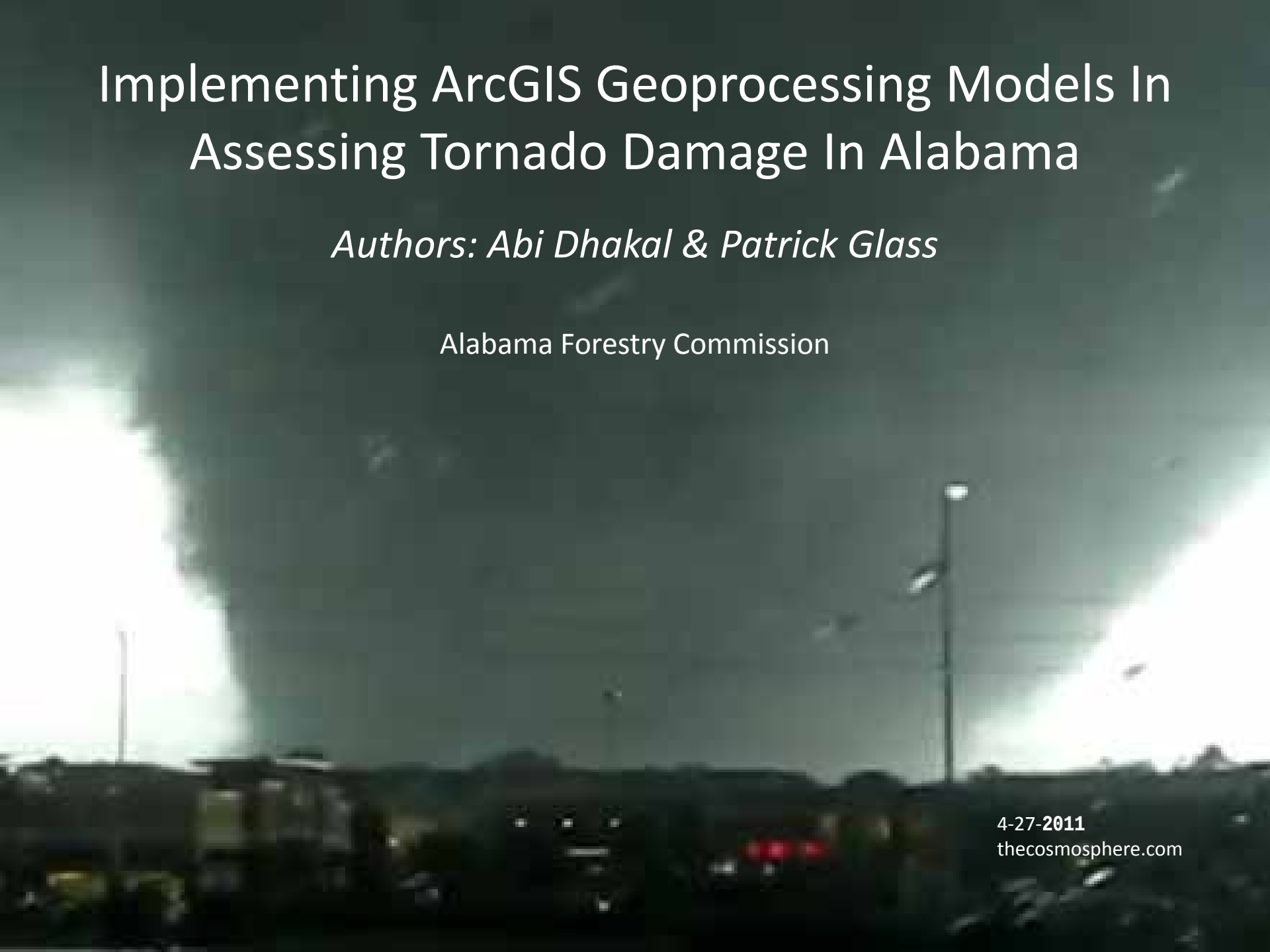
Implementing ArcGIS Geoprocessing Models In Assessing Tornado Damage In Alabama

Authors: Abi Dhakal & Patrick Glass

Alabama Forestry Commission

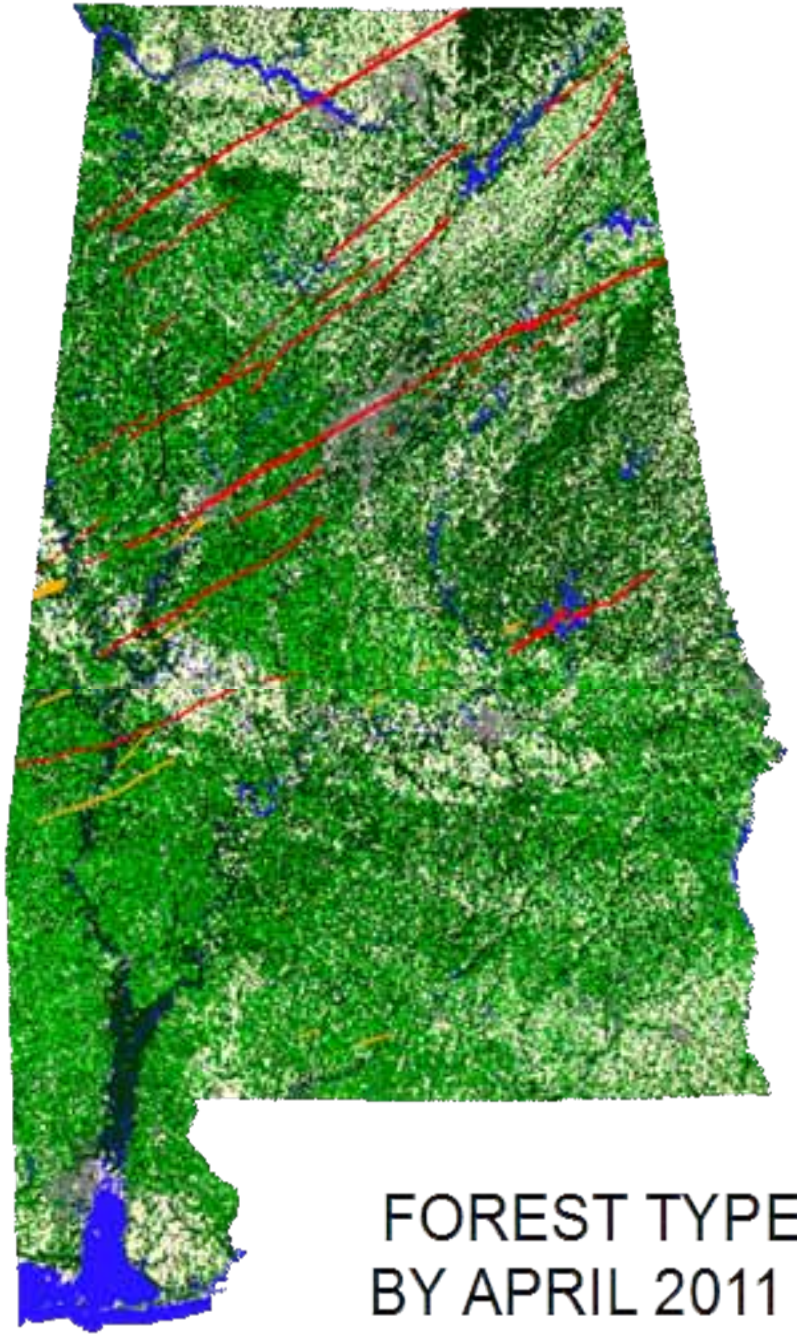


Hundreds of lives were lost in the April 2011 tornadoes.

Thousands of acres of forestland were destroyed.

Millions of tons of timber were destroyed.

The estimated value was in the millions of dollars.



Legend

Storm Date

- 4/27/2011
- 4/15/2011

Classified Land Cover

- Water
- Urban
- Non Forest
- Hardwood
- Mixed Pine - Hardwood
- Pine

Map subject To Change With Additional Data and Analysis

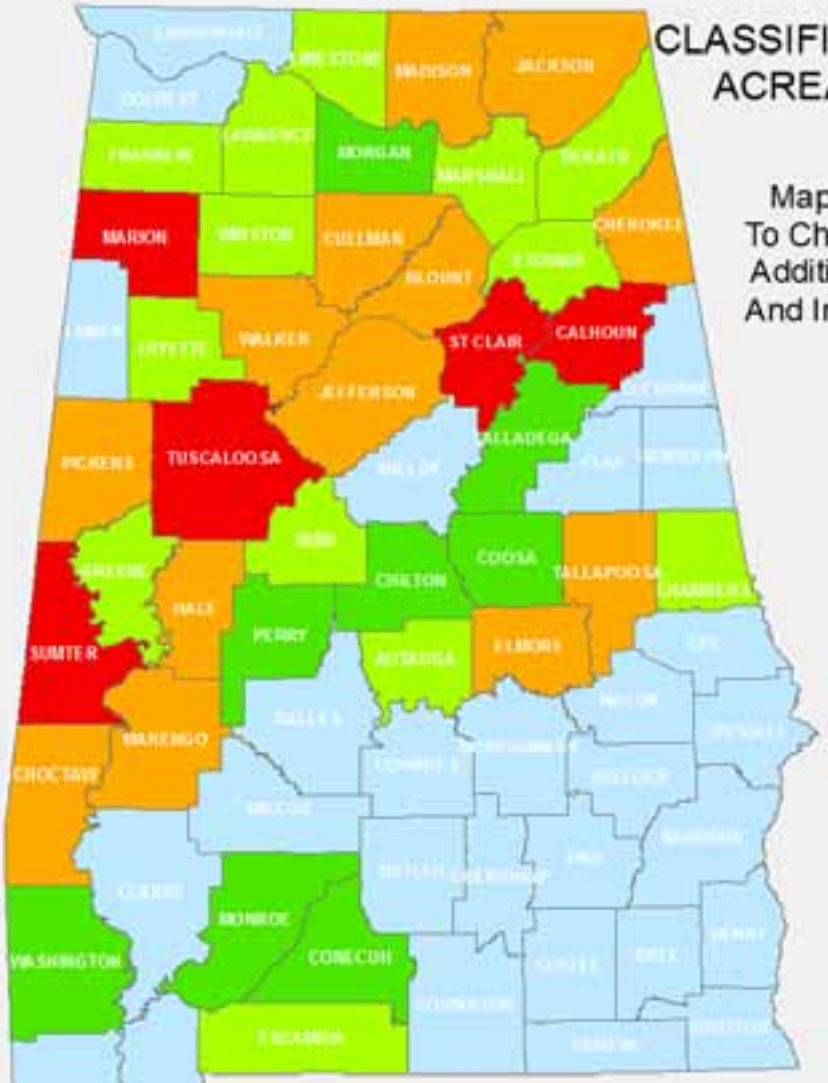
ALABAMA FORESTRY COMMISSION

FOREST TYPES IMPACTED BY APRIL 2011 TORNADOES

N W E S

CLASSIFIED COUNTY ACREAGE MAP

Map Subject To Change With Additional Data And Information



Damaged Acres

- No Damage
- Less Than 1,000
- 1,000 - 5,499,
- 5,500 - 9,999
- 10,000 or Greater

ALABAMA FORESTRY COMMISSION

Alabama Forestry Commission (AFC) Process Outline

- Implemented Methods to Acquire Tornado Damage Data
- Created Geospatial Data of the Tornado-Damaged Paths
- Coordinated with the State's GIS Task Force for Tornado Data
- Developed ArcGIS Geoprocessing Models
- Summary

Acquisition of Tornado Damage Data

- AFC pilots were tasked to send in GPS Exchange Format (GPX) files of the tornado-impacted areas to the AFC State Headquarters.
  - The GPX files came in as waypoints and tracks.
  - Waypoints were sent for impacted areas where significant linear damage was minimal.
  - Tracks were sent for areas of significant linear damage.
  - The GPX files were converted to feature classes using DNR Garmin.
- Data was also obtained from NOAA's National Weather Service.
- Some of the tornado damage paths were obtained from the State FTP site, facilitated by Information Services Division (ISD).

ALABAMA FORESTRY COMMISSION

Creation of Geospatial Representation of the Tornado Damage Paths

- Waypoint data included estimates of damaged areas that were converted to circular polygons.
- Track data included ‘width of damage’ estimates and were used to make polygons of damaged areas.
- Polygon data received for the tornado damage was used “as is.”

Coordination with the State's GIS Task Force

- AFC regularly participated in GIS Task Force telephone conferences in the immediate aftermath of the tornadoes and as required thereafter.
- AFC, with its limited resources, effectively contributed to the understanding of the extent of the tornado damage:
  - Maps of tornado damage extent, as well as data acquired and developed, was shared through the State's FTP site;
  - Comparative analysis of data from various sources resulted in more accurate data development, consequently leveraging the understanding of the extent of the damage.

Aftermath of Twister. Pratt City, Birmingham, Alabama
Source:Washingtonpost.com

ALABAMA FORESTRY COMMISSION

ArcGIS Geoprocessing Models

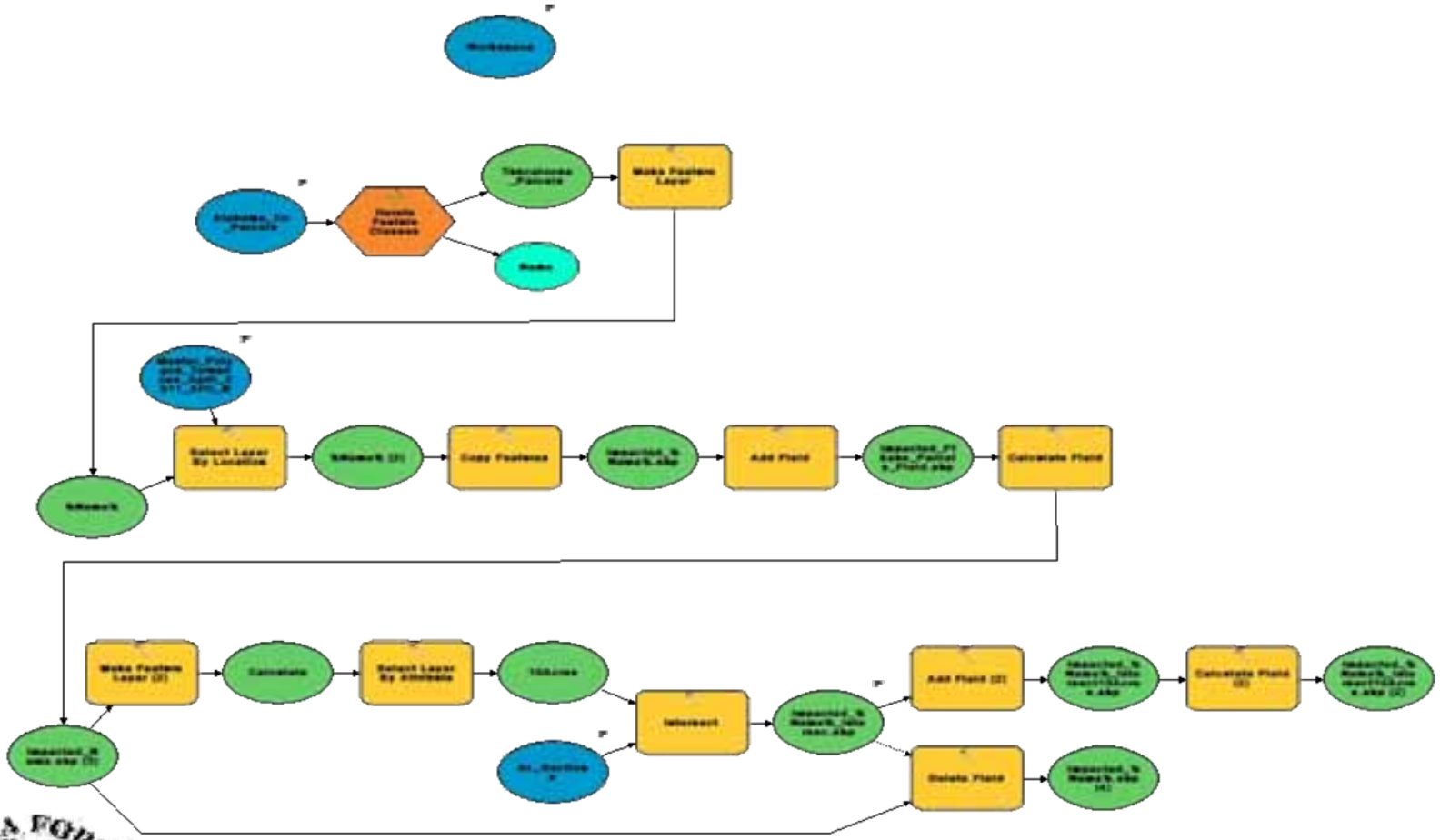
- AFC developed several geoprocessing models to accommodate most of the outputs required by the agency.

- The required outputs included:
  - Identification and extraction of all parcels in the paths of the tornadoes.
  - Extracted parcels were attributed with Section, Township, and Range (STR) information.
  - Extracted parcels were identified for urban or rural locations.
  - The parcels were further geoprocessed with National Land Cover Database (NLCD) and Wildfire Susceptibility Index (WFSI) data for forest cover and susceptibility to fire.

Tuscaloosa, Alabama

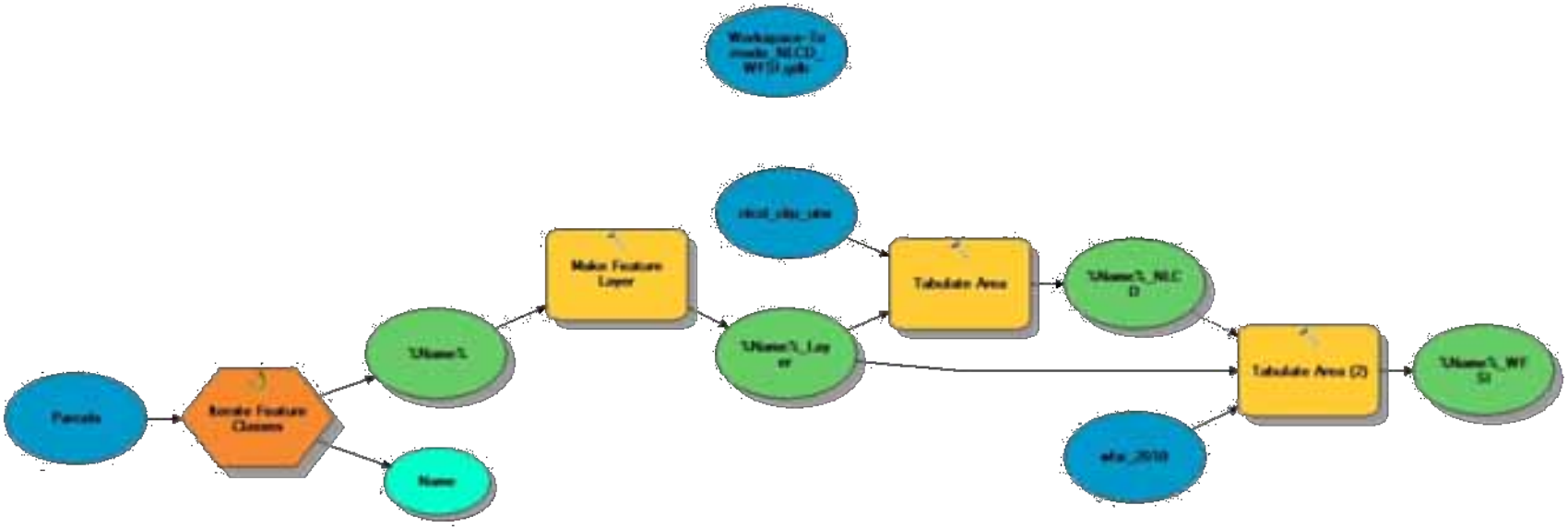
ALABAMA FORESTRY COMMISSION

Sequestering Tornado-Damaged Parcels, Calculating Acres, and Appending STR

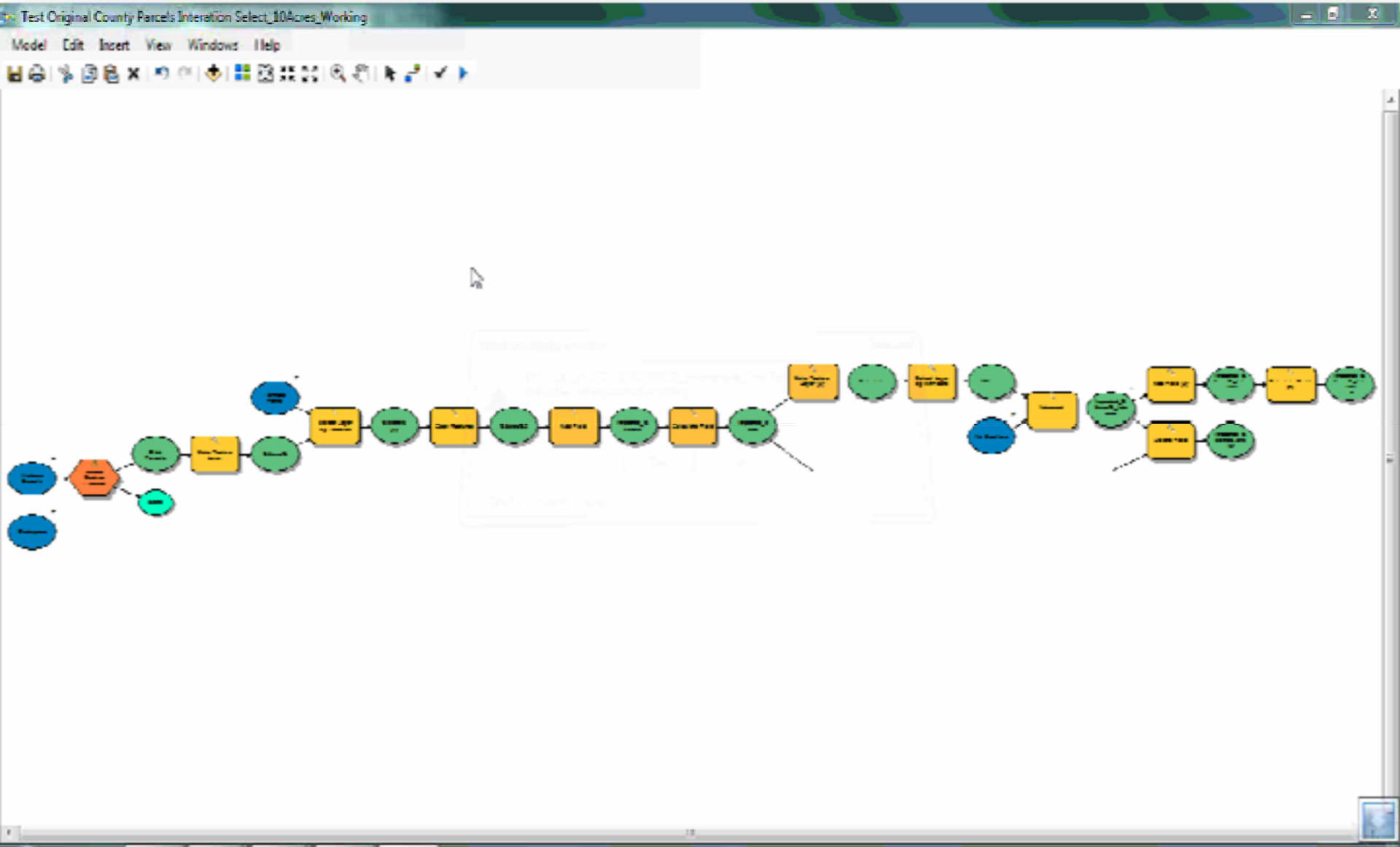


ALABAMA FORESTRY COMMISSION

Appending NLCD and WFSI Values to the Parcel Records



ArcGIS Geoprocessing Model



Results/Example

Impacted Madison County Parcels - NLCD Value in Sq Meters

OBJECT	Urb/Rural	HW_41	Pine_42	Mixed_43	Mixed_52	HW_90
1	Rural	26,999	0	1,800	2,700	0
2	Rural	137,695	0	16,199	900	0
3	Rural	0	0	0	0	0
4	Rural	0	0	0	0	0
5	Rural	0	0	0	0	0
6	Rural	0	0	0	0	0
7	Rural	0	0	0	0	0
8	Rural	0	0	0	0	0
9	Rural	0	0	0	0	0
10	Rural	0	0	0	0	0
11	Rural	0	0	0	0	0
12	Rural	0	0	0	0	0
13	Urban	0	0	0	0	0
14	Rural	0	0	0	0	0
15	Rural	0	0	0	6,300	0
16	Rural	0	900	0	0	0
17	Rural	0	0	0	0	0
18	Rural	0	1,800	0	0	0
19	Rural	0	0	0	0	0
20	Rural	0	0	0	0	0
21	Rural	0	0	0	0	0
22	Rural	0	0	0	0	0
23	Rural	0	0	0	0	0
24	Rural	0	0	0	0	0
25	Rural	0	0	0	0	0
26	Rural	0	0	0	0	0
27	Rural	0	0	0	0	0
28	Rural	900	0	0	900	0
29	Rural	0	0	0	0	0

41 – Deciduous Forest
42 – Evergreen Forest
43 – Mixed Forest
52 – Scrub/Shrub
90 – Woody Wetlands

Anderson Hills, Madison County
Wednesday, April 27, 2011
Source: Internet

Results/Example

Impacted Sumter County Parcels - WFSI Value in Sq Meters

OBJECTID	Low_1	Medium_2	High_3
1	9,900	380,700	95,400
2	2,700	0	0
3	900	30,600	0
4	16,200	37,800	0
5	6,300	6,300	0
6	900	6,300	0
7	3,600	0	0
8	118,800	0	0
9	103,500	315,900	84,600
10	3,600	0	0
11	7,200	0	0
12	4,500	0	0
13	5,400	0	0
14	2,700	0	0
15	493,200	0	0
16	940,500	0	0
17	14,400	0	0
18	655,200	0	0
19	247,500	98,100	0
20	1,925,100	243,000	0
21	192,600	74,700	0
22	3,600	0	0

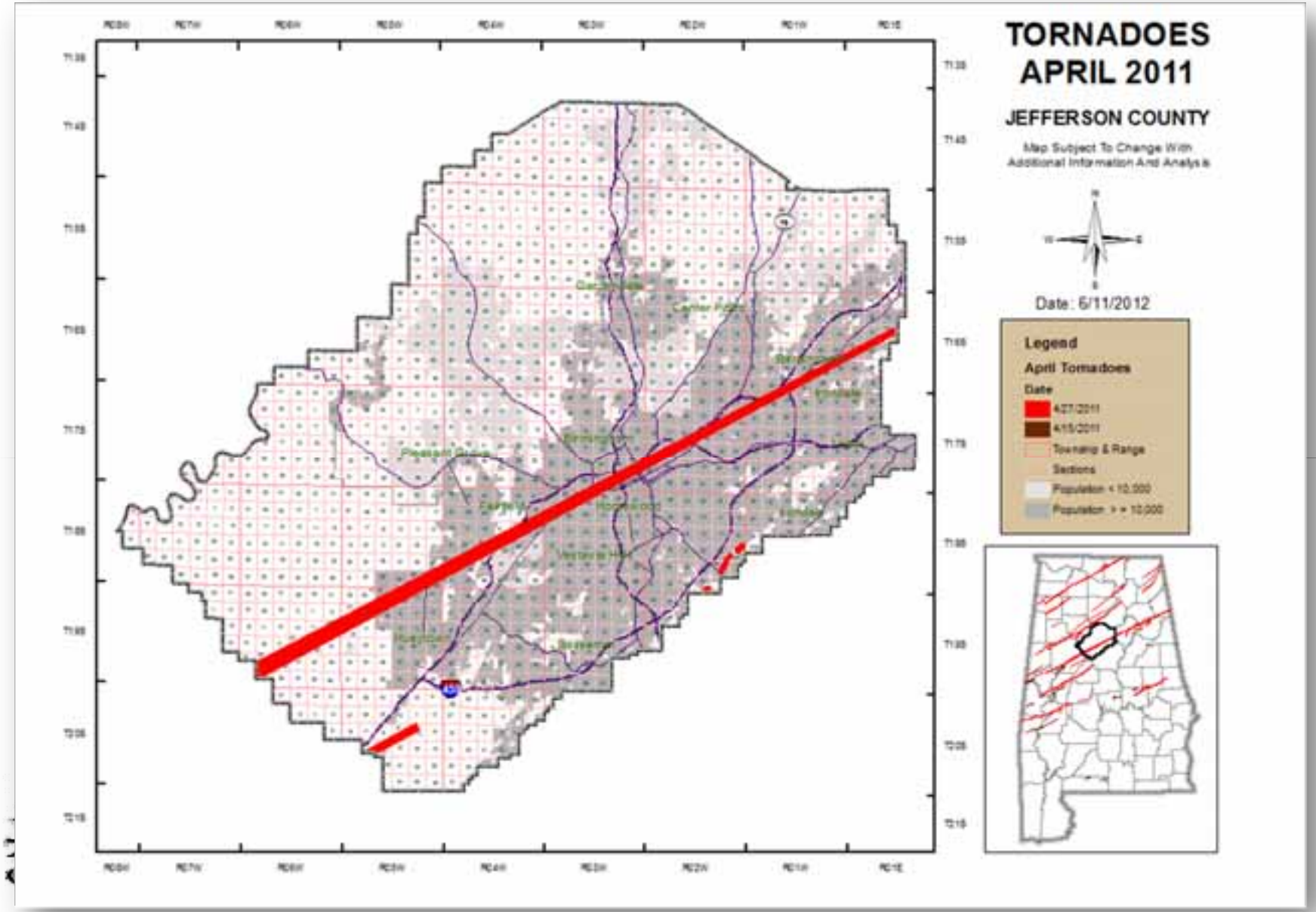
Geiger, Alabama
Source: Internet

ALABAMA FORESTRY COMMISSION

Results of the ArcGIS Geoprocessing Models

- All parcels in the path of the tornadoes were identified.
- Parcels greater than 10 acres in the tornado path were identified for a separate analysis.
- The parcels were intersected with STR Information for ease of reference.
- The parcels were also classified in terms of rural or urban setting.
- Wildfire Susceptibility Index (WFSI) And National Land Cover Database (NLCD) values were appended to the parcel records.

AFC-Generated Map by County



TORNADOES APRIL 2011

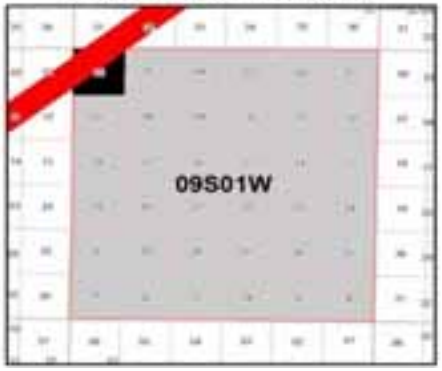
Image Source: NOAA

Damage Site
Cullman County

Legend
April Tornadoes
Date
4/27/2011
4/15/2011

CULLMAN COUNTY

Section, Township & Range



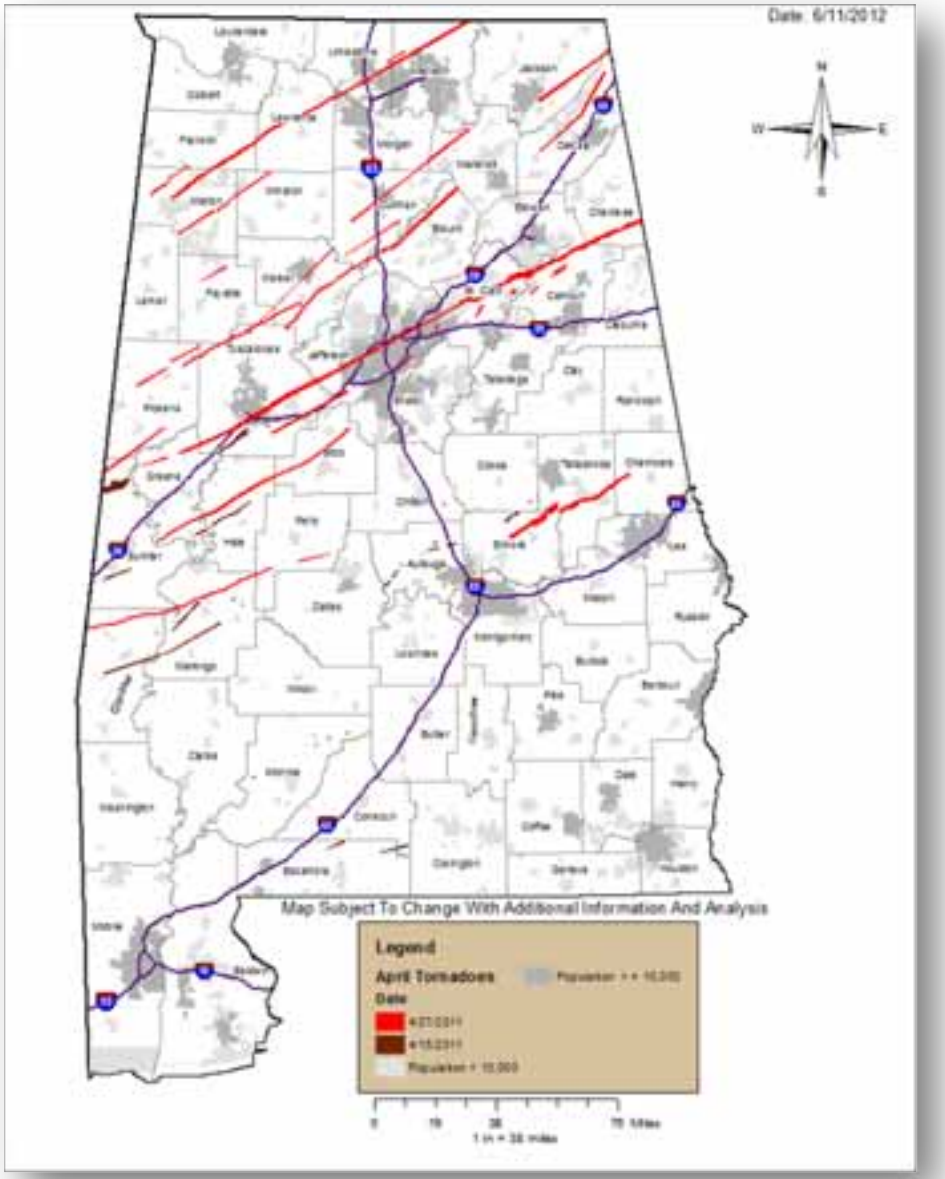
N
W
E
S

ALABAMA FORESTRY COMMISSION

100 50 0 100 Feet

Date: 5/19/2011

Urban Impact from April 2011 Tornadoes



ALABAMA FORESTRY COMMISSION

Summary

- AFC resources and preliminary National Weather Service data were used to determine the paths of damage.
- The ArcGIS geoprocessing models were developed within days of the tornado impact.
- The models were modified to helped AFC understand the extent of forest damage by the April tornadoes.
- Models greatly reduced the time for analysis of the 42 impacted counties.
- Geoprocessing models, used with accurate tornado-path data, produce results of high confidence.
- Model was sent to Joplin, Missouri to aid their impact analyses.

ALABAMA FORESTRY COMMISSION

Contact Information:

Abi Dhakal
Alabama Forestry Commission
513 Madison Avenue
Montgomery, Alabama 36104
Phone : 334-240-9365
Email: abi.dhakal@forestry.alabama.gov

Patrick Glass
Alabama Forestry Commission
Assistant State Forester
Phone : 334-240-9367
Email : patrick.glass@forestry.alabama.gov

Questions?

ABSTRACT

The spring 2011 tornadoes were historic in nature and were recorded in more than half of Alabama's counties. The models were very effective in classifying areas of tornado damage, forested versus non-forested parcels, parcels with varying Wildfire Susceptibility Indices, and segregating parcels into urban and rural classes.
The total for impacts to the forestland in Alabama from the April storms: 204,590 acres with an assessed value of $266,088,751.

The results of the analysis were used by Alabama's Congressional Delegation to document a supplemental funding request for the USDA Farm Services Agency's Emergency Forest Restoration Program. Results are also being used by the AFC, Alabama Forestry Recovery Task Force, Alabama Cooperative Extension Service, and other agencies to manage recovery of the forest resources.
Implementation of such models for large-scale analysis during emergency management and recovery phases can benefit subtleties in analysis objectives.

ALABAMA FORESTRY COMMISSION