

A NOVEL METHOD FOR MAPPING HIGH RISK WILDFIRE IGNITION AREAS

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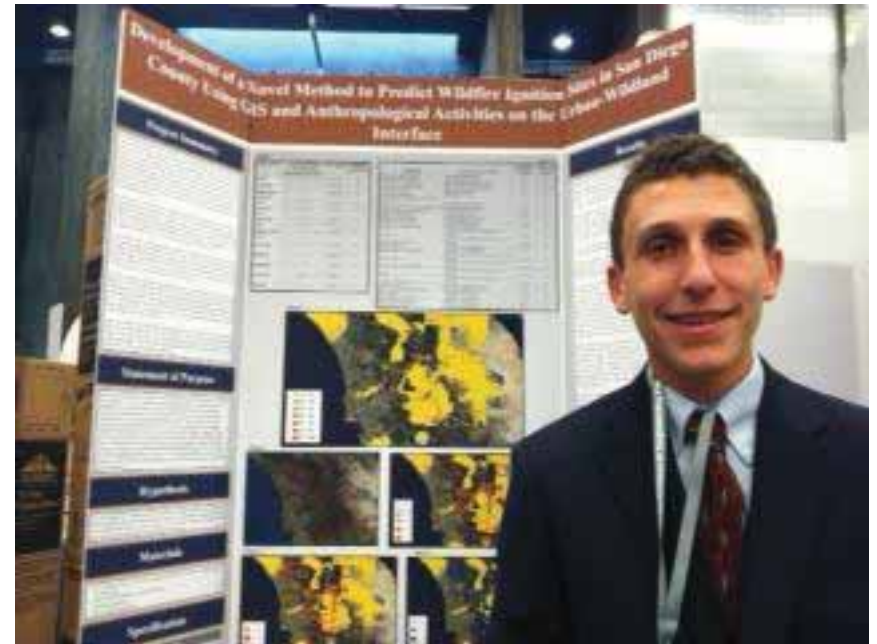


Alexander Cowan High School Senior

□ Rowing



□ Science Fair



Project Purpose

- The purpose of this project was to create a novel, proactive, and more effective fire risk ignition map that incorporated anthropological data. This was completed through GIS mapping using ESRI ArcGIS software as well as analysis of shapefile/layer intersection.



Section One

Project Background

Wildfire Statistics

- 100,000 wildfires burn between 4 to 5 million acres across the United States every year.
- Wildfires cause over \$800 million worth of damage in California every year.
- Between 80 and 90 percent of all wildfires are started by humans and human related activities/technology.

Factors Contributing to Wildfire Severity

- Vegetation i.e., fuel sources.
- Climate i.e., temperature, winds, humidity.
- Location, elevation and topography.

Wildfire Ignition Causes

- Natural e.g., lightning, spontaneous heating, and volcanic eruptions.
- Human
 - ▣ Human technology e.g., power lines, machinery and vehicles.
 - ▣ Direct human activity e.g. campfires and arson.

Existing Predictive Maps Incorporating Human Related Data

- Chuvieco & Congalton, 1989, used GIS
 - ▣ Data included, elevation, vegetation, proximity to roads, trails and human activity.
 - ▣ Captured 42% of fires in risk map of Spanish Coast.
- Vega-Garcia et al, 2008, used GIS
 - ▣ Data included meteorological, topographic, vegetation and socio-demographic e.g., transportation and urban housing.
 - ▣ Captured 78% of fires in Catalonia; high false positives.

Existing Predictive Maps Incorporating Human Related Data Continued

- Dickson et al., 2006. used GIS
 - ▣ Data included topographic roughness, vegetation, elevation and road density.
 - ▣ Correlations of risk and occurrence in Arizona.
- Kolden and Weigel, 2007, used GIS
 - ▣ Data included elevation, land use and land cover, ownership and proximity to roads.
 - ▣ Correlations with fire risk particularly with roads for San Diego County.



Section Two

Project Development, Results and Analysis

Hypothesis

- If GIS software could generate a wildfire ignition risk area map based on anthropological activity on the urban-wildland interface, it is anticipated that there would be at least a 30% overlap between retrospective fire ignition site records and those newly identified high-risk areas.

Specification

Component	Performance
GIS Platform	Able to Generate a Map
Retrospective Data	Able to Import Anthropological Based Shape Files
Union Analysis	Able to Create Combined Union Map
Fire Ignition Prediction	>30% Accuracy

Materials

- PC Computer with 2.2 GHz CPU speed, 2GB RAM, 24-bit color depth, and 2.4 GB Disk space
- ESRI ArcGIS Desktop 10.1 Student Edition
- SANDAG shapefiles
- CalFire FRAP shapefiles

Procedural Outline

1. Uploaded and edited shapefiles onto ArcGIS.
2. Analyzed retrospective fire ignition data for the County between 2000-2005.
3. Created weighting system based on 2.
4. Applied weights.
5. Created Union Map.
6. Analyzed resulting maps.
7. Tested resulting maps.

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Developing the Risk Maps

Type of Fire	Number of Fires Caused Between 2000-2005 (Out of 94)	Percentage	Weighted Coefficient
Arson	9	9.57	10
Campfire	11	11.70	12
Illegal Alien Campfire	13	13.83	14
Debris	2	2.13	2
Equipment Use	13	13.83	14
Lightning	4	4.26	4
Misc.	9	9.57	0
Playing with Fire	3	3.19	3
Power line	2	2.13	2
Railroad	1	1.06	1
Smoking	1	1.06	1
Unknown	22	23.40	0
Vehicle	1	1.06	1

Shapefile	Perceived Type of Fire	Associated Weights	Adjusted Weight
Waste Facilities 150 Meter Buffer	Quassi-Equipment/Debris	5, 1	6
Gas Stations 150 Meter Buffer	Quassi-Equipment/Vehicle	3, 1	4
SD Rec Centers	Quassi-Equipment/Playing with Fire	7, 3	10
SD Rec Centers 150 Meter Buffer	Quassi-Equipment/Playing with Fire	4, 2	6
CN Rec Centers	Quassi-Equipment/Playing with Fire	7, 3	10
CN Rec Centers 150 Meter Buffer	Quassi-Equipment/Playing with Fire	4, 2	6
Ports of Entry 5k Buffer	Illegal Alien Campfire	14	14
Unincorporated Cell Phone Towers 150 Meter Buffer	Quassi-Equipment Use/Arson	4, 4	8
Incorporated Cell Phone Towers 150 Meter Buffer	Quassi-Equipment Use/Arson	4, 4	8
Collector Substations 150 Meter Buffer	Powerline/Equipment Use	2, 10	12
Railroads 150 Meter Buffer	Railroad	1, 4	5
Bike Routes 150 Meter Buffer	Quassi-Equipment Use/Arson	4, 1	5
Trunklines 150 Meter Buffer	Powerline/Equipment Use	2, 10	12
Collector Lines 150 Meter Buffer	Powerline/Equipment Use	2, 10	12
CN Parks	Campfire/Playing With Fire/Equipment Use/Smoking	6, 3, 6, 6, 1	22
CN Parks 150 Meter Buffer	Campfire/Playing With Fire/Equipment Use/Smoking	3, 2, 4, 4, 1	14
Military Facilities	Equipment Use/Miscellaneous	6, 4	10
Military Facilities 150 Meter Buffer	Equipment Use/Miscellaneous	4, 2	6
Active Use Parks	Campfire/Playing With Fire/Equipment Use/Arson/Smoking	6, 3, 6, 6, 1	22
Active Use Parks 150 Meter Buffer	Campfire/Playing With Fire/Equipment Use/Arson/Smoking	3, 2, 4, 4, 1	14
SD Parks	Campfire/Playing With Fire/Equipment Use/Smoking	6, 3, 6, 6, 1	22
SD Parks 150 Meter Buffer	Campfire/Playing With Fire/Equipment Use/Smoking	3, 2, 4, 4, 1	14
Mobile Home Parks	Debris/Smoking/Playing with Fire	2, 1, 3	6
Mobile Home Parks 150 Meter Buffer	Debris/Smoking/Playing with Fire	1, 1, 1	3
National Forests	Campfire/Arson/Smoking	12, 8, 1	21
Palomar Mountain State Park	Campfire/Arson/Smoking	12, 8, 1	21
Rancho Cuyamaca State Park	Campfire/Arson/Smoking	12, 8, 1	21
Anza Borego State Park	Campfire/Arson/Smoking	12, 8, 1	21

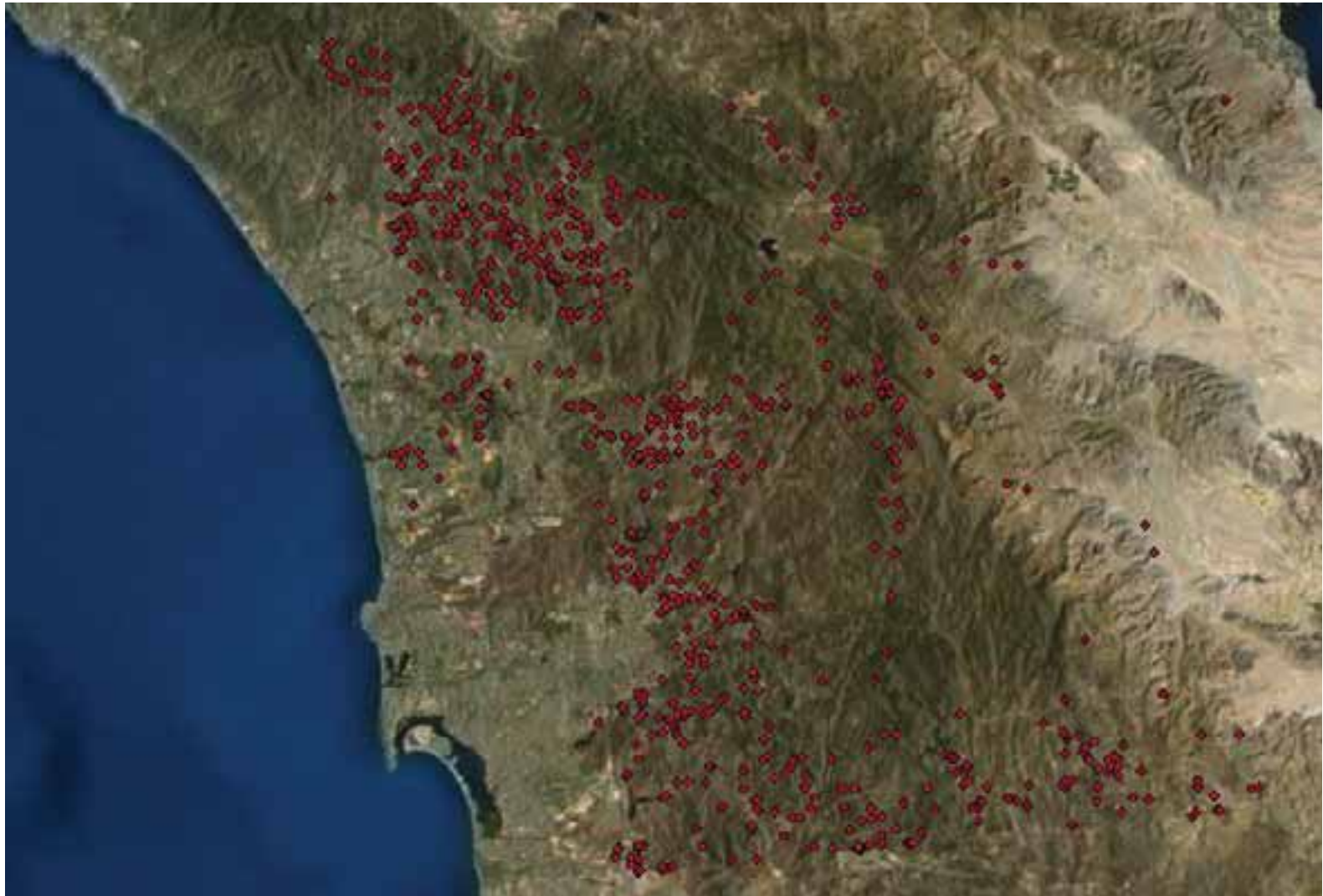
Final Combined Union Map

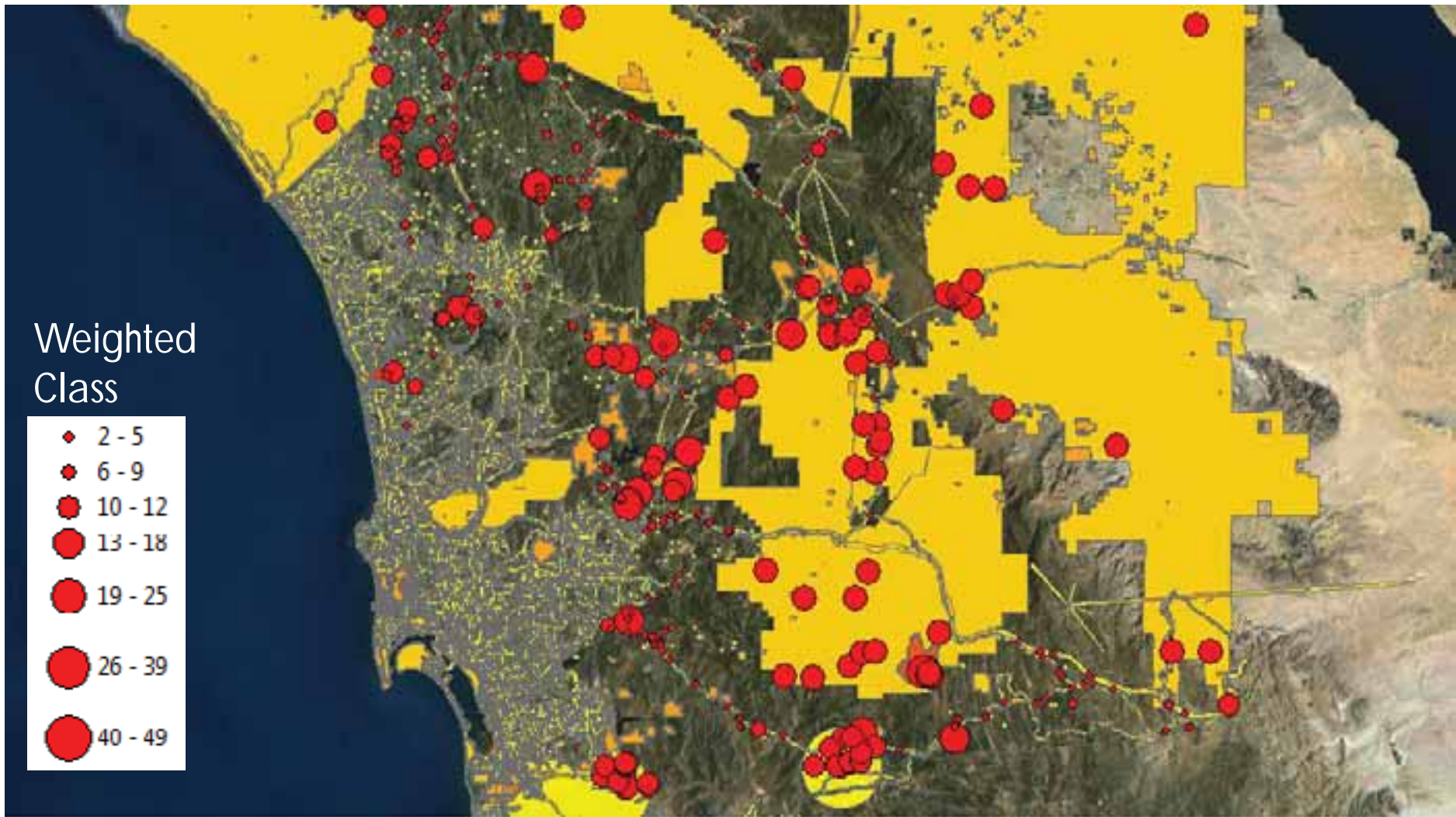




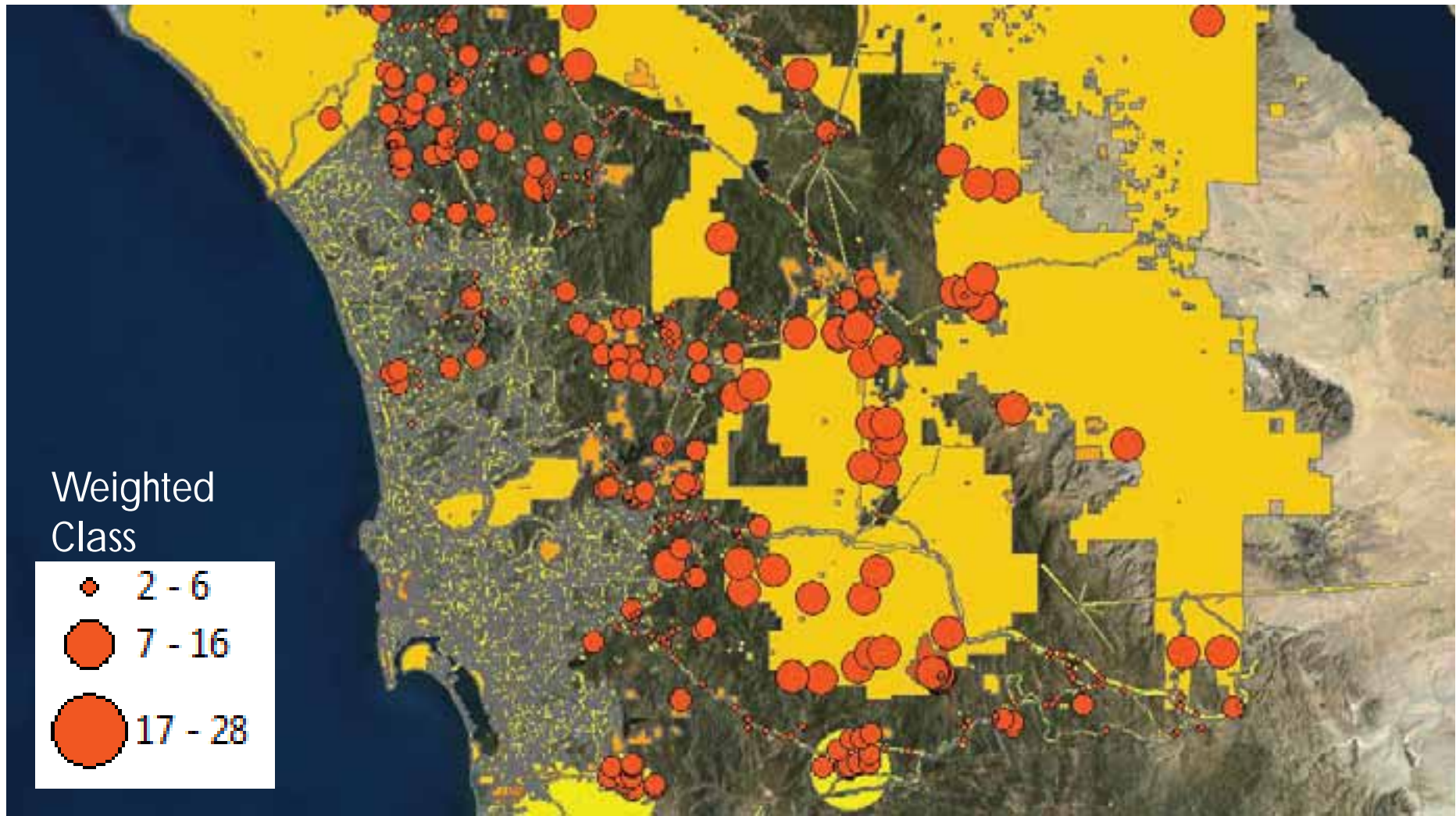
Testing Risk Maps

San Diego County Fire Ignition Sites 2006-2010





Original Overlay Test
(464 Ignition Sites)



Overlay Test With 250 Meter Buffer Zone
(591 Ignition Sites)

Key Shows Weighting for Additional Ignition Sites Only

Weighted
Class

◆ 2 - 5

● 6 - 8

● 9 - 16

● 17 - 28

Overlay Test With 500 Meter Buffer Zone
(686 Ignition Sites)

Key Shows Weighting for Additional Ignition Sites Only

Predictive Test Summary

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Type of Overlay Test	Number of Wildfire Ignition Sites that Occurred in Overlay Test (out of 972)	Accuracy
Intersection	464	47.74
Intersection and Within 250 Meters	591	60.80
Intersection and Within 500 Meters	686	70.58

Tabulated Results

Spatial Join Test 1: Fire Ignition Sites that Fall Within Risk Map			
Weight Class	Weights	Number of Fires (out of 464)	%
Very Low Risk	2.0-14.0	351	75.65
Low Risk	15-28	94	20.26
Moderately Low Risk	29-42	17	3.66
Moderate Risk	43-56	2	0.43
Moderately High Risk	57-70	0	0
High Risk	71-84	0	0
Very High Risk	85-104	0	0

Tabulated Results Continued

Spatial Join Test 2: Fire Ignition Sites that Fall Within 250 Meters of Risk Map			
Weight Class	Weights	Number of Fires (out of 591)	%
Very Low Risk	2.0-14.0	527	89.17
Low Risk	15-28	64	10.83
Moderately Low Risk	29-42	0	0
Moderate Risk	43-56	0	0
Moderately High Risk	57-70	0	0
High Risk	71-84	0	0
Very High Risk	85-104	0	0

Tabulated Results Continued

Spatial Join Test 3: Fire Ignition Sites that Fall Within 500 Meters of Risk Map			
Weight Class	Weights	Number of Fires (out of 686)	%
Very Low Risk	2.0-14.0	622	90.67
Low Risk	15-28	64	9.33
Moderately Low Risk	29-42	0	0
Moderate Risk	43-56	0	0
Moderately High Risk	57-70	0	0
High Risk	71-84	0	0
Very High Risk	85-104	0	0

Analysis

- Capability of map to predict fire ignition risk areas demonstrated equivalent or improved accuracy than other published data.
- In this study, with a 500 meter buffer 70% of wildfire ignition sites in San Diego County were predicted using human data only.



Section Three

Conclusions & Recommendations

Conclusions

- Validated hypothesis of generating a fire risk map that would capture minimally 30% of fires.
- Fire risk map could be a very useful tool in fire prevention, mitigation and regional planning.
- With 70% accuracy (500m buffer), the map indicates certain areas of San Diego County to be considered high risk zones for wildfire ignition.

Recommendations

- Incorporate vegetation, climate, and topographical data into map.
- Incorporate minor roads and minor power line shapefile layers.
- Integrate Bayesian Statistics and apply to other wildfire prone regions.

Acknowledgements

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