



# **Integrated Wildfire Evacuation Decision Support System - IWEDSS Design & Focus Group Outcome -**

Atsushi Nara, Ming-Hsiang Tsou, Xianfeng Yang, Sahar Ghanipoor Machiani

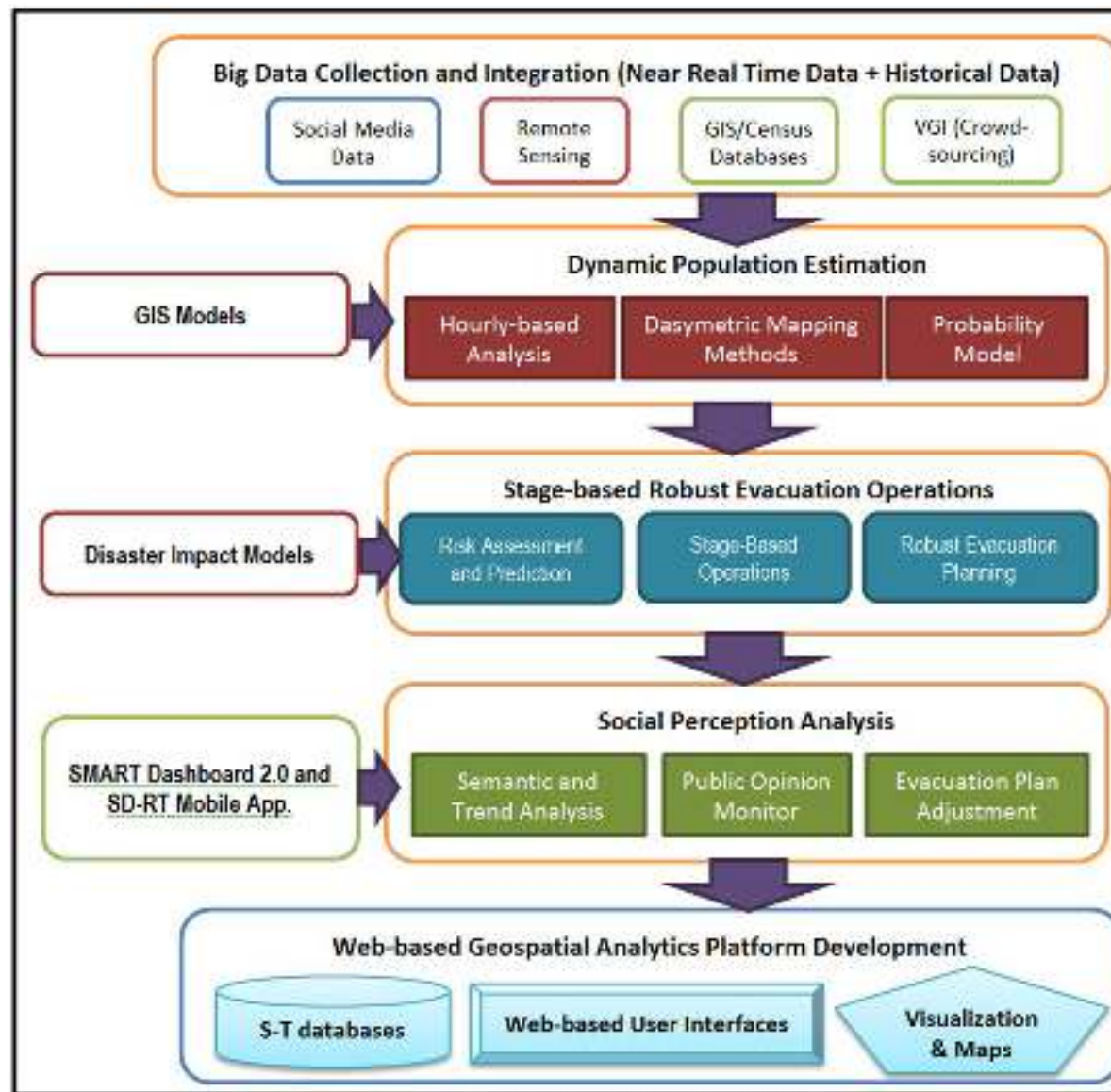
August 16, 2017



**Integrated Stage-Based Evacuation with Social Perception Analysis  
and Dynamic Population Estimation**



# IWEDSS Framework



# IWEDSS Web-GIS Mockup

IWEDSS

2017-07-24 10:23 AM

**Login**

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**Tools**

- Map
- Wildfire Simulation
- Population
- Evacuation
- Social Perception

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**Admin Tools**

- User accounts
- Configurations

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**About**

- People
- Research
- Acknowledgement
- Links

Home | Map | Wildfire Simulation | Population | Evacuation | Social Perception | Info

**Wildfire**

- Active Fire
- Recent Fire
- Fire History
- Simulation
- Scenario 1
- Scenario 2
- Scenario 3

Weather

Land-Cover / Land-Use

Population

Evacuation

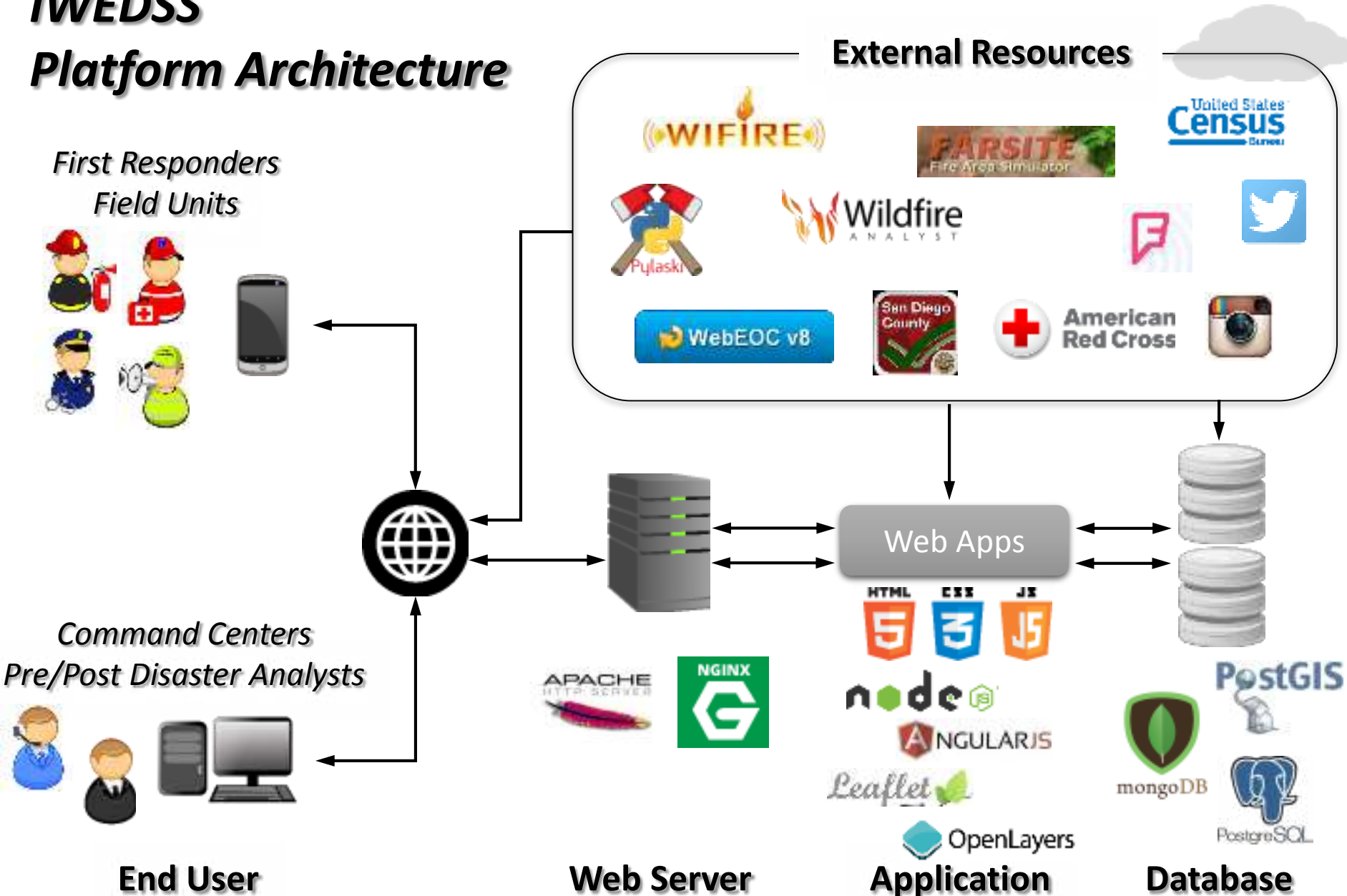
Social Perception

Map Source: CALFIRE

TAZ	Pop (Census)	Pop Density
2855	1649	1762.4
2909	1600	7011
2774	1245	787.6



# IWEDSS Platform Architecture



## ***Focus Group***

### Objective:

To seek opinions/suggestions from decision makers and domain experts about IWEDSS  
Discussed IWEDSS design, tools, interface, functionalities and/or usability

### Date & Time:

July 24, 2017, 9 am – 12 pm

### Number of Participants:

Invited: 8 (+2)

SDSU: 7

### Invited Participants' Affiliations:

Office of Emergency Services (OES), County of San Diego;

American Red Cross – San Diego; 2-1-1 San Diego; United States Forest Service (USFS);

San Diego County Sheriff's Department; San Diego Gas & Electric (SDG&E)

California Department of Forestry and Fire Protection (CALFIRE)

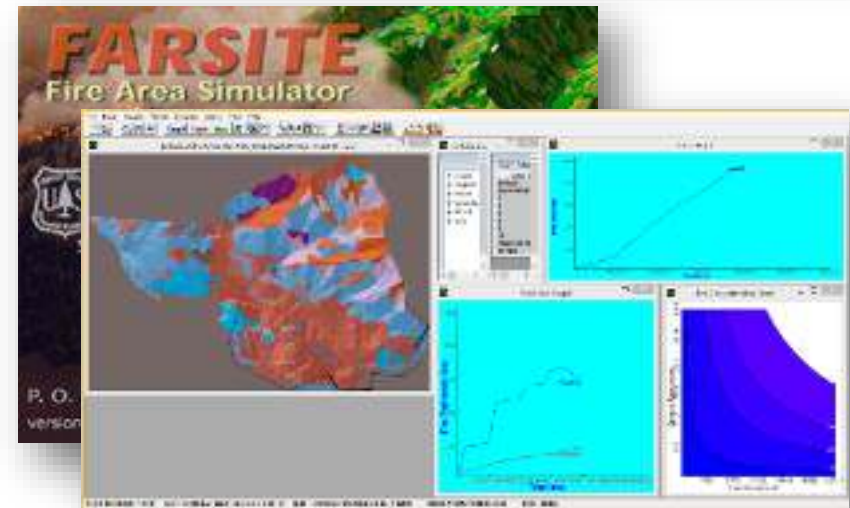
## ***Focus Group Agenda***

- 1. Reviewed existing decision support software**
- 2. Introduced a mock-up design of IWEDSS**
- 3. Discussed existing software, tools, services, and data for wildfire management in practice**
- 4. Discussed the IWEDSS design, interface, tools, functionalities and usability**

# ***1. Reviewed existing decision support software***

- Hazus-Multi-Hazard
  - FEMA
  - <https://www.fema.gov/hazus>
- FARSITE
  - USDA
  - Used in Wifire-FireMap (USCD-SDSC) for wildfire simulation
  - <https://www.firelab.org/project/farsite>
- Wildfire Analyst
  - technosylva
  - <http://wildfireanalyst.com/>
- RtePM
  - Old Dominion University
  - Real time evacuation Planning Model
  - <http://rtepm.vmasc.odu.edu/>

# 1. Reviewed existing decision support software





## 2. Introduced a mock-up design of IWEDSS

The mock-up shows a web browser window with the URL 'http://'. The page title is 'IWEDSS'. The navigation menu includes: Home, Map, Wildfire Simulation, Population, Evacuation, Social Perception, and Info. The main content area is divided into several sections:

- Tools:** A vertical sidebar on the left containing: Login, Tools (Map, Wildfire Simulation, Population, Evacuation, Social Perception), Admin Tools (User accounts, Configurations), About (People, Research, Acknowledgement, Links).
- Main Contents:** A central panel with a 'Wildfire' section containing: Active Fire, Recent Fire, Fire History, Simulation (Scenario 1, Scenario 2, Scenario 3), Weather, Land-Cover / Land-Use, Population, Evacuation, and Social Perception. To the right is a map of San Diego with various markers.
- Analytics Contents:** A bottom section featuring a table of TAZ data, a bar chart, and a line graph.

Callouts in orange speech bubbles identify these sections: 'Tools' points to the sidebar, 'Main Contents' points to the central panel, 'Analytics Contents' points to the bottom section, and 'Menu' points to the navigation bar.

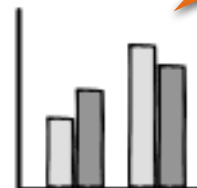
**Tools**

**Main Contents**

**Analytics Contents**

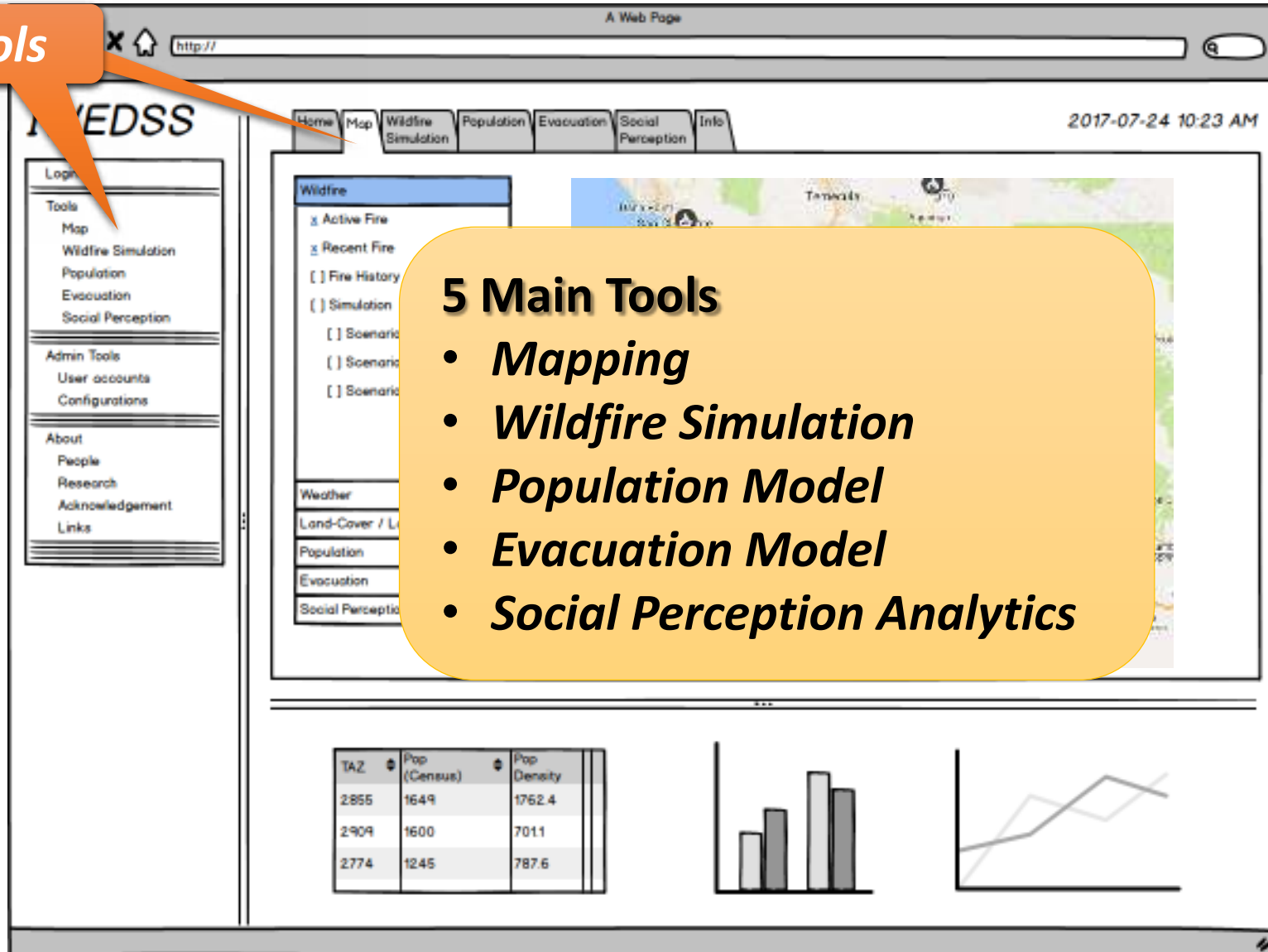
**Menu**

TAZ	Pop (Census)	Pop Density
2855	1649	1762.4
2909	1600	7011
2774	1245	787.6



## 2. Introduced a mock-up design of IWEDSS

**Tools**



**5 Main Tools**

- *Mapping*
- *Wildfire Simulation*
- *Population Model*
- *Evacuation Model*
- *Social Perception Analytics*

TAZ	Pop (Census)	Pop Density
2855	1649	1762.4
2909	1600	7011
2774	1245	787.6

# Wildfire Simulation

A Web Page

http://

Q

IWEDSS

Home
Map
Wildfire Simulation
Population
Evacuation
Social Perception
Info

2017-07-24 10:23 AM

Login

Tools

[Map](#)  
[Wildfire Simulation](#)  
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Admin Tools

[User accounts](#)  
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About

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[Links](#)

Wildfire

Active Fire  
 Recent Fire  
 Fire History  
 Simulation
 

- Scenario 1
- Scenario 2
- Scenario 3

Weather

Land-Cover / Land-Use

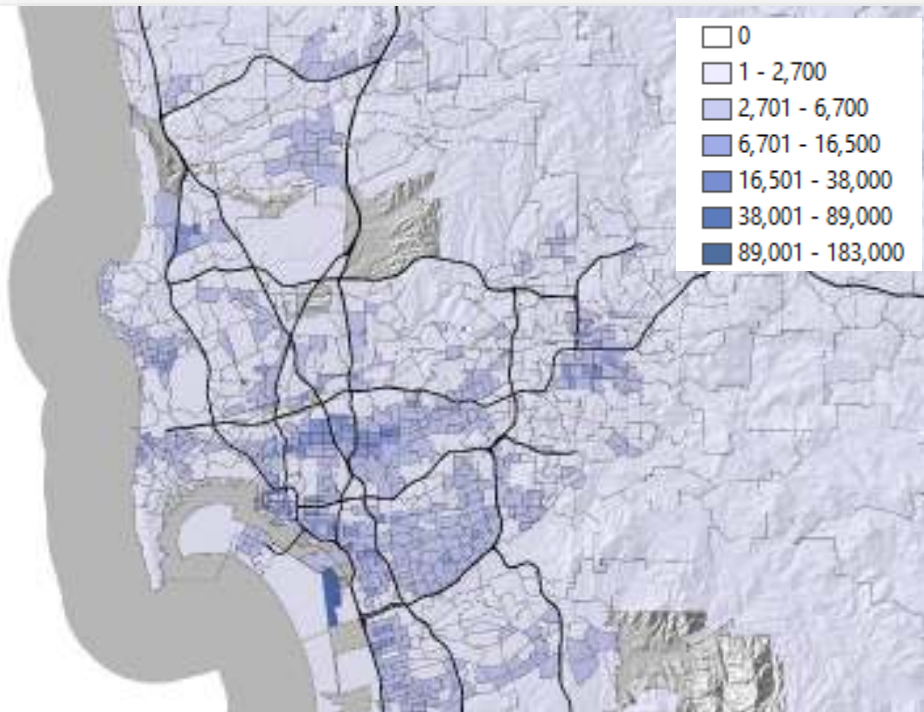
Population

Evacuation

Social Perception

TAZ	Pop (Census)	Pop Density
2855	1649	1752.4
2909	1600	7011
2774	1245	787.6

# Population

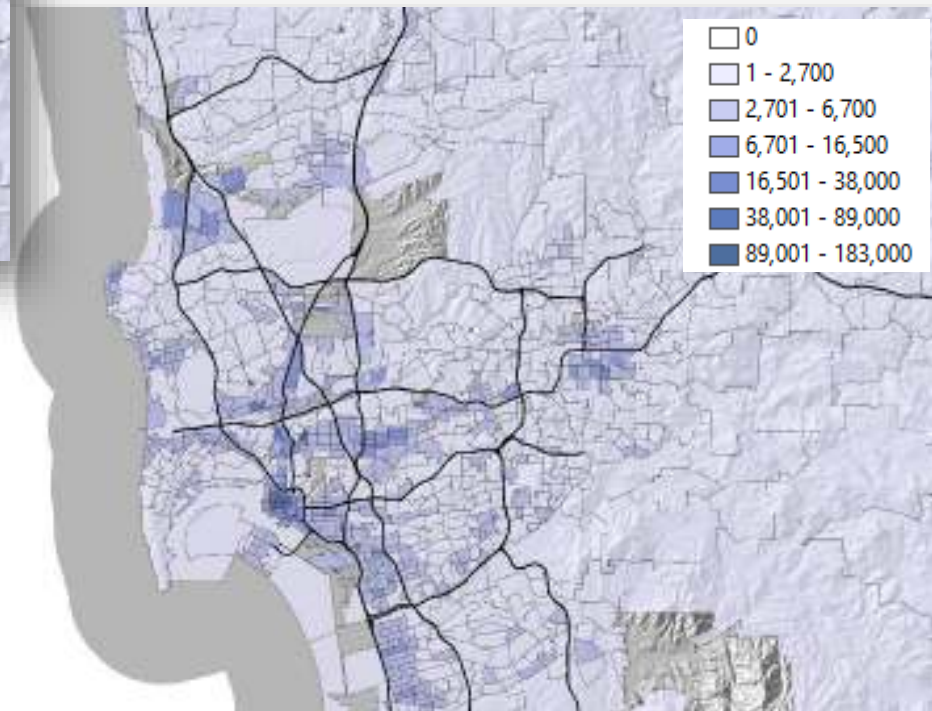


## Daytime Population Estimate

*Commuter adjusted population =  
Total area population + Total workers working  
in area - Total workers living in area*

## Nighttime Population Estimate

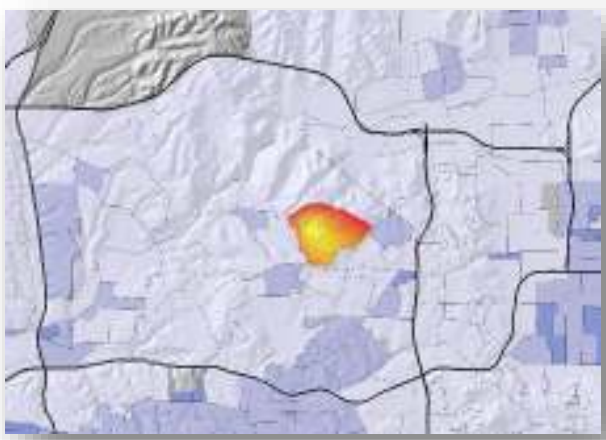
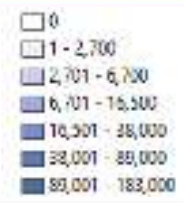
*Census Survey*





# Population

## Nighttime Population Estimate



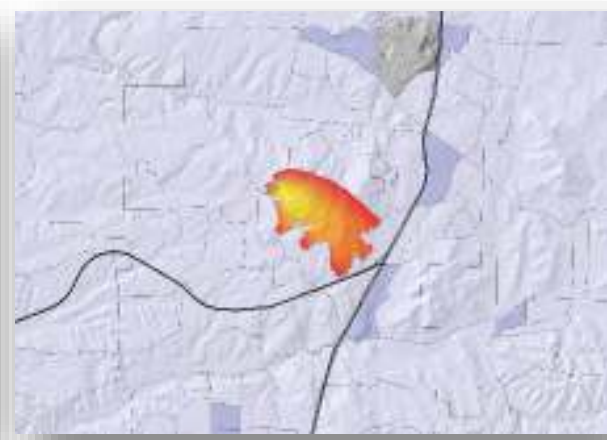
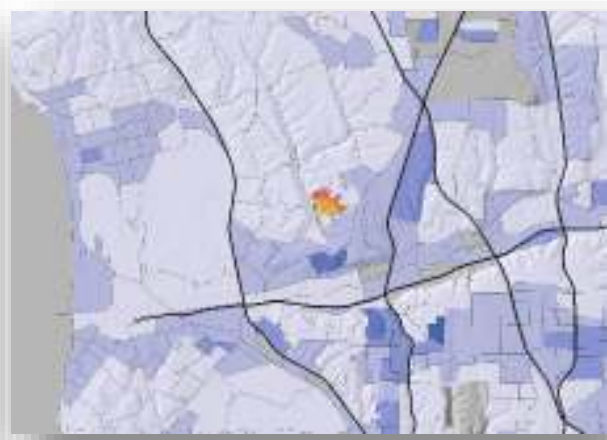
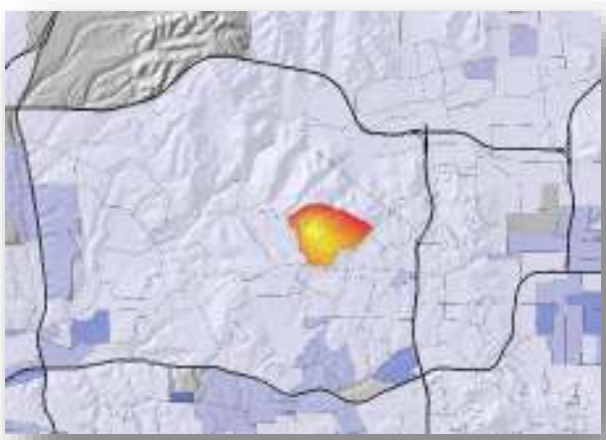
Cowles Mt.



Linda Vista

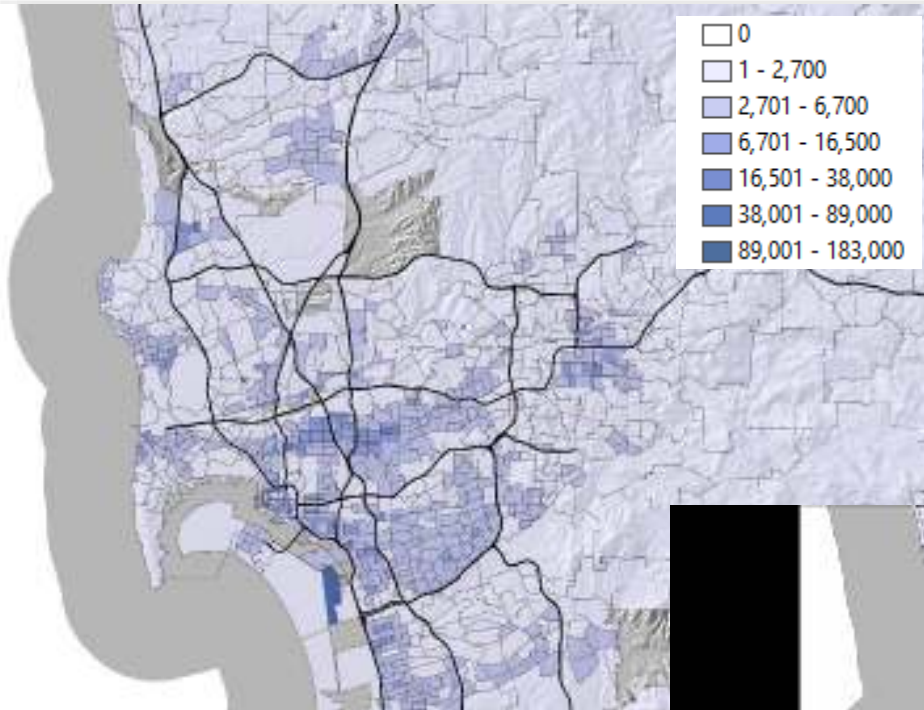


Black Mt.



## Daytime Population Estimate

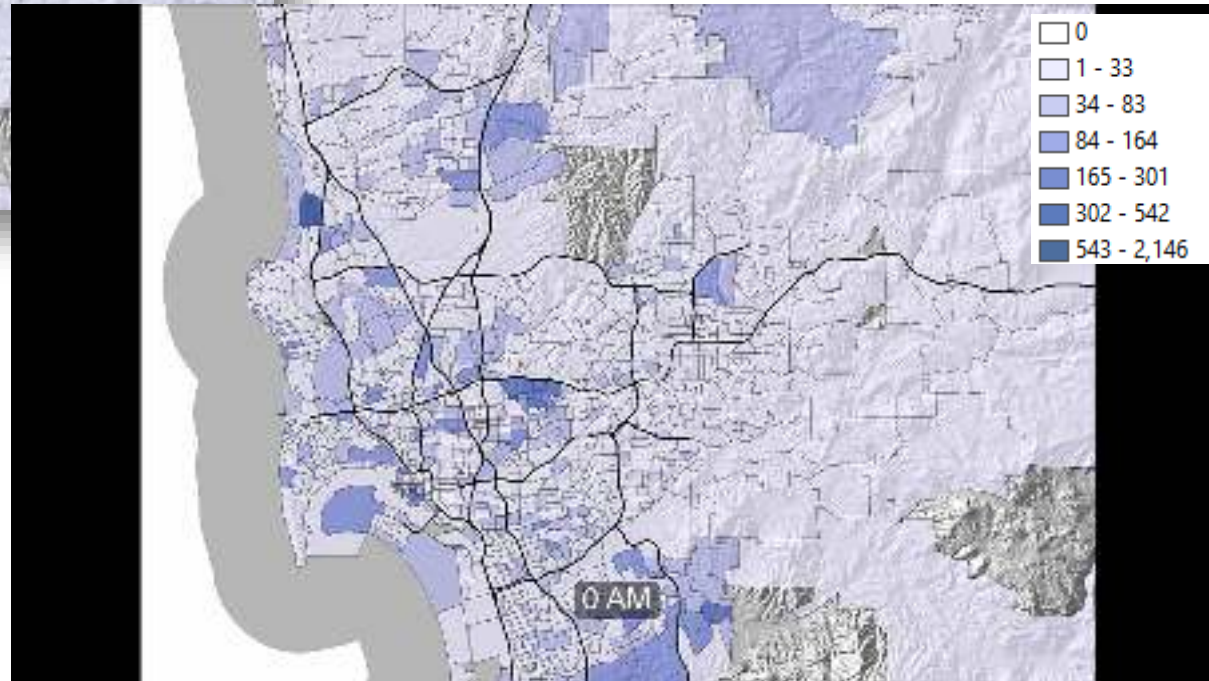
# Population



## Nighttime Population Estimate

*Census Survey*

Example: Twitter Users (Weekday)



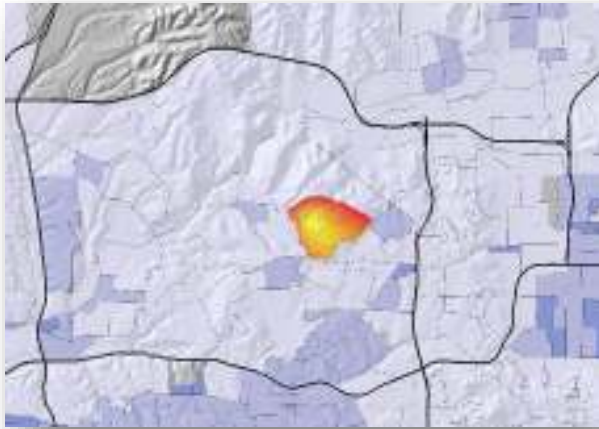
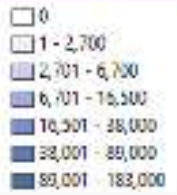
## Hourly Population Estimate

*Modeling based on the Number of Hourly Unique Social Media Users (e.g., Twitter, Instagram)*



# Population

## Nighttime Population Estimate



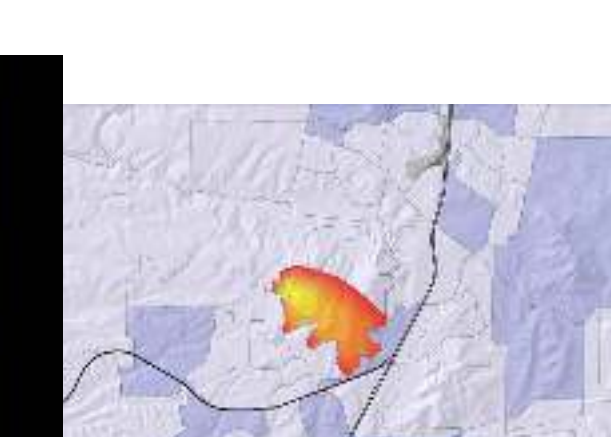
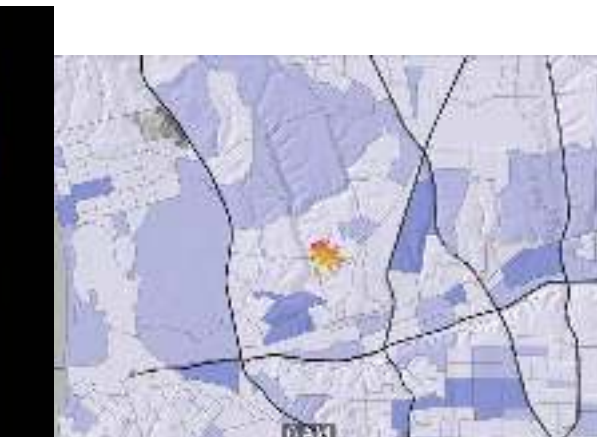
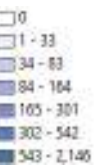
Cowles Mt.



Linda Vista



Black Mt.



## Number of Hourly Unique Twitter Users (Weekday)

# Population

Spearman's rank correlation coefficient between the hourly unique twitter users' density [weekday or weekend] and [ census nighttime population or commuter adjusted daytime population ]

Time	Weekday		Weekend	
	Nighttime	Daytime	Nighttime	Daytime
0:00-1:00	0.615 ***	0.640 ***	0.572 ***	0.604 ***
1:00-2:00	0.564 ***	0.597 ***	0.498 ***	0.537 ***
2:00-3:00	0.451 ***	0.496 ***	0.442 ***	0.471 ***
3:00-4:00	0.399 ***	0.468 ***	0.311 ***	0.344 ***
4:00-5:00	0.317 ***	0.429 ***	0.222 ***	0.294 ***
5:00-6:00	0.453 ***	0.560 ***	0.231 ***	0.348 ***
6:00-7:00	0.473 ***	0.601 ***	0.351 ***	0.464 ***
7:00-8:00	0.446 ***	0.611 ***	0.462 ***	0.554 ***
8:00-9:00	0.428 ***	0.606 ***	0.488 ***	0.595 ***
9:00-10:00	0.427 ***	0.616 ***	0.485 ***	0.608 ***
10:00-11:00	0.423 ***	0.619 ***	0.504 ***	0.637 ***
11:00-12:00	0.431 ***	0.634 ***	0.470 ***	0.615 ***
12:00-13:00	0.435 ***	0.637 ***	0.500 ***	0.643 ***
13:00-14:00	0.450 ***	0.645 ***	0.497 ***	0.642 ***
14:00-15:00	0.473 ***	0.661 ***	0.493 ***	0.636 ***
15:00-16:00	0.496 ***	0.673 ***	0.488 ***	0.628 ***
16:00-17:00	0.501 ***	0.667 ***	0.515 ***	0.651 ***
17:00-18:00	0.529 ***	0.672 ***	0.521 ***	0.639 ***
18:00-19:00	0.555 ***	0.684 ***	0.524 ***	0.639 ***
19:00-20:00	0.576 ***	0.685 ***	0.551 ***	0.652 ***
20:00-21:00	0.608 ***	0.690 ***	0.584 ***	0.659 ***
21:00-22:00	0.619 ***	0.682 ***	0.600 ***	0.665 ***
22:00-23:00	0.653 ***	0.695 ***	0.617 ***	0.665 ***
23:00-24:00	0.646 ***	0.684 ***	0.602 ***	0.648 ***

(n=1,571 TAZs)

\*\*\*p<0.001



# Population

## Hourly Population Estimate Model

$$\rho_{(t,s)} = D_{(t,s)}\varphi(t)\phi(s)$$

$\rho_{(t,s)}$  : Population density estimate in an hour ( $s$ ) at a TAZ ( $t$ )

$D_{(t,s)}$  : Average density of unique social media users in  $t$  at  $s$

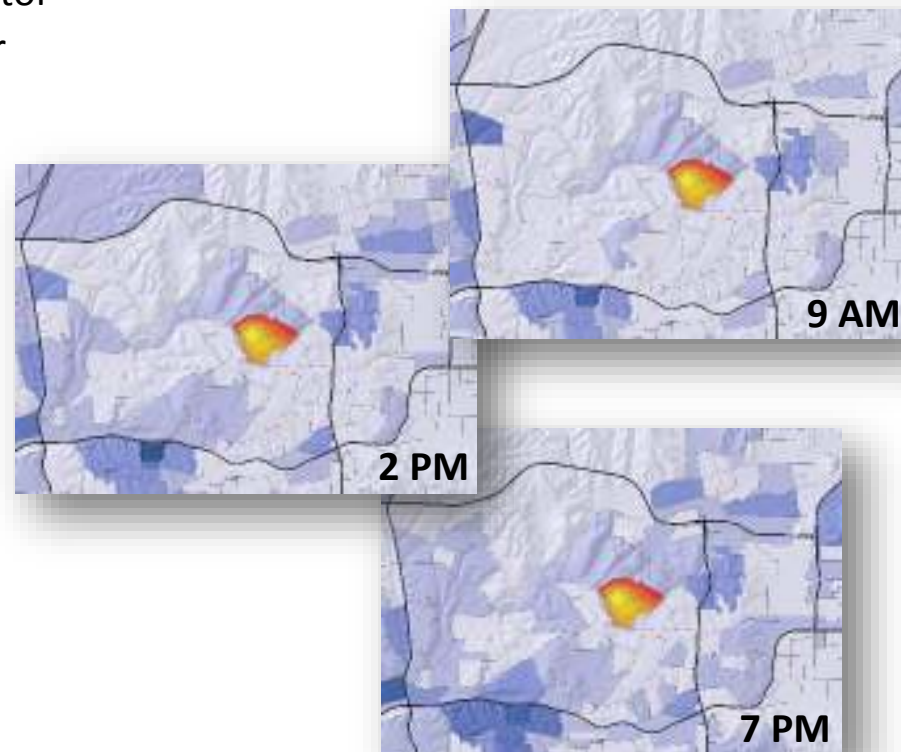
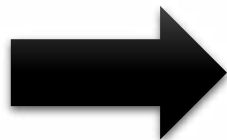
$\varphi(t)$  : Temporal scaling factor

$\phi(s)$  : Spatial scaling factor

United States  
**Census**  
Bureau



Land-Use



# Evacuation

A Web Page

Q

IWEDSS

2017-07-24 10:23 AM

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Wildfire

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Weather

---

Land-Cover / Land-Use

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Population

---

Evacuation

---

Freeways

---

Major Road

---

Destination

---

Evacuation Risk Zone

Stage

- 1
- 2
- 3

---

Social Perception

TAZ	Pop (Census)	Pop Density
2855	1649	1762.4
2909	1600	7011
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# Social Perception

**IWEDSS** 2017-07-24 10:23 AM

Home | Map | Wildfire Simulation | Population | Evacuation | **Social Perception** | Info

**Login**

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[SMART Dashboard 2.0](#)

[ReadySD Social \(1.1\) for Android](#)

[ReadySD Social \(1.1\) for iOS](#)

TAZ	Pop (Census)	Pop Density
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### 3. Discussed existing software, tool, services, and data for wildfire management in practice

General Category	Name	Type	Application Category	Provider	License	Adopted SD Agency
Tool, App, Service	Blackbird.AI	Web-based platform	Data analytics	SocialTrendly	Commercial	211 OES
	ForSight/HelioSight	Platform/API	Data analytics	Crimson Hexagon	Commercial	
	Nextdoor	Mobile app	Local social network		Free	
	GeoFeedia	Mobile app	Geotagged social media data feed		Free	
	Hootsuite	Mobile app	Social media communication		Free	
	Waze	Mobile app	Navigation and live traffic information		Free	
	NICS	Web-based platform	Next-generation incident command system	MIT-Lincoln Lab & California First Responder Community	Open source	
	SCOUT	Web-based platform	Situation awareness and collaboration tool	Cal OES, CAL FIRE, DHS S&T	Open source*	
Data management system	GeoCortex App	Mobile app	Evacuation response reporting tool	OES, Sheriff's Department		
	National Shelter System	Web-based platform	Database	Red Cross		
	SanMaps	Web-based platform	Data integration via Web-GIS	County of San Diego		
	WebEOC	Web-based platform	Crisis information management system	County of San Diego		

\*for baseline code





### 3. Discussed existing software, tool, services, and data for wildfire management in practice

General Category	Name	Short Description
Tool, App, Service	Blackbird.AI	A.I. driven anomaly detection for crisis and risk management
	ForSight/HelioSight	Social media analytics for business marketing (consumer references, trends, sentiment, social conversation around events, brands)
	Nextdoor	Private social network app for a local community
	GeoFeedia	Social media intelligence platform that associates social media posts with geographic locations
	Hootsuite	Share and schedule posts from Twitter, Facebook, Instagram, and LinkedIn accounts all from one app
	Waze	Navigation and live traffic app
	NICS	Communication platform for first responders
	SCOUT	Interagency situational awareness for CA emergency responders
	GeoCortex App	A quick reporting tool to record people responses for evacuation order
Data management system	National Shelter System	Over 56,000 potential shelter facilities and their information for disaster management
	SanMaps	A regional group, data library, and standardized application
	WebEOC	Provides secure real-time text-based information sharing



## ***4. Discussed the IWEDSS design, interface, tools, functionalities and usability***

- **General Feedback about IWEDSS**
- **Suggestions/Considerations**
  - **Interface**
  - **Data**
  - **Model/Functionality**

## ***4. Discussed the IWEDSS design, interface, tools, functionalities and usability***

### **General Feedback**

- **“Can provide technology supports to validate their decision making”**
- **“Great to have a technology component to run simulations and make recommendations not only to tactical and strategical fire decisions but route planning”**
- **“Useful to have social perception analytics tools available to local communities for emergency responses”**
- **“Has merit to the First Responder Community, and once completed will save lives”**

## ***4. Discussed the IWEDSS design, interface, tools, functionalities and usability***

### **Interface**

- **Have a simple interface with robust processing power behind the interface**
- **Who will be the end user, field units or command centers?**
  - Have adaptability to service both
  - Network connectivity issue for field units
    - Small data pipe for field units compared to buildings with established networks
- **Make recommendations for**
  - Evacuation Warning – Notice to prepare to evacuate
  - Evacuation Order – you need to leave now
  - Shelter In Place – stay where you are and lock down
- **Multi-platform compatible. PC, Apple, Android, iPhone, etc.**



## ***4. Discussed the IWEDSS design, interface, tools, functionalities and usability***

### **Data**

- **Build or get access to a shelter database which has shelter information (e.g., locations, capacity) from both national shelter service and WebEOC (SD County)**
  - Shelter locations, evacuation end points (e.g., parking lots, schools, recreational centers), pre-identified end points and shelters by sheriff's department & red cross, private shelter locations (e.g., churches)
- **Have autonomous data collection capabilities**
  - Using automated protocols to seeks (nearly) real-time data requirements
  - End user should not have to search for information to input
  - The system should know where to look automatically given the users location and data pipe
- **Power outage map for repopulation**
  - SDG&E has a 10 min. update map

## ***4. Discussed the IWEDSS design, interface, tools, functionalities and usability***

### **Model/Functionality**

- **Take into account the human stress factors of response and mitigation while under duress. Whether sensory, mental, physical, etc.**
- **Take a deeper dive on what IWEDSS traffic models utilize as factors in slowing or increasing speed of vehicles. Consider factors like:**
  - human factors such as time of day, experience (fire prone area, evacuated before)
  - demographics, metropolitan vs. rural
  - environmental conditions such as heat, smoke, visibility
  - law Enforcement response times and efficiencies in setting up routes and traffic control points
- **How does the model incorporate human decisions? Who will evacuate, who will go to shelters, who will go to hotel, which shelter, etc.**
- **Estimate likelihood by considering demographics**

## ***4. Discussed the IWEDSS design, interface, tools, functionalities and usability***

### **Model/Functionality**

- **Consider traffic control for larger vehicles (e.g., bus and horse trailers)**
- **Wish Items**
  - Awareness level matrix to provide awareness level based on the scan of social media (e.g., green, yellow, red)
  - Track where evacuees go and which shelter/end point

## Next Step

- **Implementation!**

## **Acknowledgement**

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