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Community Risk Assessment:

A GIS-based model for wildfire prediction and mitigation

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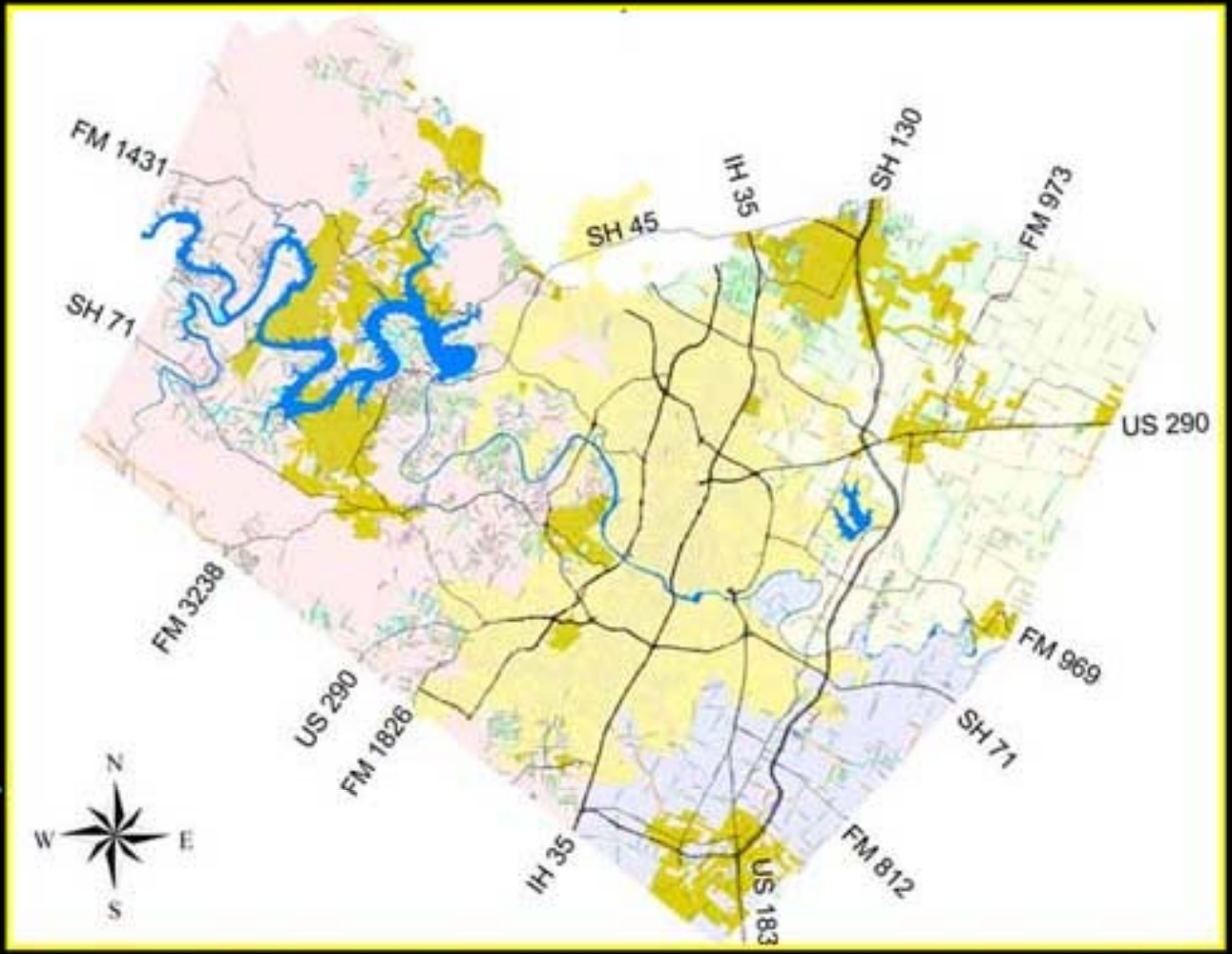
ESRI

Purpose of Study:

- Spatial modeling and representation of wildfire hazard
- Spatio-temporal interpolation of communities at risk
- Developing a standardized PSS for methodology of GIS-based regional molding of Wildfire Susceptibility Index (WFSI) for planning and policy making
- Identifying areas at risk (hotspots) and vulnerable population
- Providing better assessment tools and capabilities for land use policy and decision making

Target Region: Travis County, Texas

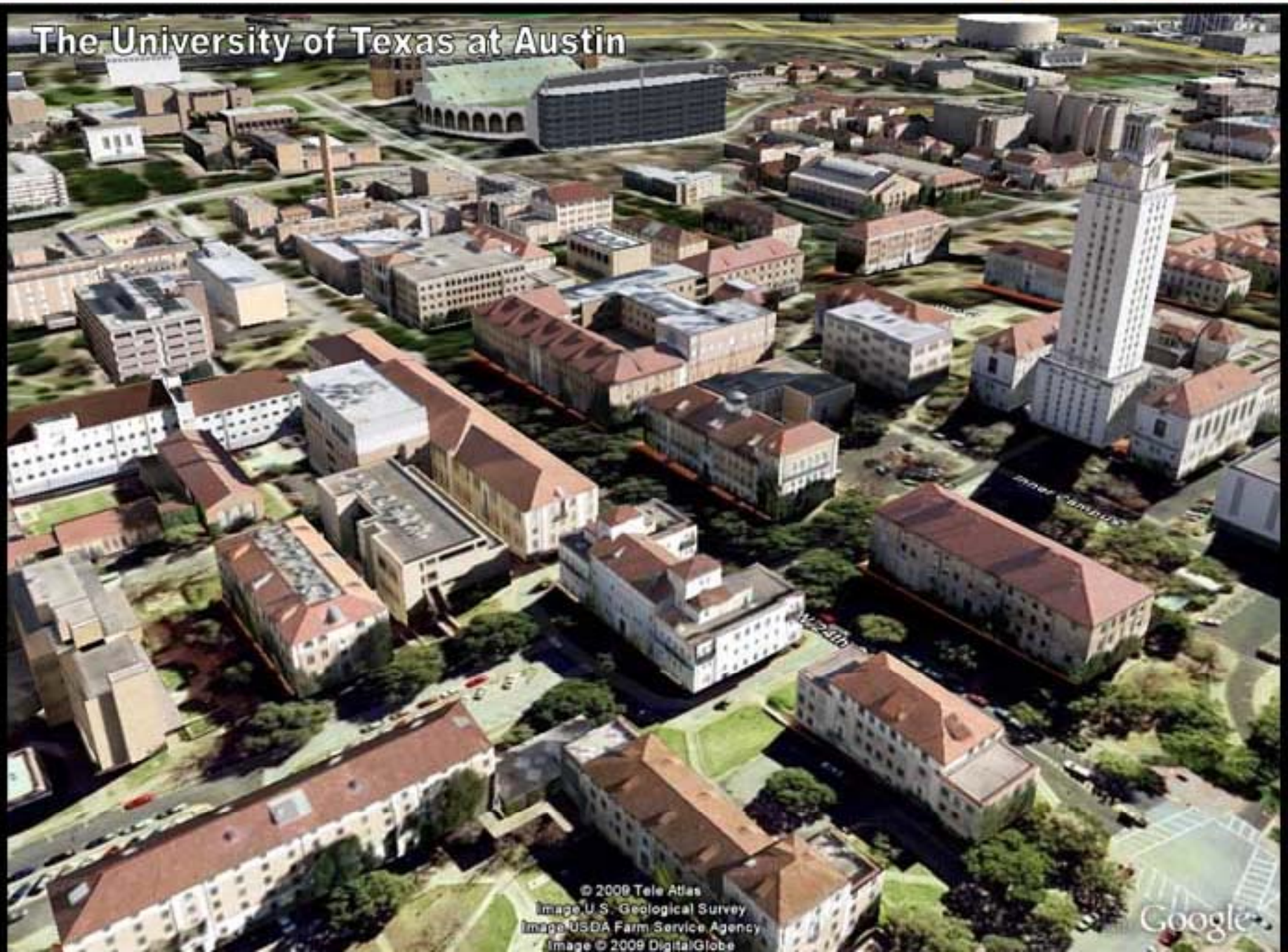


Target Region: Travis County, Texas

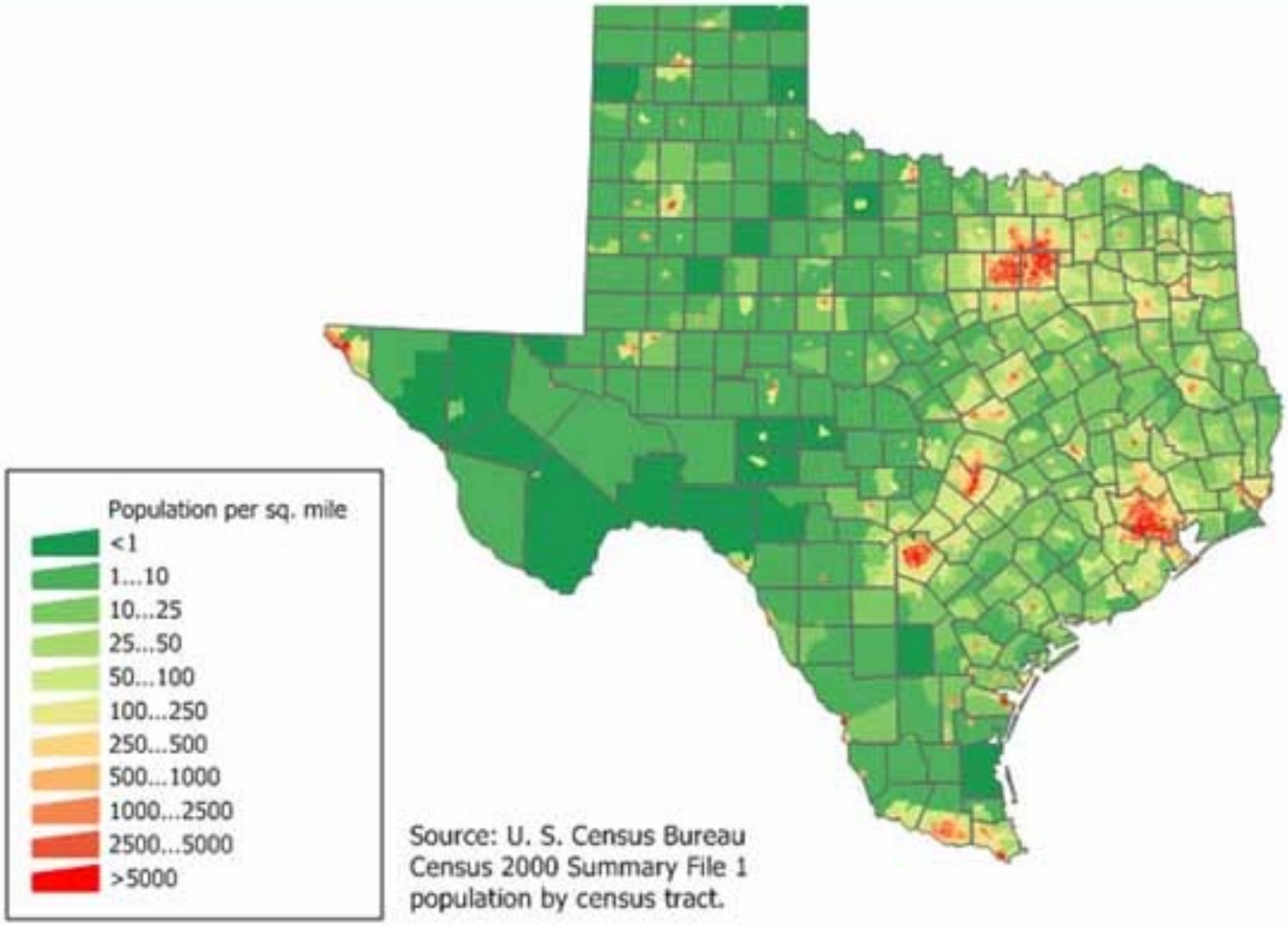
Target Region: Travis County, Texas

Downtown Austin

Target Region: Travis County, Texas



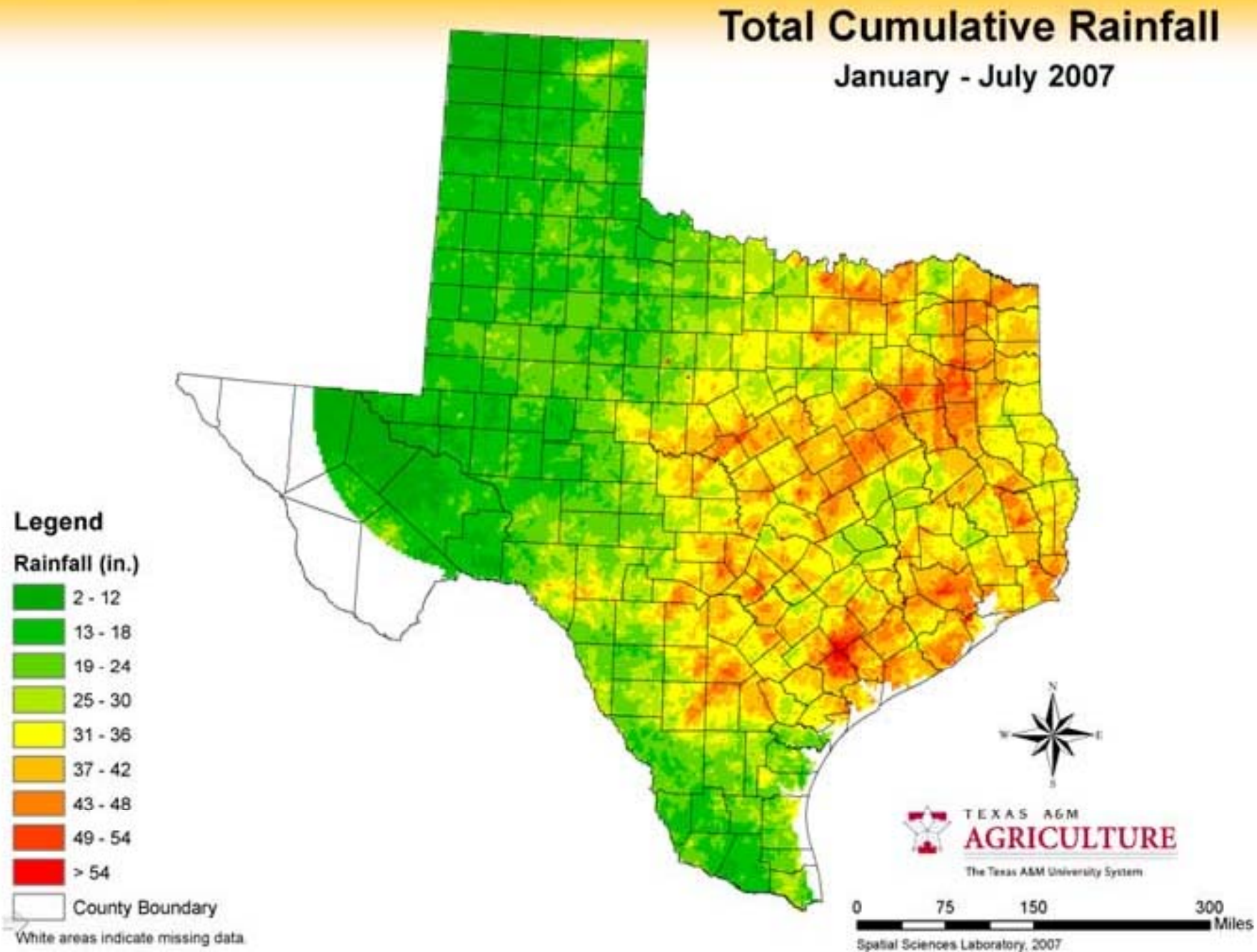
Demographic and Anthropogenic Characteristics



Source: U. S. Census Bureau
Census 2000 Summary File 1
population by census tract.

Demographic and Anthropogenic Characteristics

Precipitation



Analysis Trilogy

Temporal indicators

Potential for Ignition

1- Current & Historical Climate Data:
- Precipitation/drought events
- Lightning strikes
- Wind speed & direction

2- Current & Historical Fire Occurrences Data

3- Current & Historical Emergency Calls Data

380 Total Points: 38% †

Spatial indicators

Potential for Combustibility/Propagation

1- Existing Fuel & Topographic Data:
- Fuel types
- Slope, Elevation, Aspect

2- Fire Suppression Capability
- Initial dispatch locations
- Spatial morphology:
  - Emergency response time
  - Fire containment
  - Dry hydrants

420 Total Points: 42% †

Human indicators

Potential Ramification

Existing Data on Structure/Infrastructure:

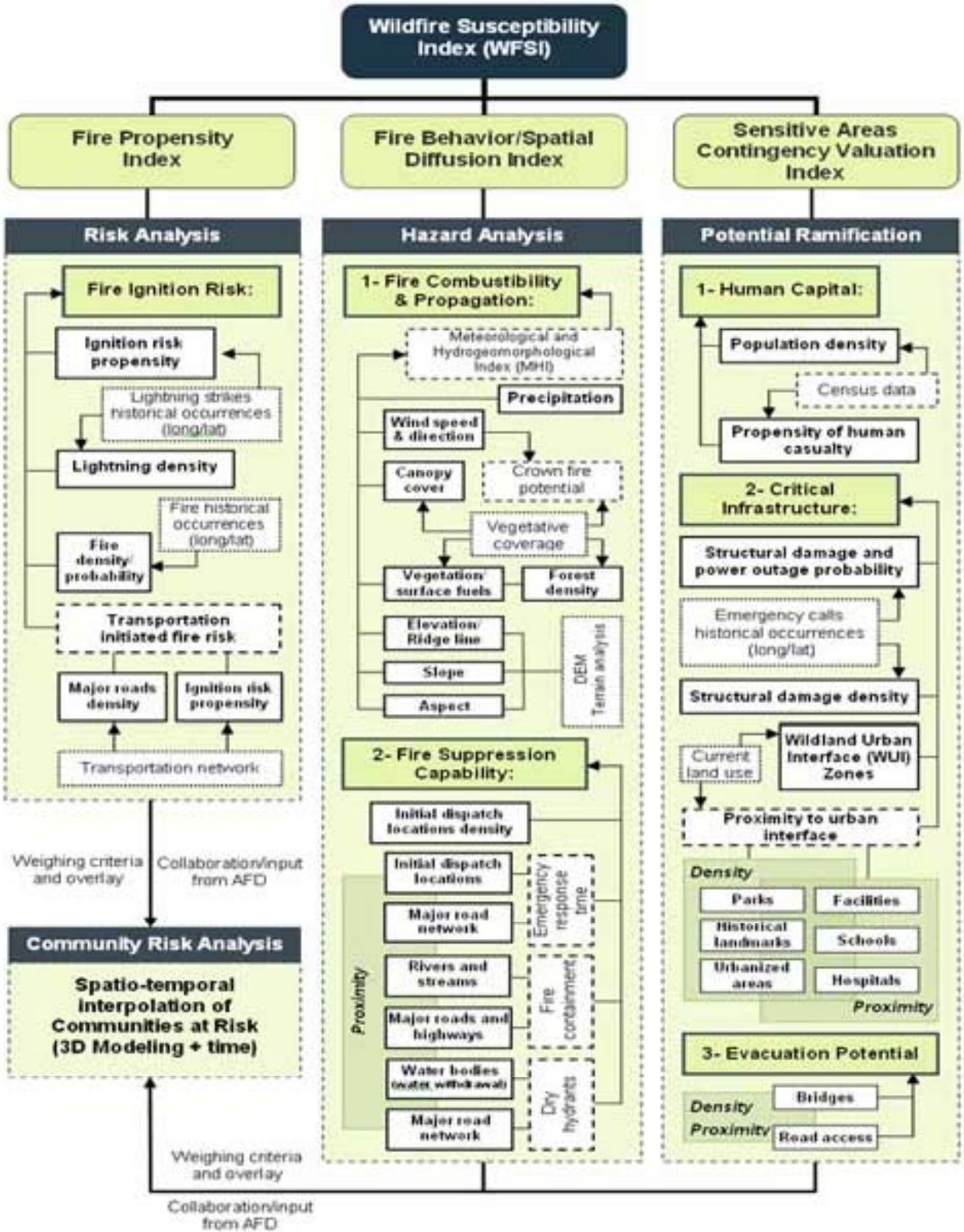
- Population centers
- Urban interface
- Critical infrastructure
- Evacuation potential

200 Total Points: 20% †

† These are identified in collaboration with AFD

Conceptual diagram of Wildfire Risk Assessment Methodology

PROCESS & DECISION MAKING FLOW CHART



A recipe for disaster - blazing inferno potential (30-40m/h):

- Three main ingredients (***firenado*** potential): **Weather, Fuel, and Topography**

1- Weather

  - Sever drought pattern (for the past 10 years)
  - Low participation (50-60% of normal precipitation)
  - Dry vegetation

2- Surface Fuel:

  - High forest density and canopy cover
  - Crown fire potential
  - West Austin is loaded with highly flammable trees and brush

3- Topography:

  - Steep slope: west Austin's hills and canyons – fire travels uphill
  - High wind speed and direction (Aspect)
  - High elevation (ridge line)

4- Other factors:

  - High fire ignition risk (transportation and historic occurrences)
  - High population density
  - Poor access
  - Low fire suppression capacity

Risk Register & Valuation Methodology

Risk Statement	Contributing factors	Derivative Data	Impact	Trigger Event	Valuation Methodology	Response Strategy
Firenado potential	Elevation	DEM	Very high	Fire propagation	**Very low (1):** 93-170m **Low (2):** 170-230m **Moderate (3):** 230-290m **High (4):** 290-350m **Very high (5):** 350-483m	- Very low - Fire containment: creating natural and artificial fire breaks (such as rivers and highways) - Dumping water from the sky
	Slope	DEM	Very high	Fire irruption	**Very low (1):** 0-5% **Low (2):** 5-15% **Moderate (3):** 15-30% **High (4):** 30-45% **Very high (5):** 45-133%	
	Aspect (wind direction)	DEM	Very high	Fire propagation	**Very low (1):** N, flat **Low (2):** NE, NW **Moderate (3):** E, W **High (4):** SE, SW **Very high (5):** S	
	Fuel	Vegetative coverage	Very high	Fire irruption	**Very low (1):** FBPS 97 - Non-burnable agriculture FBPS 98 - Water FBPS 99 - Non-burnable, barren **Low (2):** FBPS 96 – Urban **Moderate (3):** FBPS 10 - Timber (litter and understory) FBPS 11 - Light slash FBPS 12 - Medium slash **High (4):** FBPS 6 - Dormant brush, hardwood slash FBPS 7 - Southern rough FBPS 8 - Closed timber litter FBPS 9 - Hardwood (long-needle pine) litter **Very high (5):** FBPS 1 - Short grass (1 ft.) FBPS 2 - Timber (grass and understory) FBPS 3 - Tall grass (2.5 ft.) FBPS 4 – Chaparral FBPS 5 – Brush	Impraving structural fire safety: - Using fire resistant materials - Exits are clearly marked - Entrances are not blocked by any flammable materials -Access for a large fire truck - Reducing vegetation encroachment around buildings
Fire spread & damage	Response time	Road access and Initial dispatch locations	Very high	Fire irruption	**Very low (1):** <5min **Low (2):** 5-8min **Moderate (3):** 8-10min **High (4):** 10-15min **Very high (5):** >15 min	Early warning system: - Local officials issue burn bans - Issuance of red flag warnings - Reverse 911 calls for residents (alerting to evacuate)

Process Workflow (GIS Model Workflow)

1- Fire Propensity Index: Risk Analysis

Roads density

Ignition risk propensity

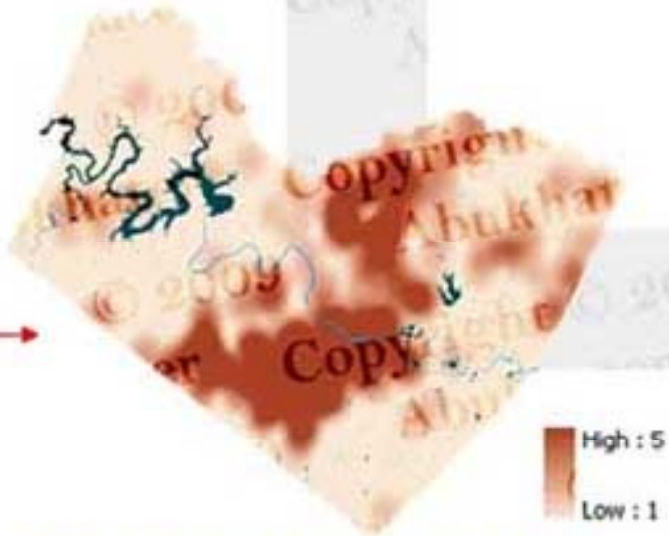
Transportation initiated fire risk

Lightning density

Ignition risk propensity

Historical fire density

Historical fire propensity

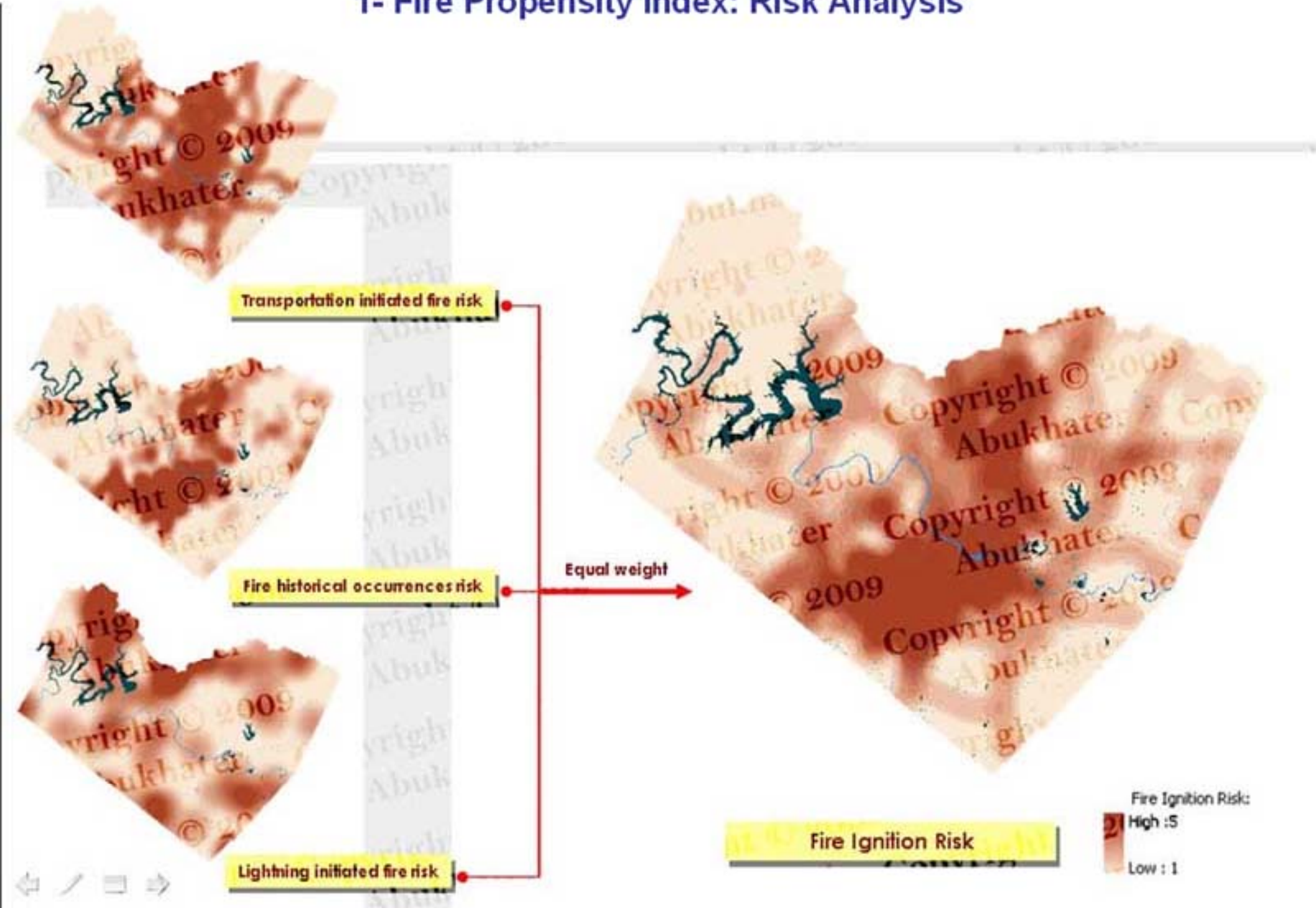


Fire historical occurrences risk

Lightning initiated fire risk

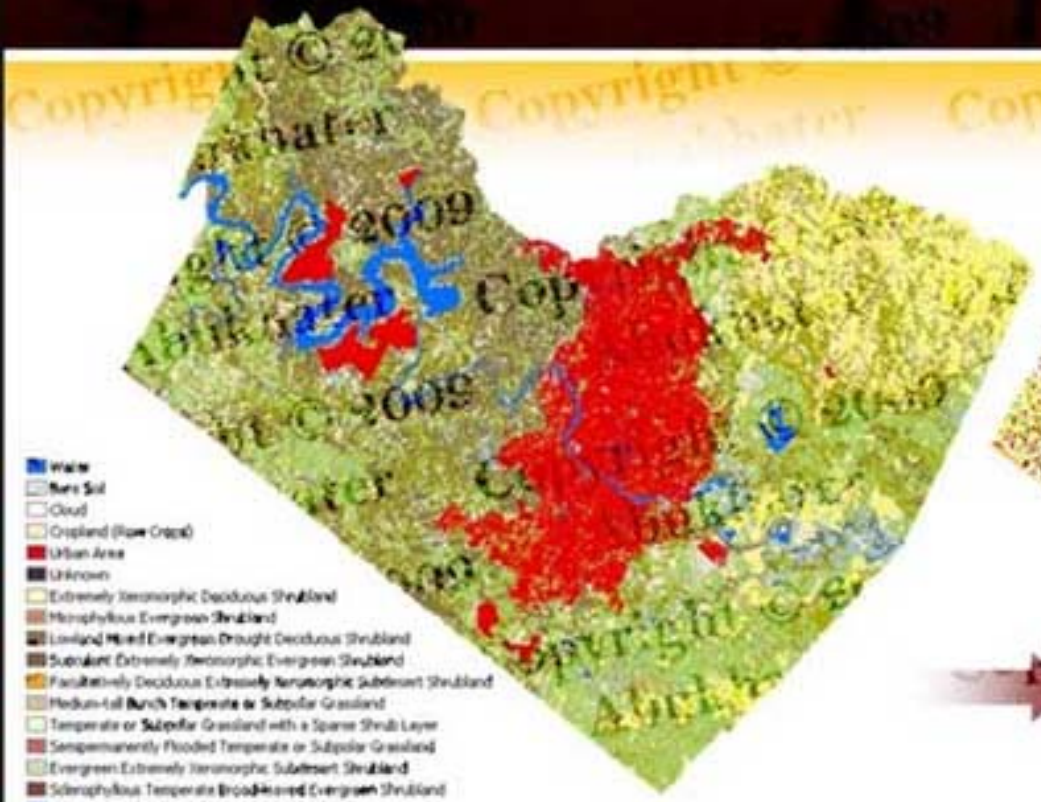
Process Workflow (GIS Model Workflow)

1- Fire Propensity Index: Risk Analysis



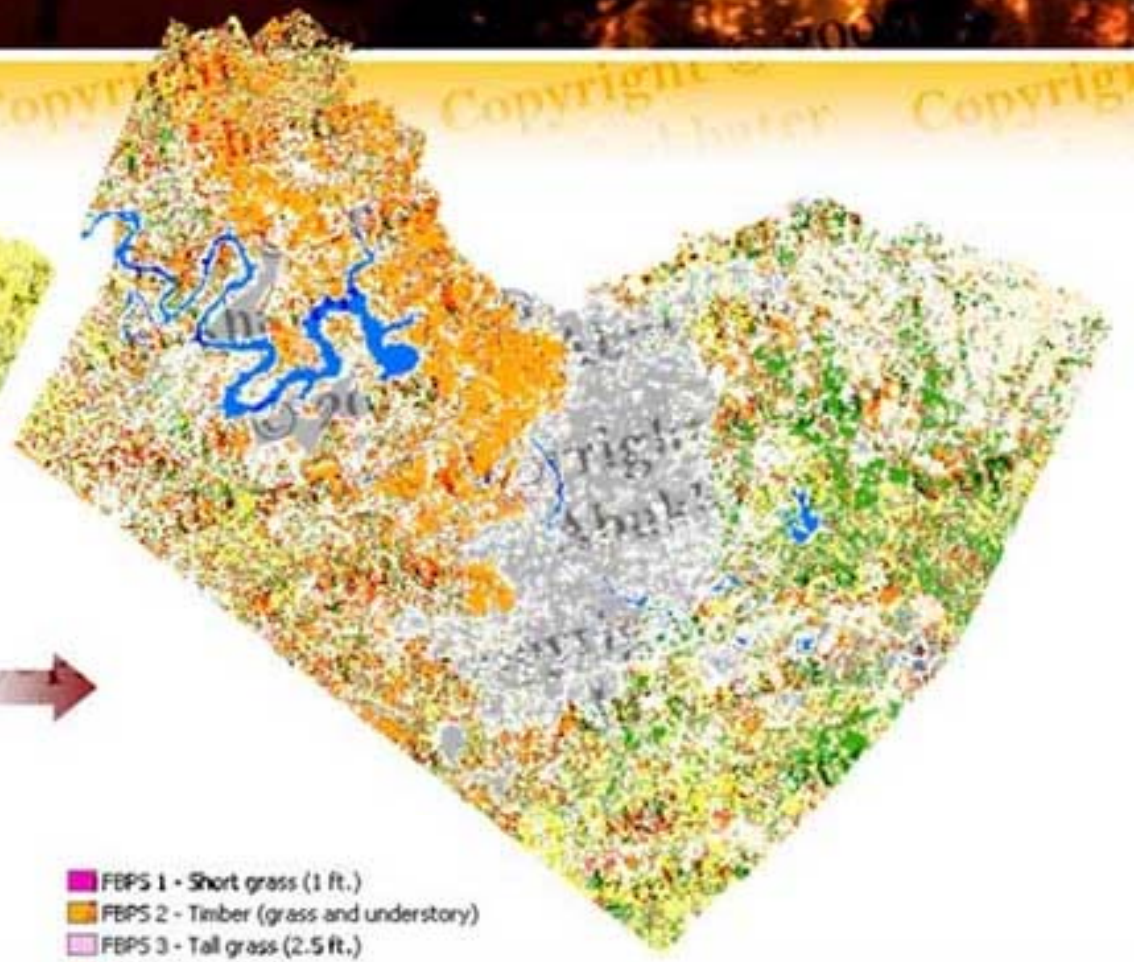
Process Workflow (GIS Model Workflow)

2- Fire Behavior/Spatial Diffusion Index: Fire Combustibility & Propagation



Water
Bare Soil
Cloud
Cropland (Row Crops)
Urban Area
Unknown
Extremely Xeromorphic Deciduous Shrubland
Microphyllous Evergreen Shrubland
Lowland Mixed Evergreen Drought Deciduous Shrubland
Succulent Extremely Xeromorphic Evergreen Shrubland
Facultatively Deciduous Extremely Xeromorphic Subtesert Shrubland
Medium-tall Bunch Temperate or Subpolar Grassland
Temperate or Subpolar Grassland with a Sparse Shrub Layer
Semipermanently Flooded Temperate or Subpolar Grassland
Evergreen Extremely Xeromorphic Subtesert Shrubland
Sclerophyllous Temperate Broadleaved Evergreen Shrubland
Temporarily Flooded Cold-Deciduous Woodland
Short Sod Temperate or Subpolar Grassland
Cold-deciduous Woodland
Annual Graminoid or Forb Vegetation
Wetland
Intermittently Flooded Temperate or Subpolar Grassland (i.e., Playa Lakes)
Round-Crowned Temperate or Subpolar Needle-leaved Evergreen Woodland
Sand Flats
Consolidated Rock Sparse Vegetation
Temporarily Flooded Temperate Grassland with Sparse Cold-Deciduous Trees
Dunes with Sparse Herbaceous Vegetation
Tall Sod Temperate Grasslands
Temperate Broadleaved Evergreen Shrubland
Temporarily Flooded Microphyllous Shrubland
Low Tropical or Subtropical Perennial Forb Vegetation
Mixed Broad-leaved Evergreen - Cold-deciduous Woodland
Lowland or Submontane Cold-deciduous Forest
Planted/Cultivated Woodland
Medium-tall Sod Temperate or Subpolar Grassland (excludes Sod or Mixed Sod-bunched Graminoids)
Temporarily Flooded Cold-deciduous Forest
Cropland (Irrigated, Herbaceous)
Temperate Broad-leaved Evergreen Woodland (Gray Oak Woodland Alliance)
Temperate Broad-leaved Evergreen Woodland (Live Oak Woodland Alliance)
Sand Flats East of I-35
Round-Crowned Temperate or Subpolar Needle-leaved Evergreen Forests (West of I-35)
Round-Crowned Temperate or Subpolar Needle-leaved Evergreen Forests (East of I-35) - SE TX
Round-Crowned Temperate or Subpolar Needle-leaved Evergreen Forests (East of I-35) - NE TX

Vegetative coverage



FBPS 1 - Short grass (1 ft.)
FBPS 2 - Timber (grass and understory)
FBPS 3 - Tall grass (2.5 ft.)
FBPS 4 - Chaparral
FBPS 5 - Brush
FBPS 6 - Dormant brush, hardwood slash
FBPS 7 - Southern rough
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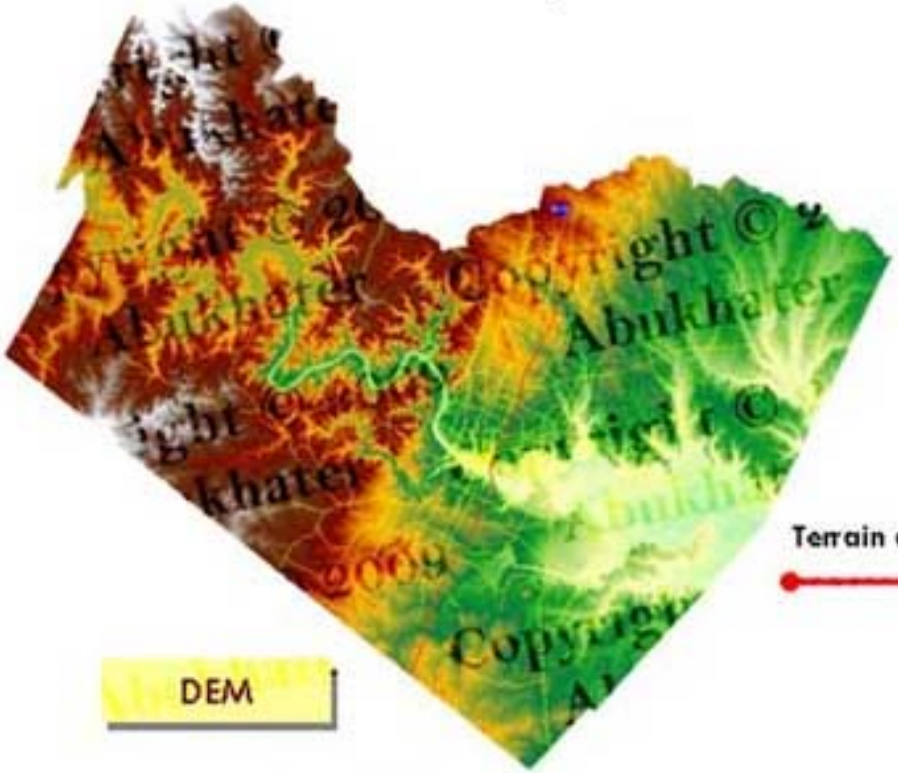
FBPS 9 - Hardwood (long-needle pine) litter
FBPS 10 - Timber (litter and understory)
FBPS 11 - Light slash
FBPS 12 - Medium slash
FBPS 96 - Urban
FBPS 97 - Non-burnable agriculture
FBPS 98 - Water
FBPS 99 - Non-burnable, barren

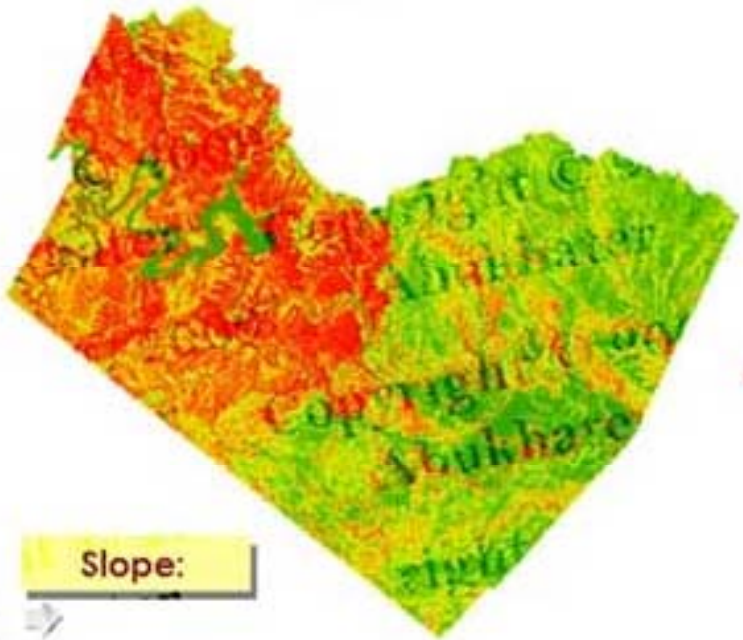
Vegetation/surface fuels

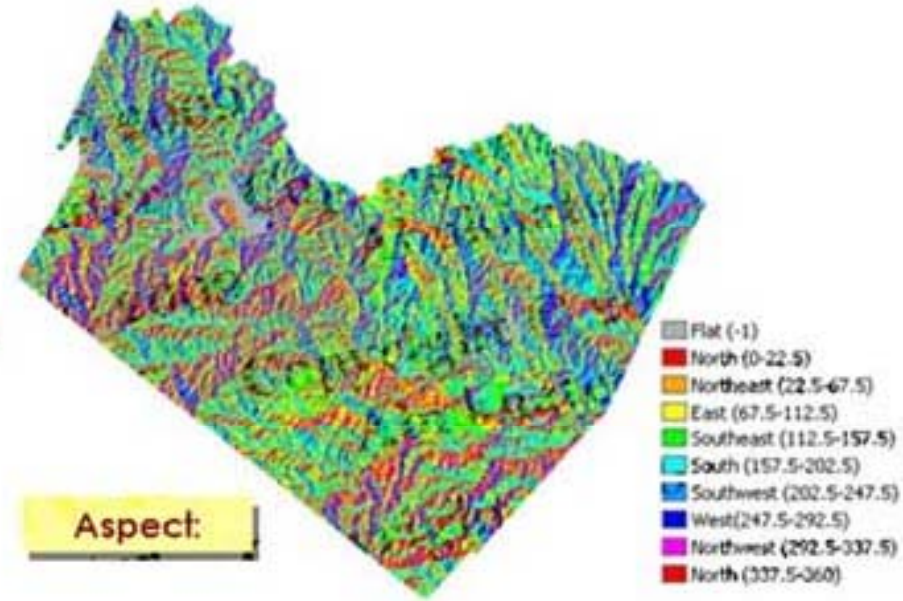
Process Workflow (GIS Model Workflow)

2- Fire Behavior/Spatial Diffusion Index: Fire Combustibility & Propagation



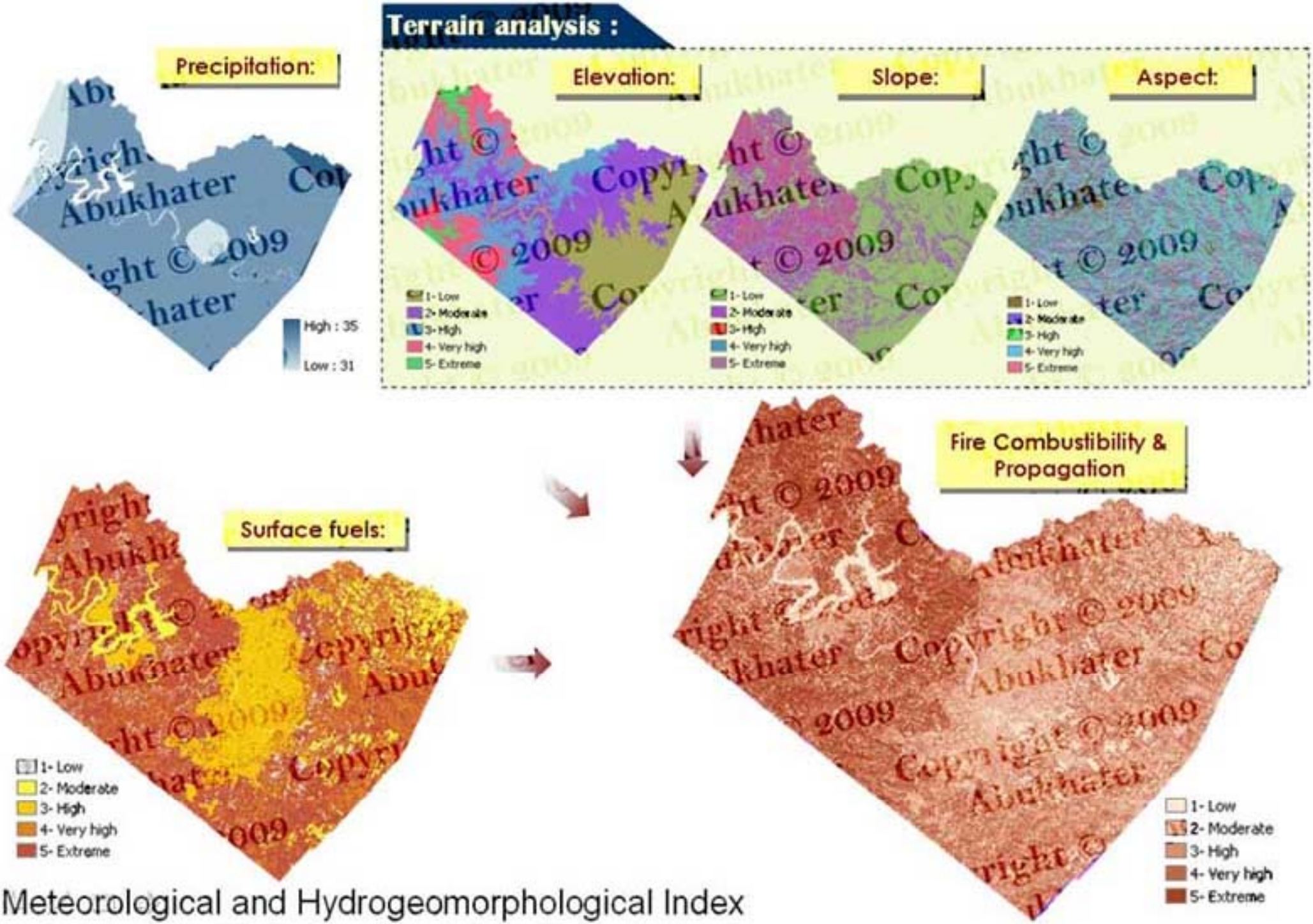
Terrain analysis





Process Workflow (GIS Model Workflow)

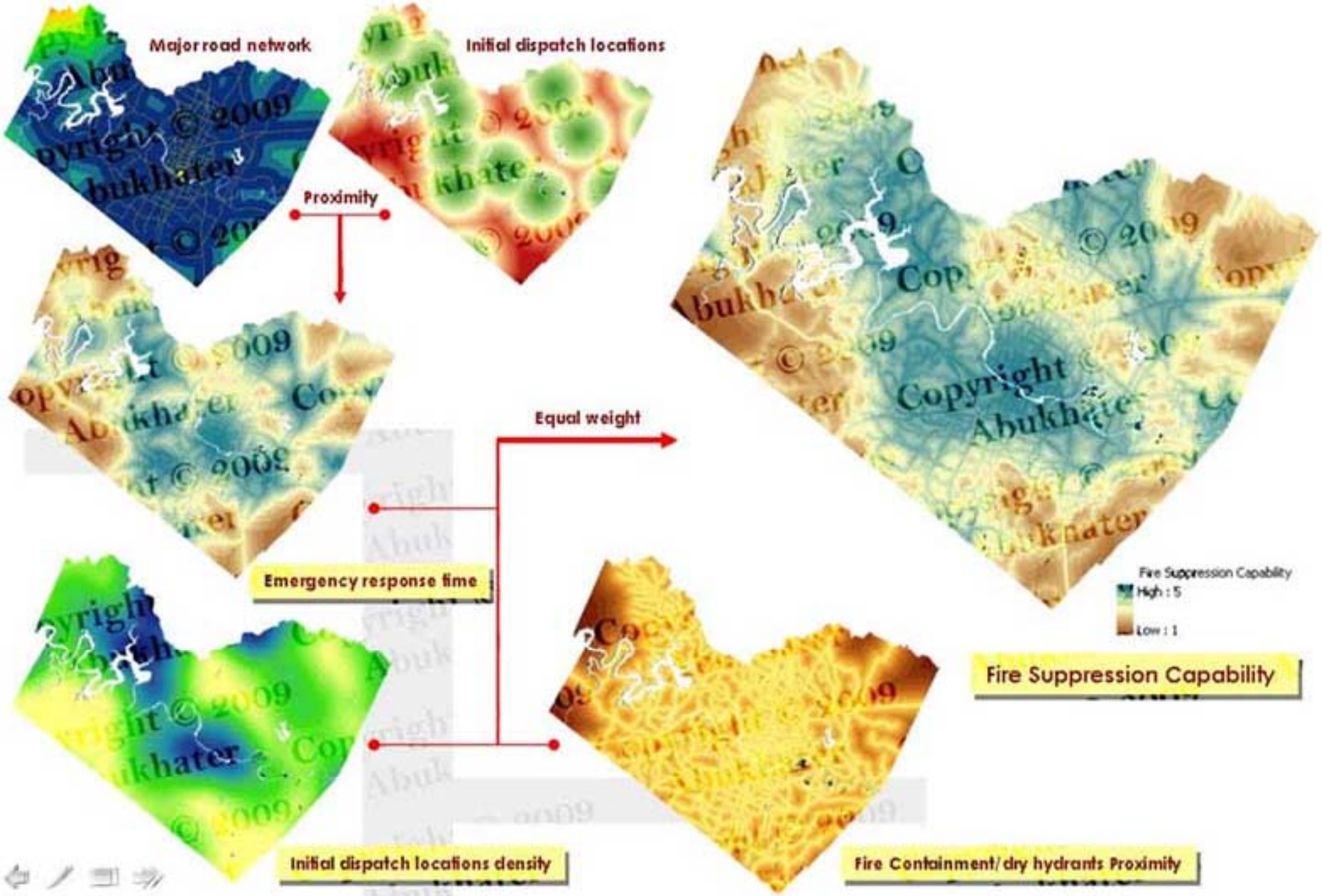
2- Fire Behavior/Spatial Diffusion Index: Fire Combustibility & Propagation



Meteorological and Hydrogeomorphological Index

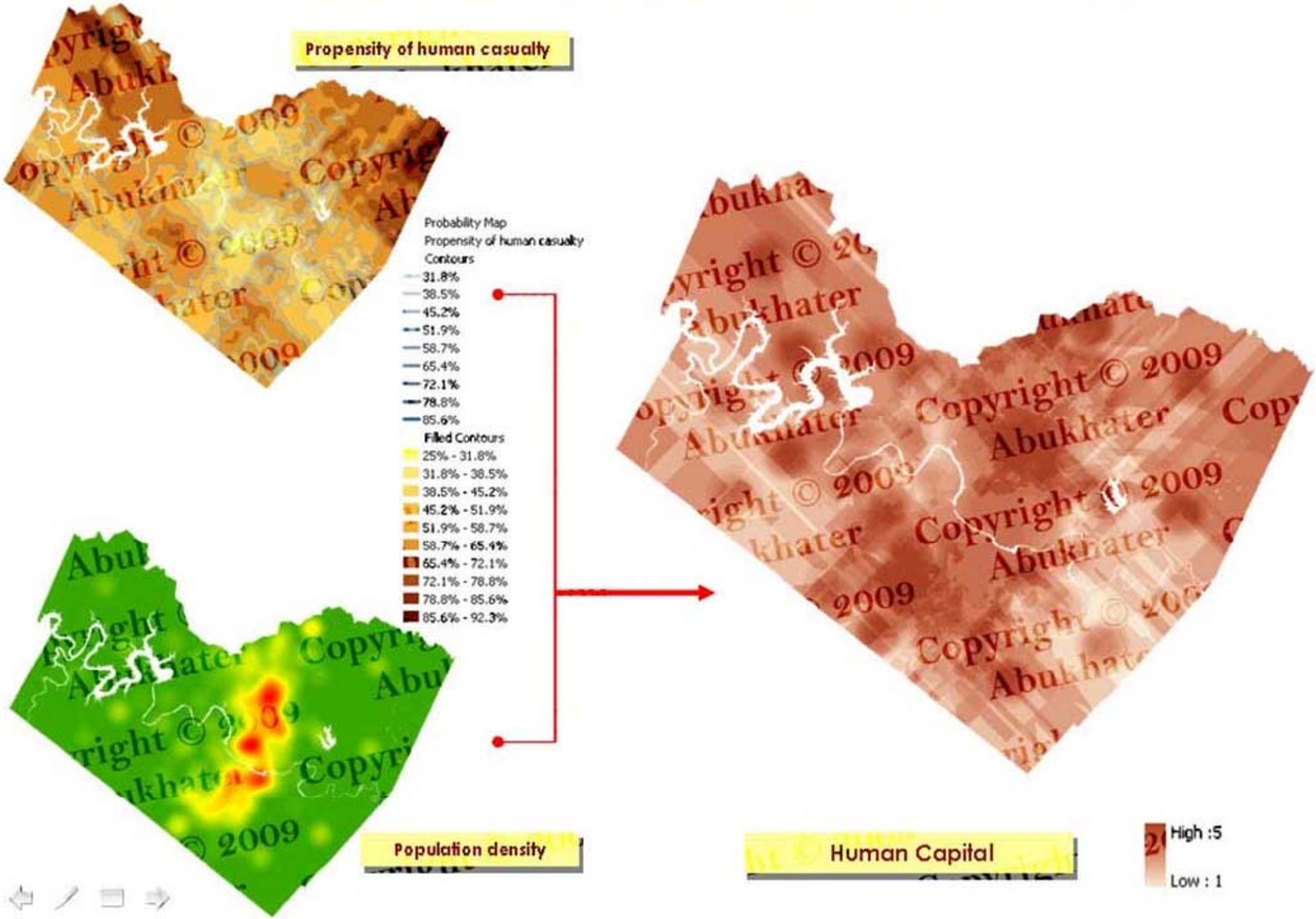
Process Workflow (GIS Model Workflow)

2- Fire Behavior/Spatial Diffusion Index: Fire Suppression Capability



Process Workflow (GIS Model Workflow)

3- Sensitive Areas Contingency Valuation Index: Human Capital

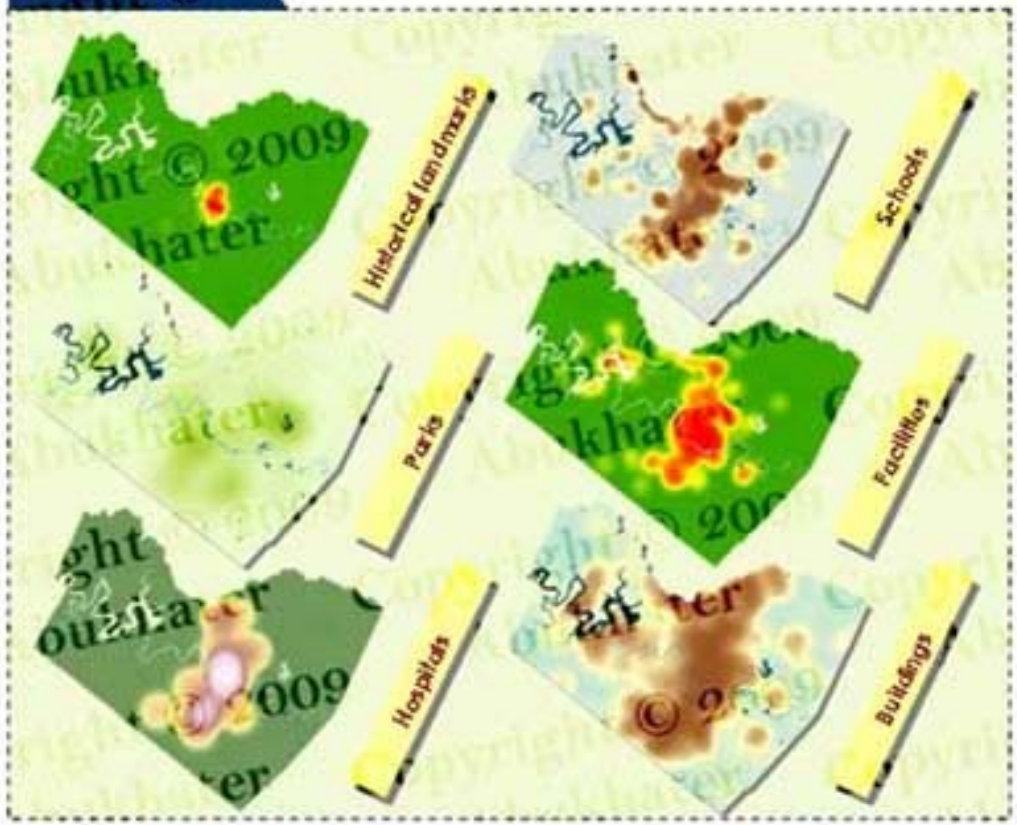


Process Workflow (GIS Model Workflow)

3- Sensitive Areas Contingency Valuation Index: Critical infrastructure

Proximity:

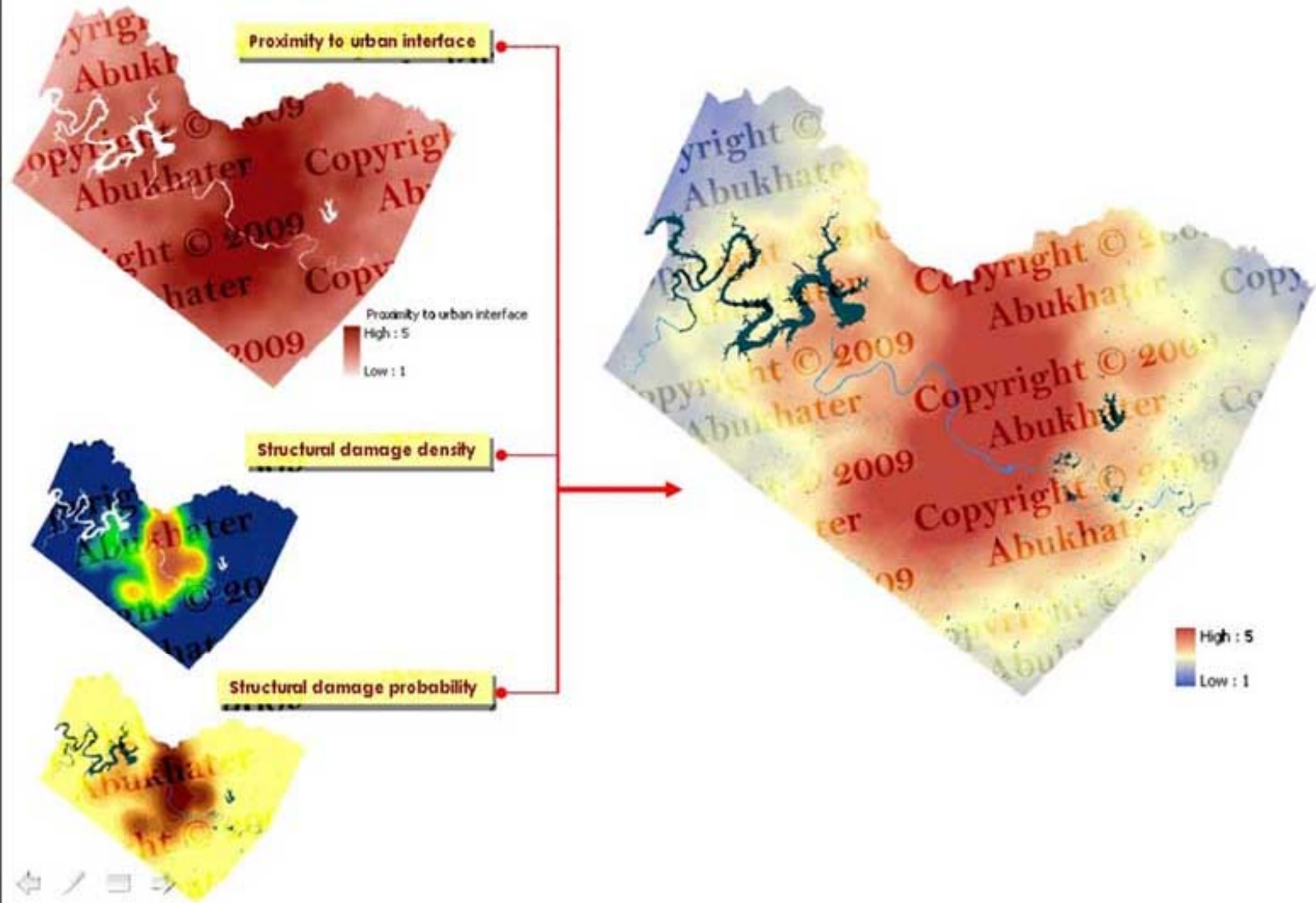
Density:



Proximity to urban interface

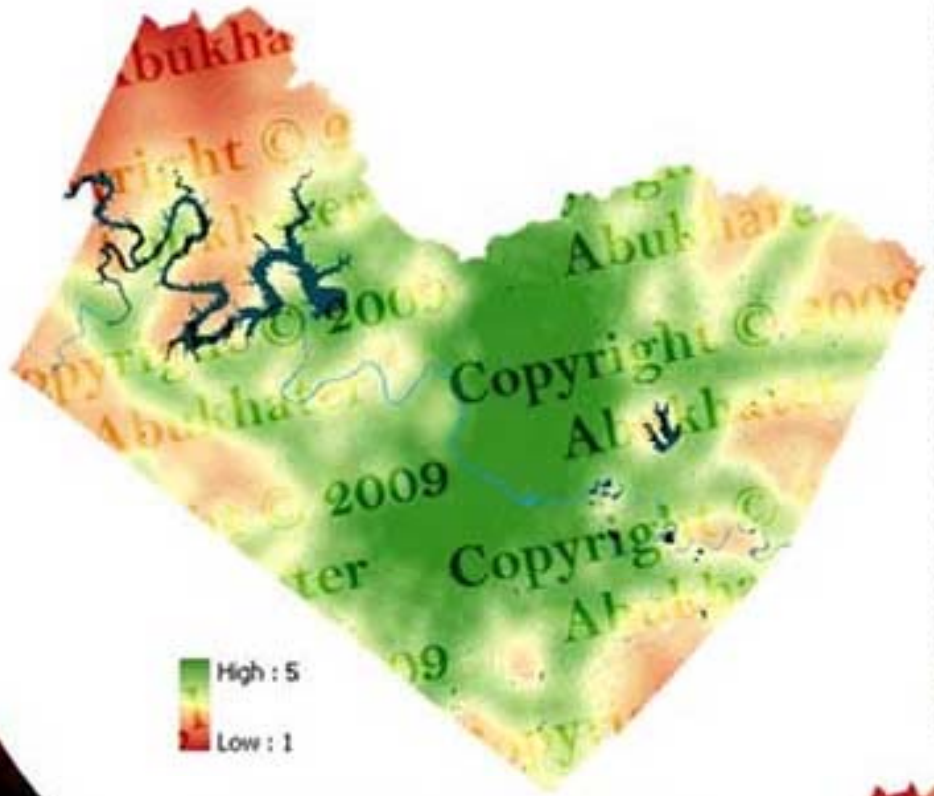
Process Workflow (GIS Model Workflow)

3- Sensitive Areas Contingency Valuation Index: Critical infrastructure



Process Workflow (GIS Model Workflow)

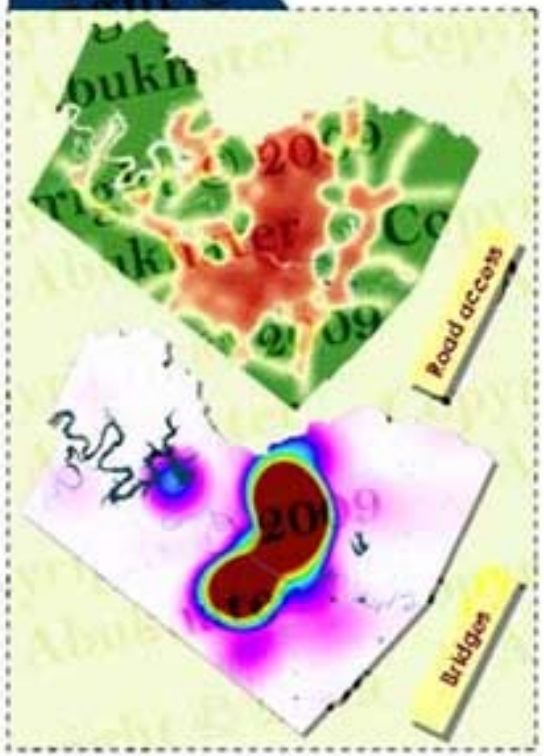
3- Sensitive Areas Contingency Valuation Index: Evacuation Potential

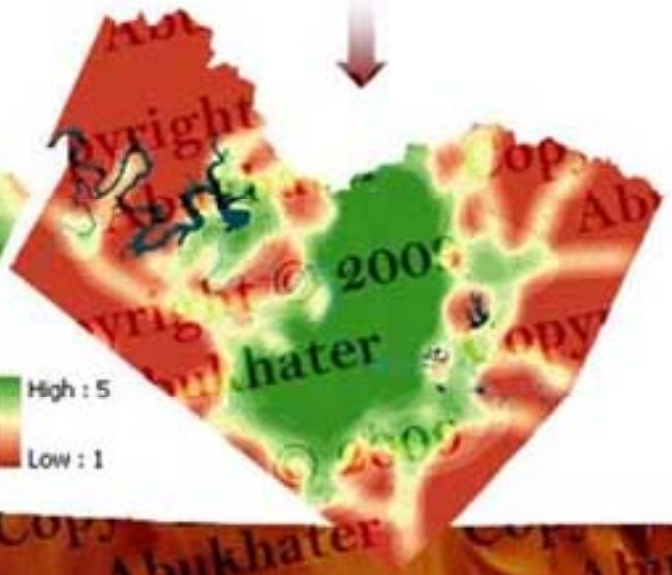


Evacuation Potential

Proximity:

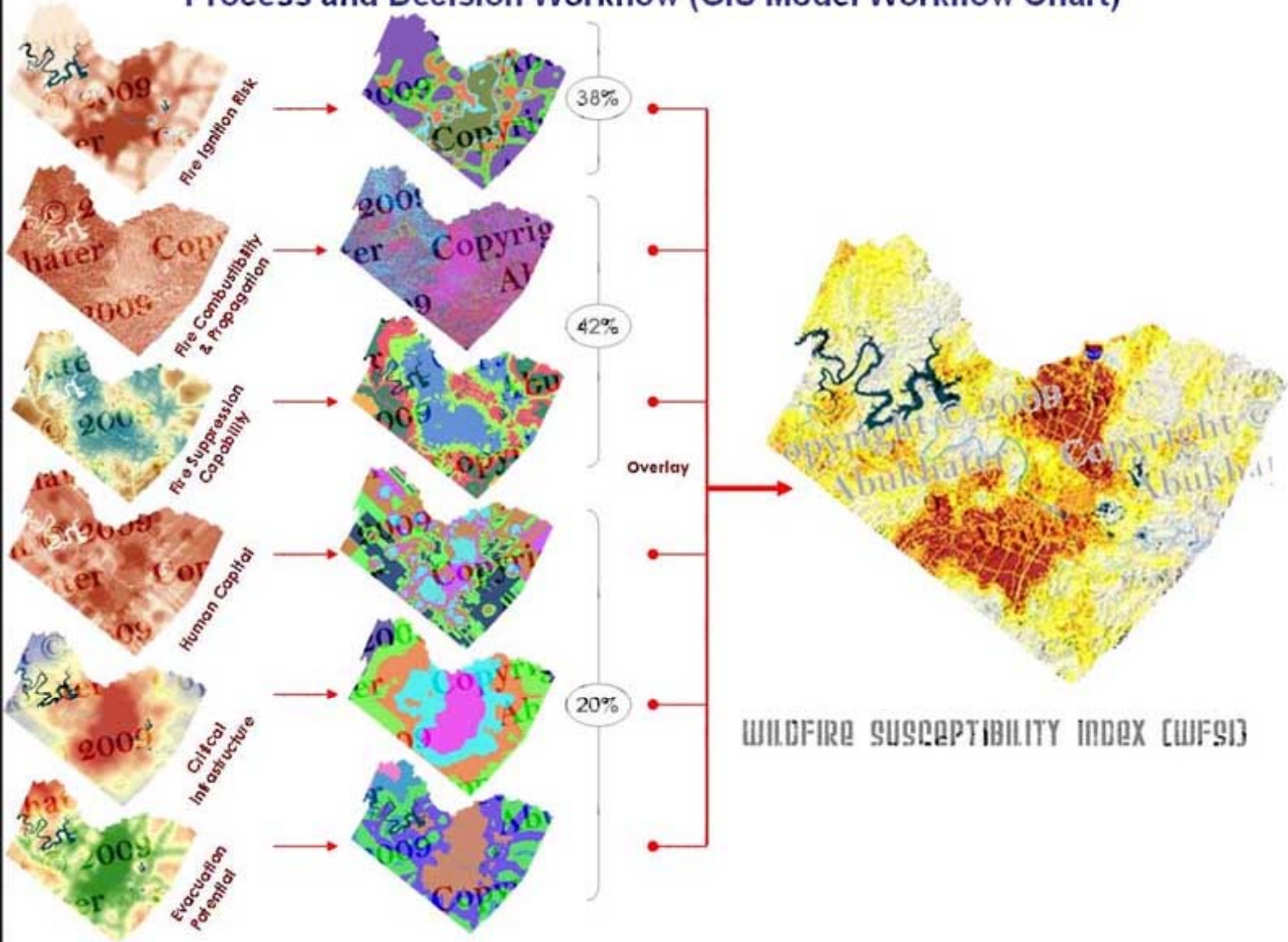
Density:





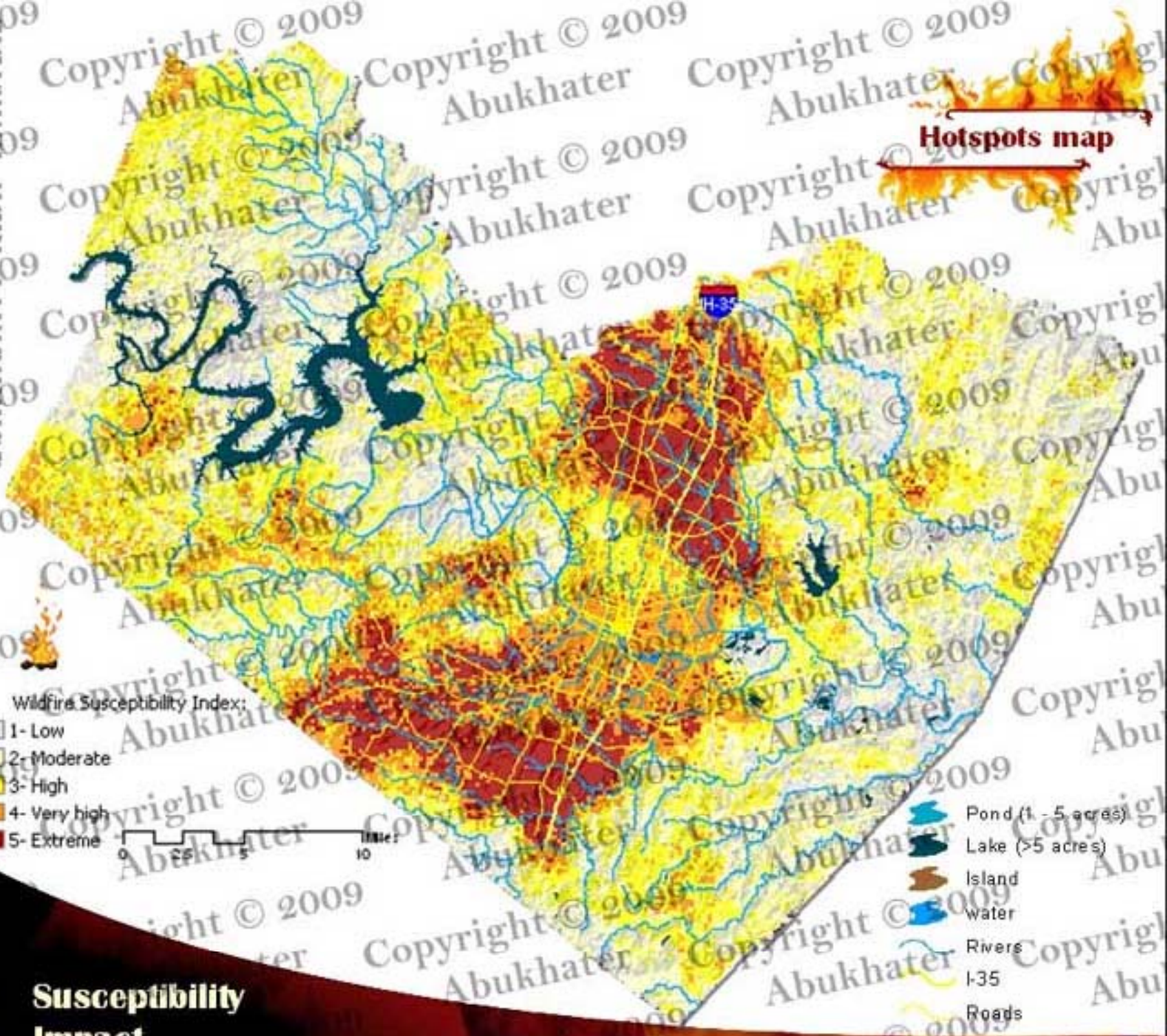
Community Risk Analysis

Process and Decision Workflow (GIS Model Workflow Chart)



Wildfire Susceptibility Index (WFSI)

COMMUNITY RISK ANALYSIS



- **Susceptibility**
- **Impact**

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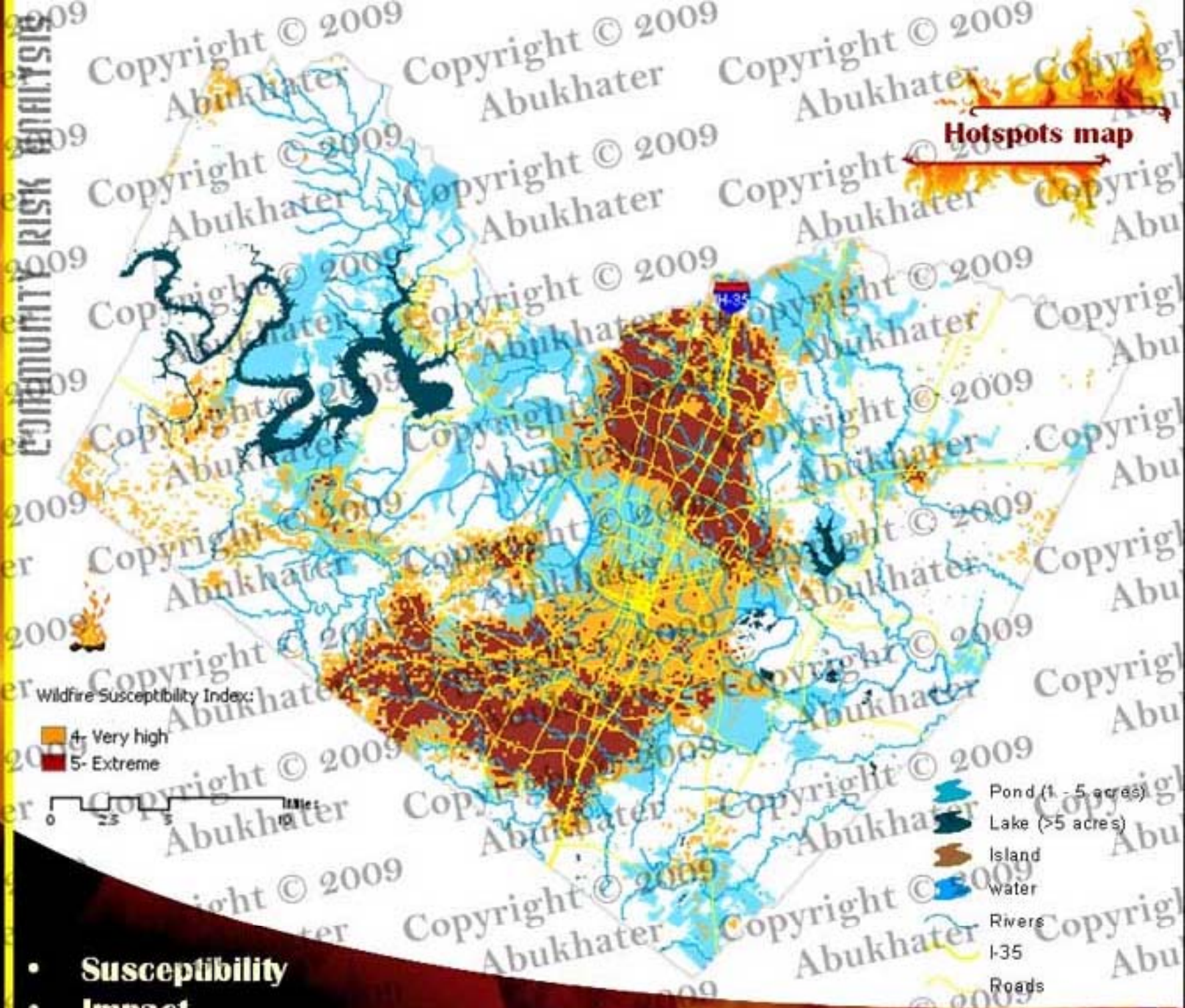
Wildfire Susceptibility Index (WFSI)

COMMUNITY RISK ANALYSIS



- **Susceptibility**
- **Impact**

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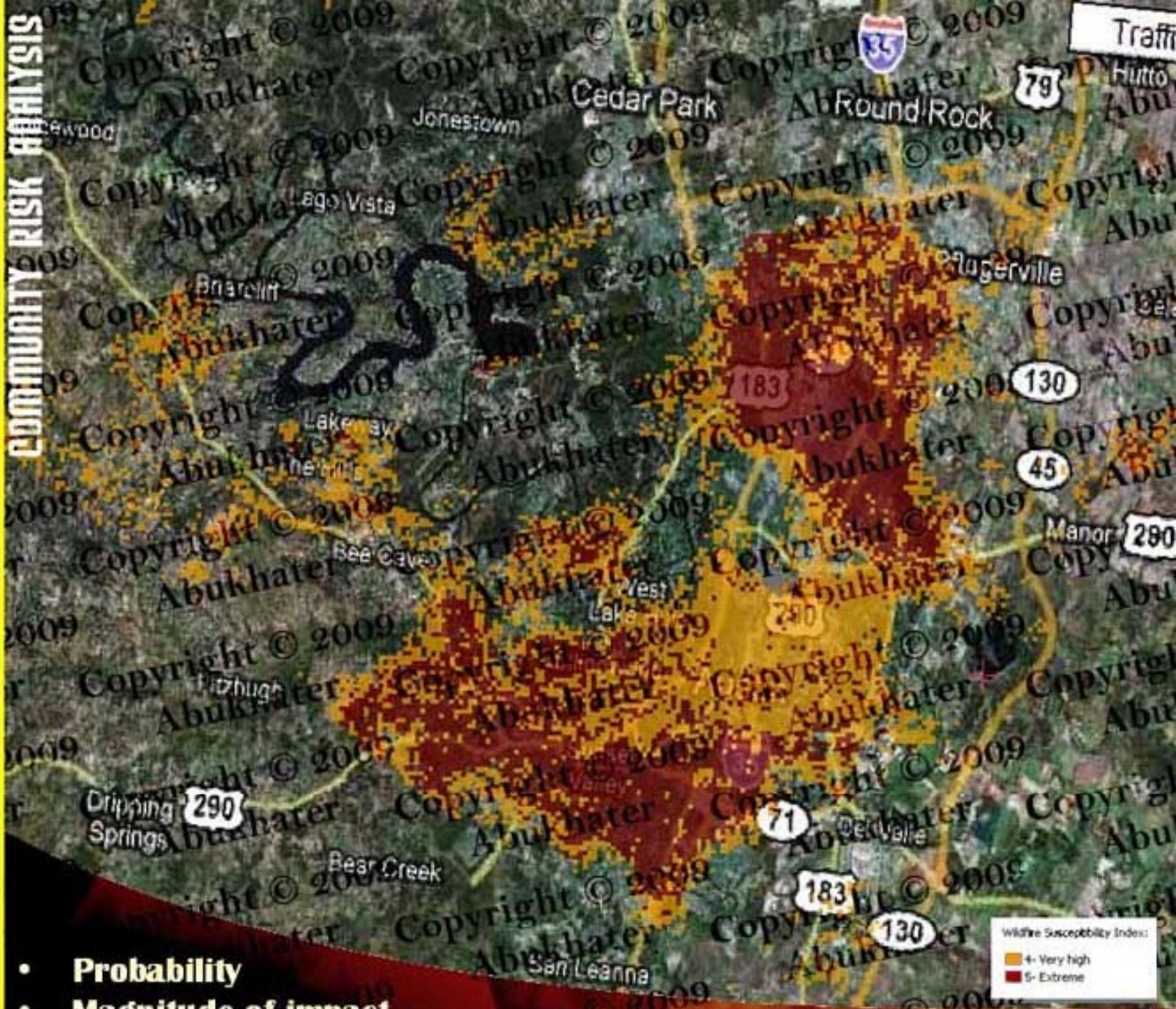
Wildfire Susceptibility Index (WFSI)

COMMUNITY RISK ANALYSIS

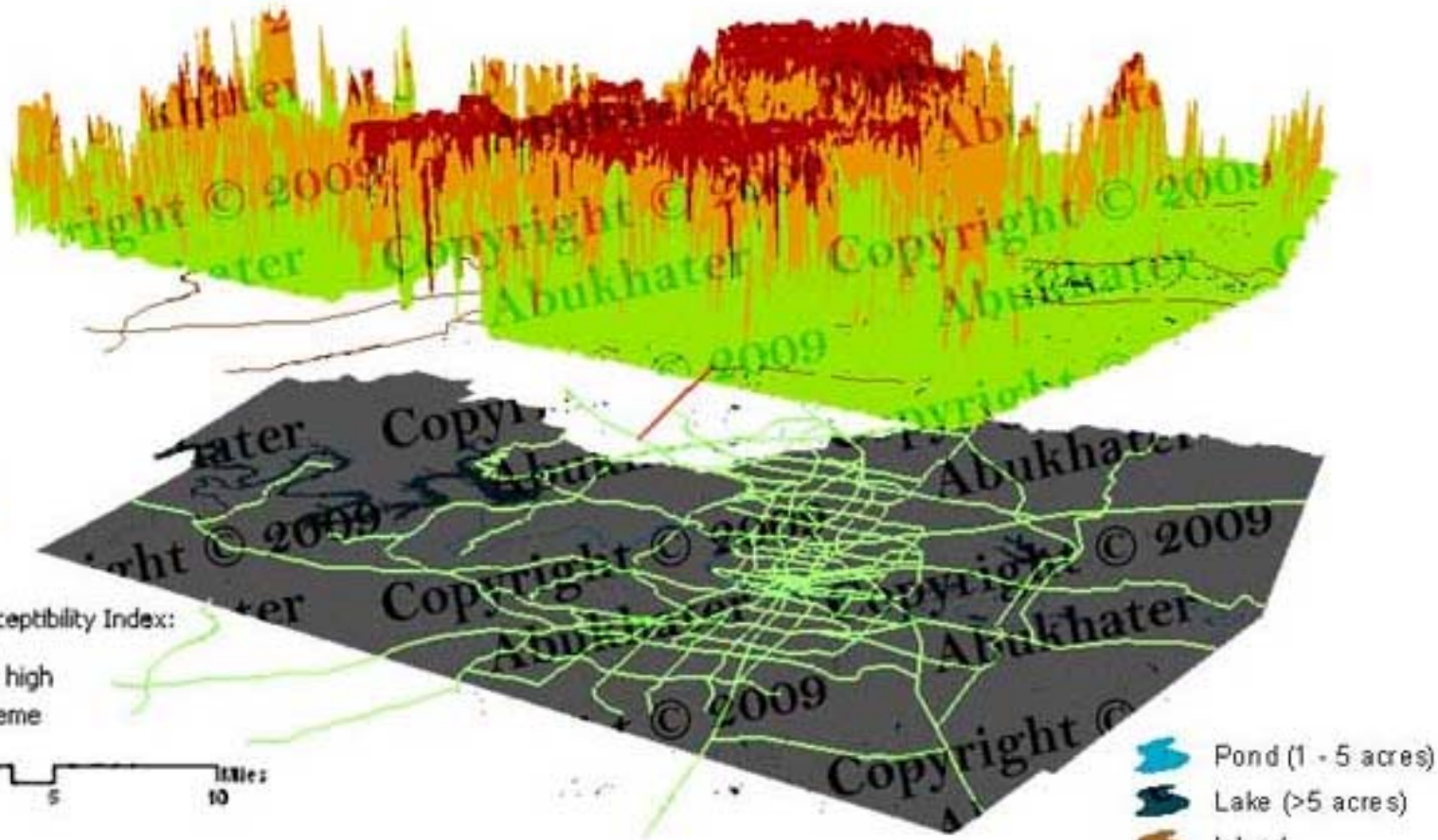


- **Probability**
- **Magnitude of impact**

Wildfire Susceptibility Index (WFSI)

COMMUNITY RISK ANALYSIS

Hotspots map



- **Probability**
- **Magnitude of impact**

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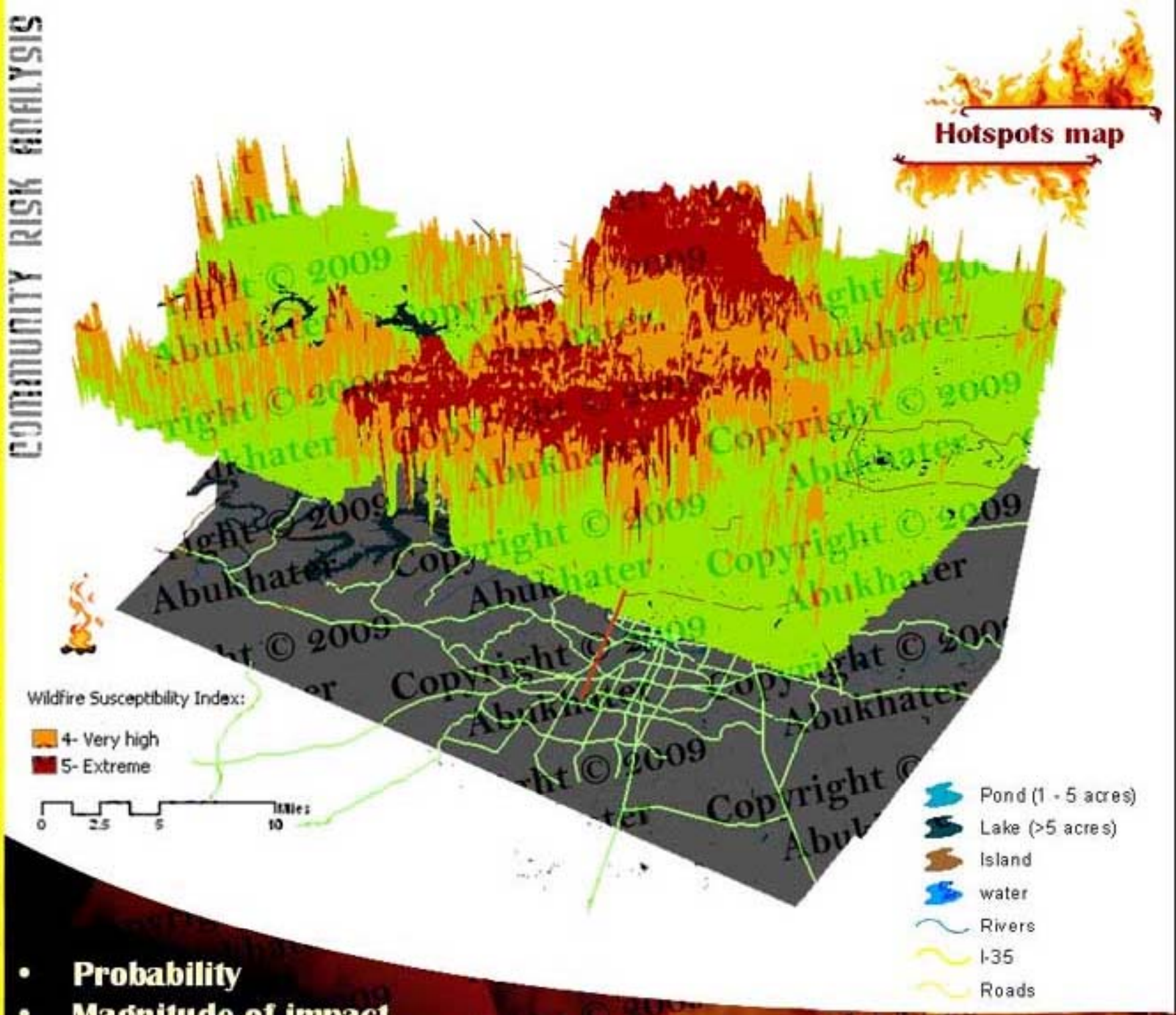
Wildfire Susceptibility Index (WFSI)

COMMUNITY RISK ANALYSIS



- **Probability**
- **Magnitude of impact**

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Wildfire Susceptibility Index (WFSI)

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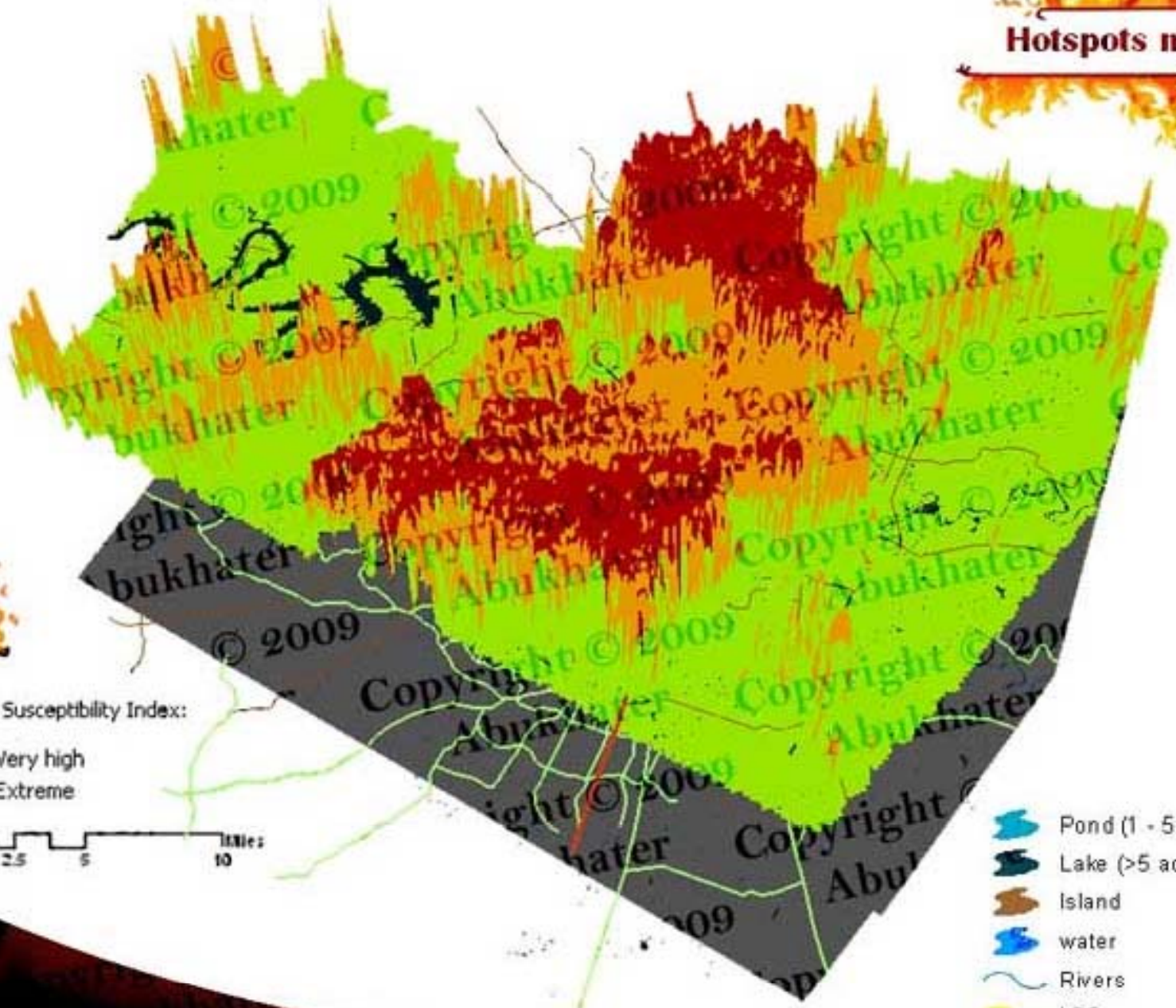

- **Probability**
- **Magnitude of impact**

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Wildfire Susceptibility Index (WFSI)

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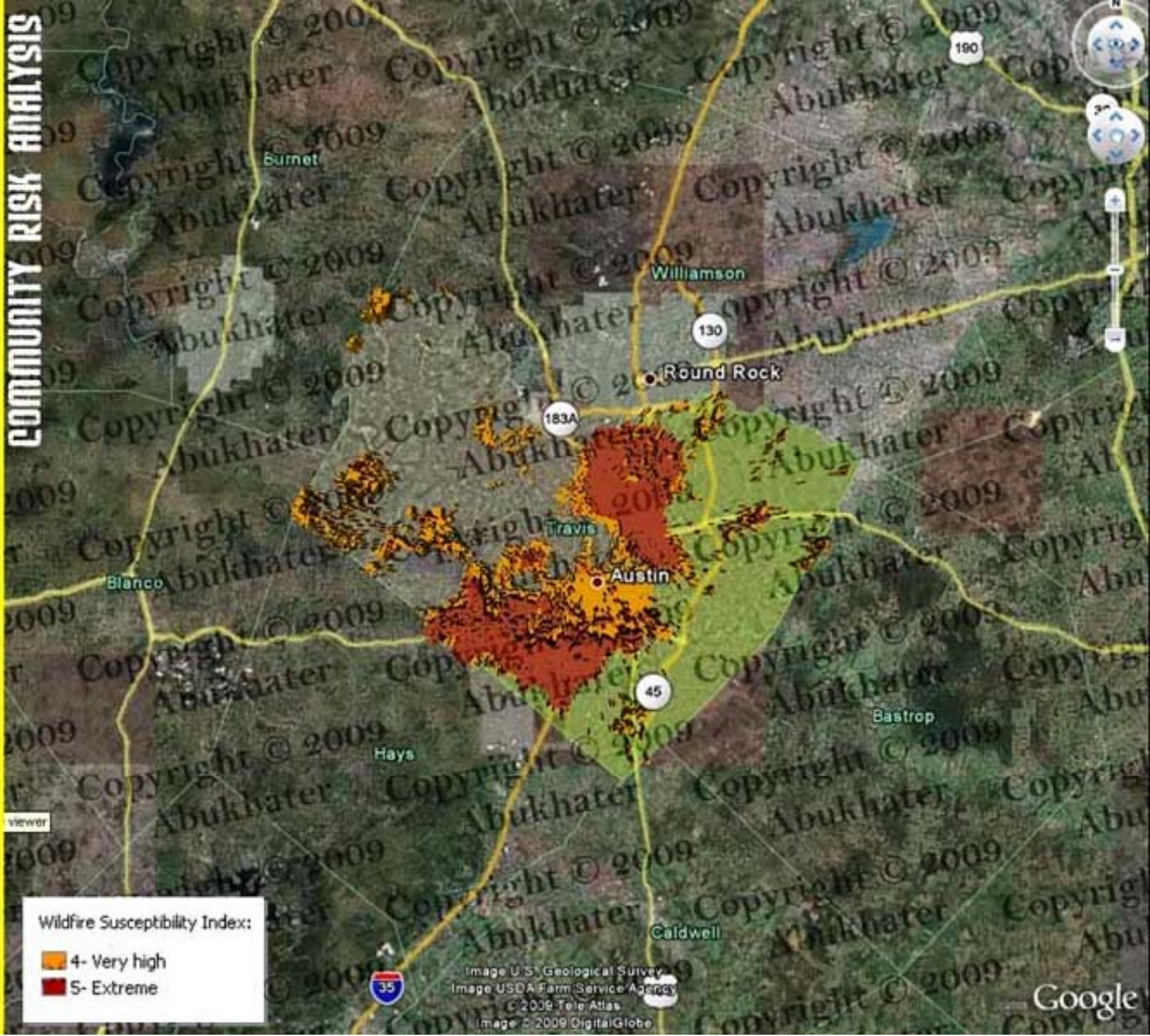

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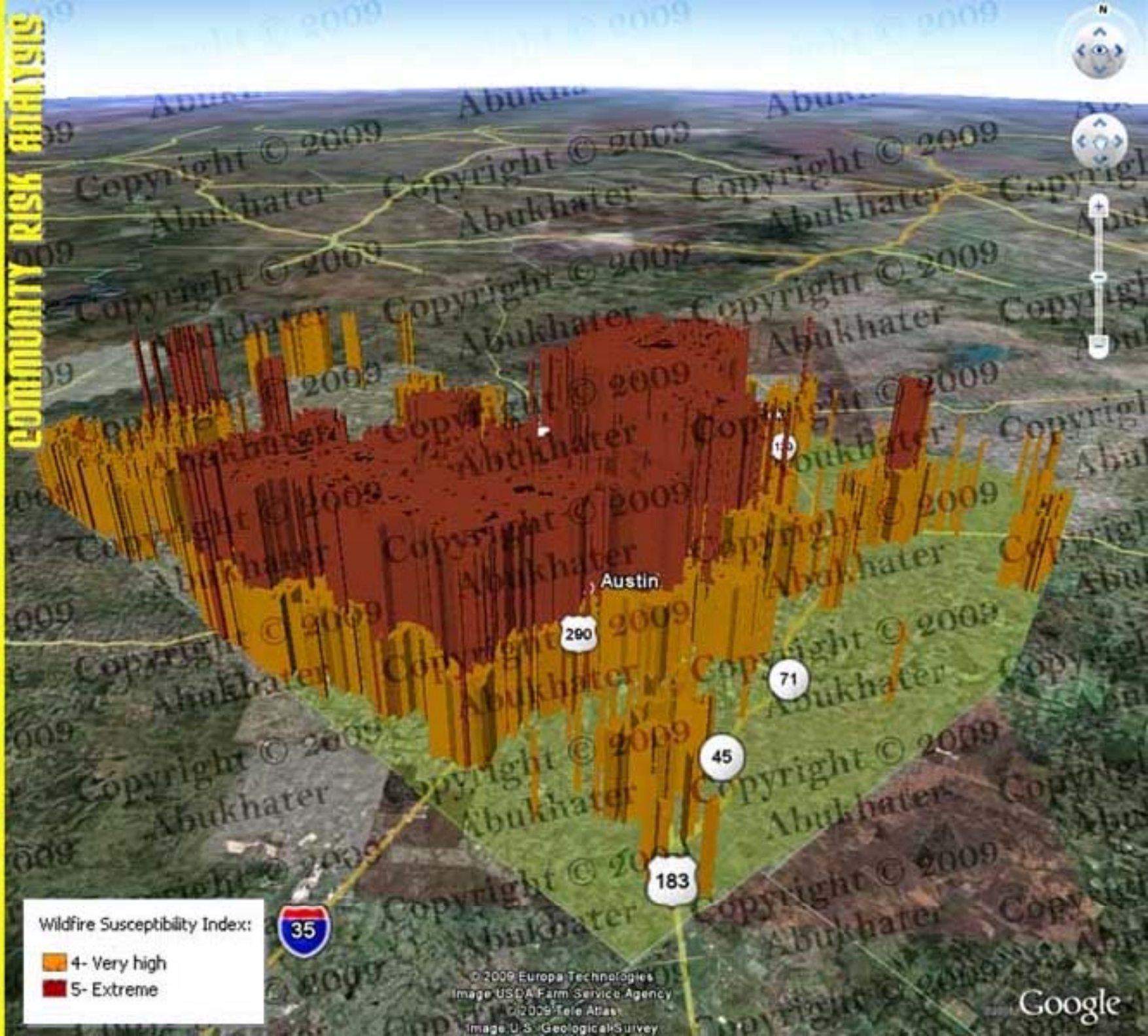

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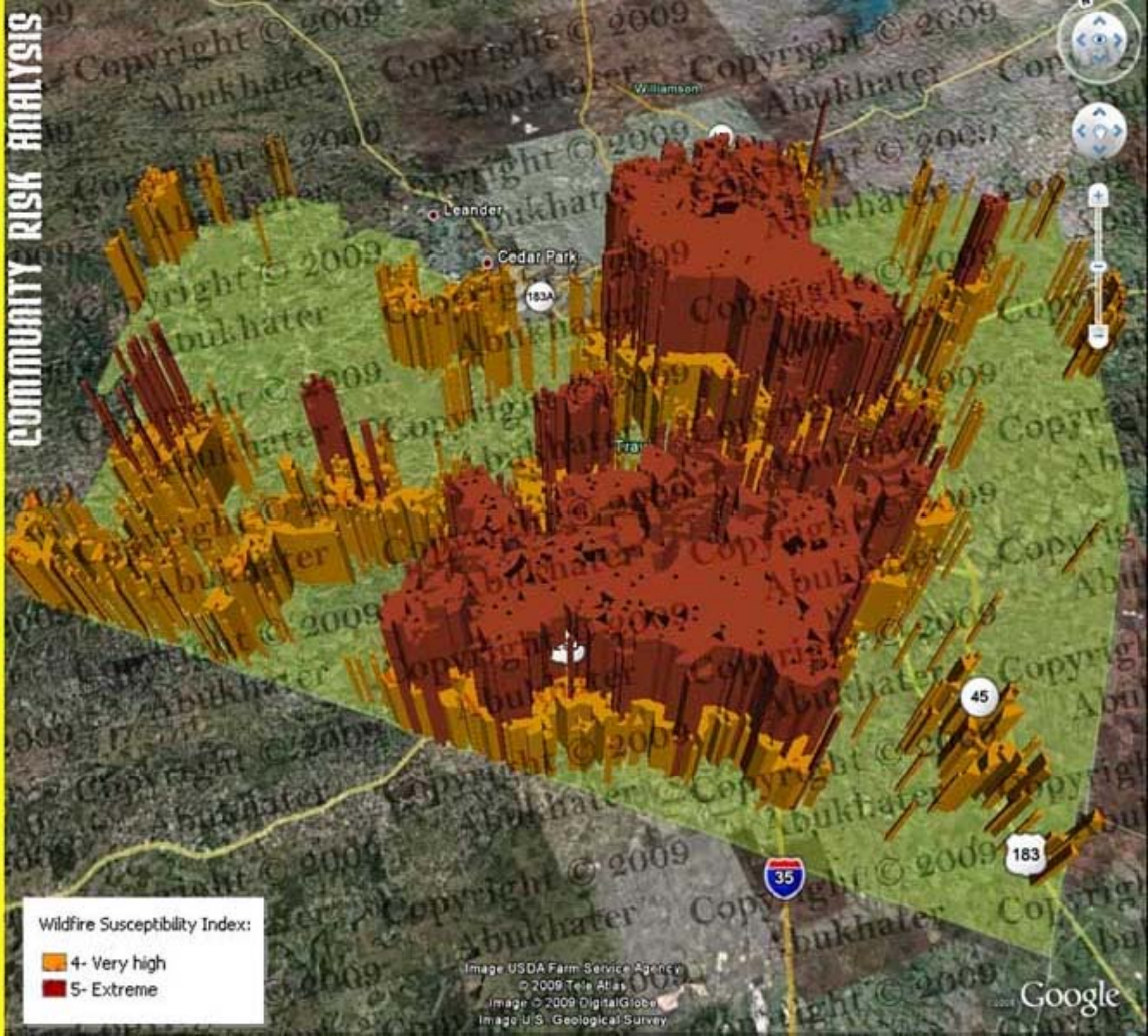

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- **Next steps & future analysis:**
  - **Spatio-temporal interpolation of Communities at Risk (3D Modeling + time)**
  - **Land use policy implications:** assessment tools and capabilities for land use policy and decision making
  - **Land use applications:**
    - Future land use suitability analysis
    - Conflict maps

Questions:

Thank you…

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