SAN DIEGO STATE UNIVERSITY

Integrated Wildfire Evacuation Decision Support System (IWEDSS)

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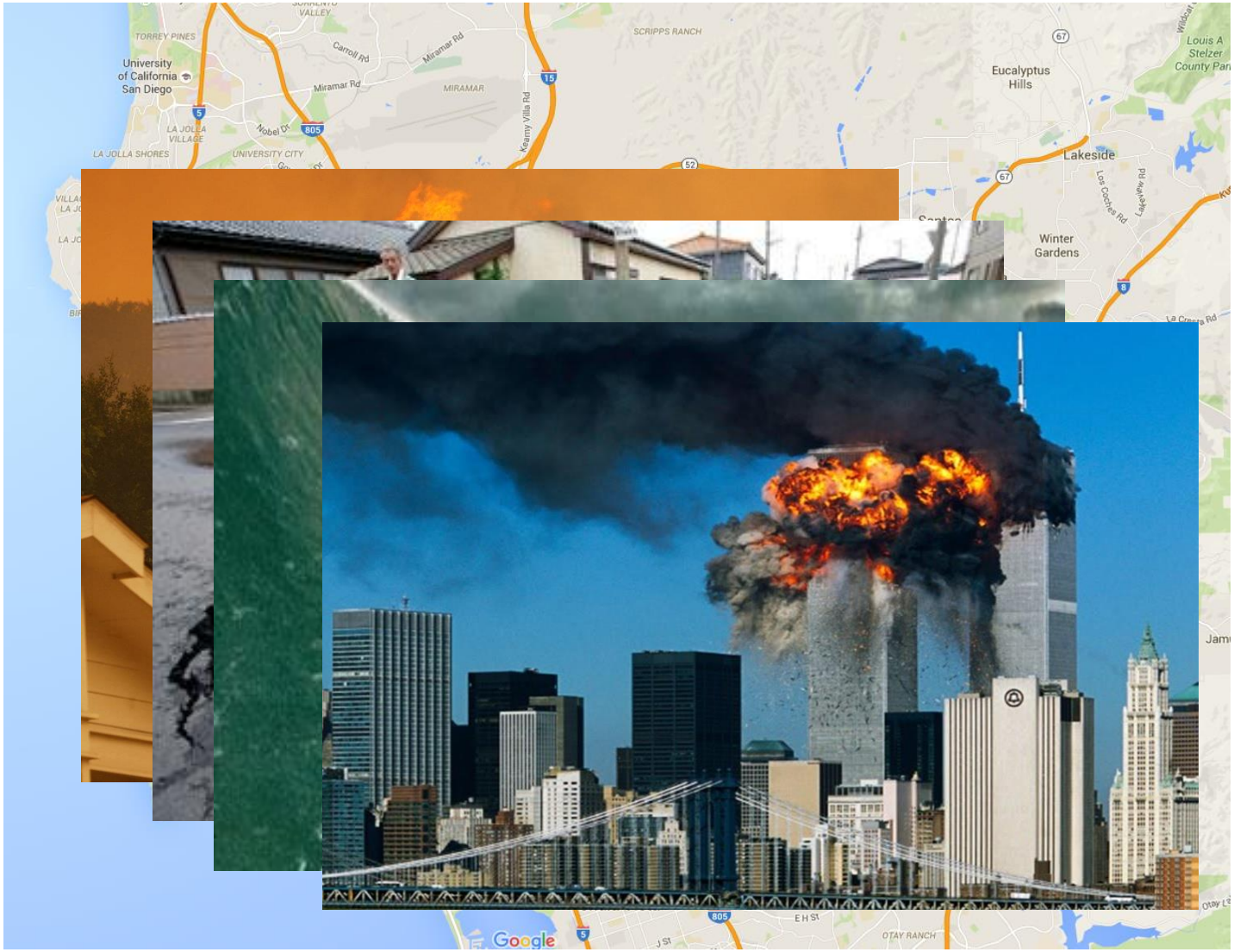
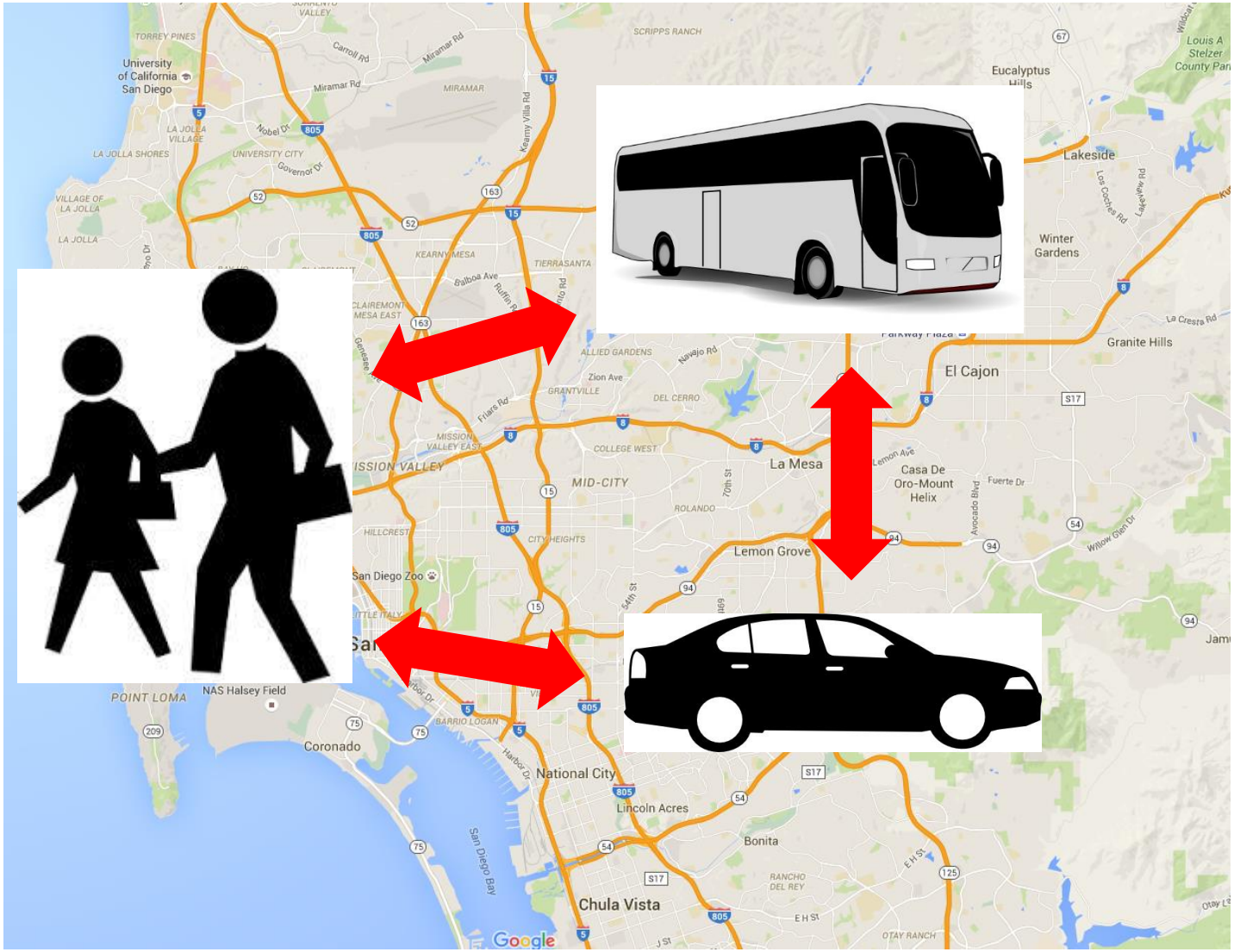
Department of Civil Engineering

San Diego State University

Evacuation Need in San Diego



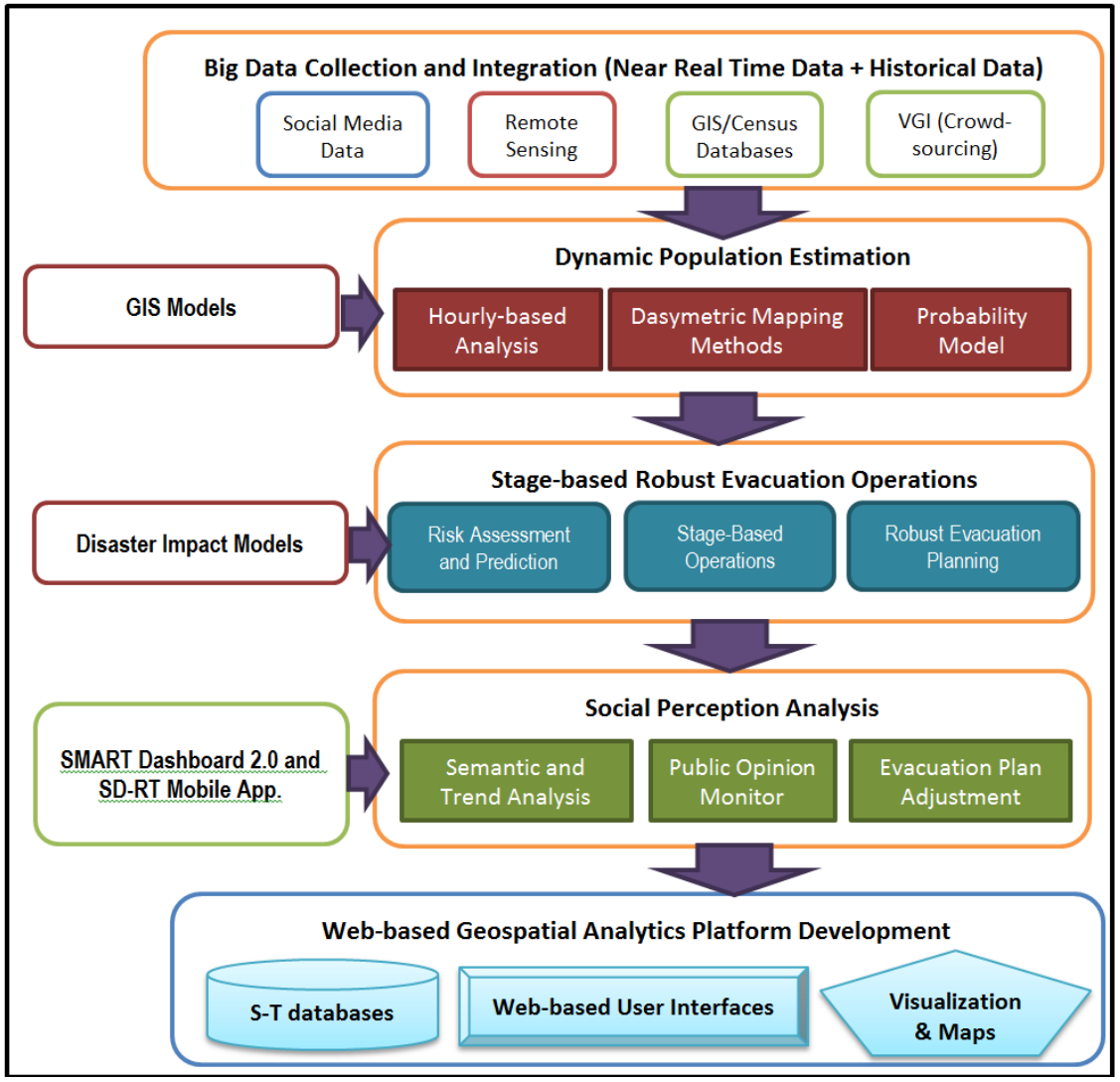
Multi-Modal Evacuation



Challenge Issues

- To build an effective evacuation model and response plans, the responsive agencies need to consider the dynamic change of human population in impact areas and social perception from local residents;
- Conventionally, population data come from government cross-sectional episodic census surveys;
- It represents only the night-time population distribution, which hardly reflects dynamic population during a day, on weekdays vs. weekends, or with variations in seasons and holidays.

System Framework

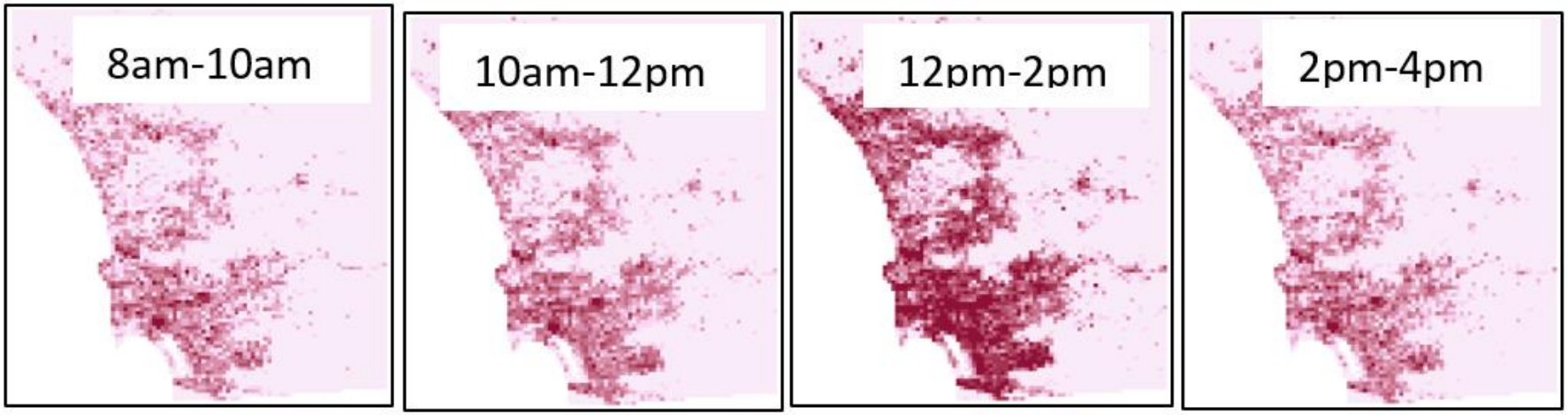


Goal 1

- **Build a dynamic estimated population distribution (density) model in urban areas by integrating multiple data sources and GIS models**
  - ***Task 1A:*** *Integrate and clean heterogeneous geo-tagged or check-in social media data for population density estimation*
  - ***Task 1B:*** *Develop GIS models for improving population distribution (density) estimation by combining social media data and other data sources .*

Task 1A

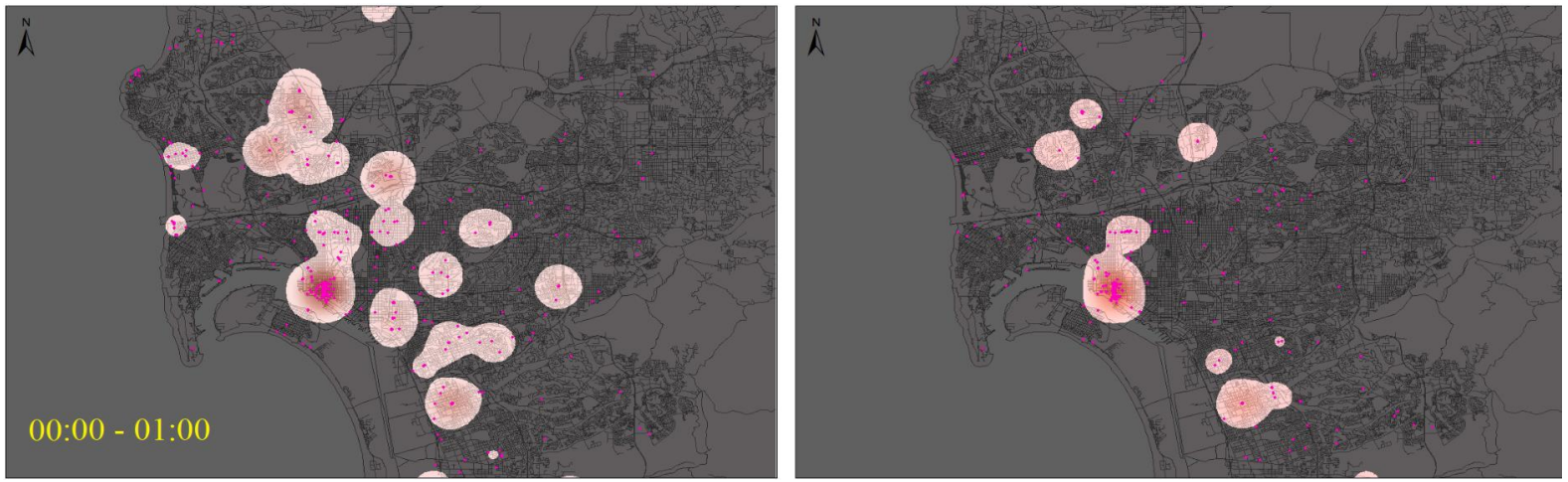
- Collect and integrate multiple geo-tagged or check-in social media data (including Twitter, Instagram, Foursquare, and Flickr) within the San Diego County



The hourly-based Twitter message density distribution maps based on geo-tagged tweets in San Diego County in July, 2015

Task 1A

- Collect and integrate multiple geo-tagged or check-in social media data (including Twitter, Instagram, Foursquare, and Flickr) within the San Diego County

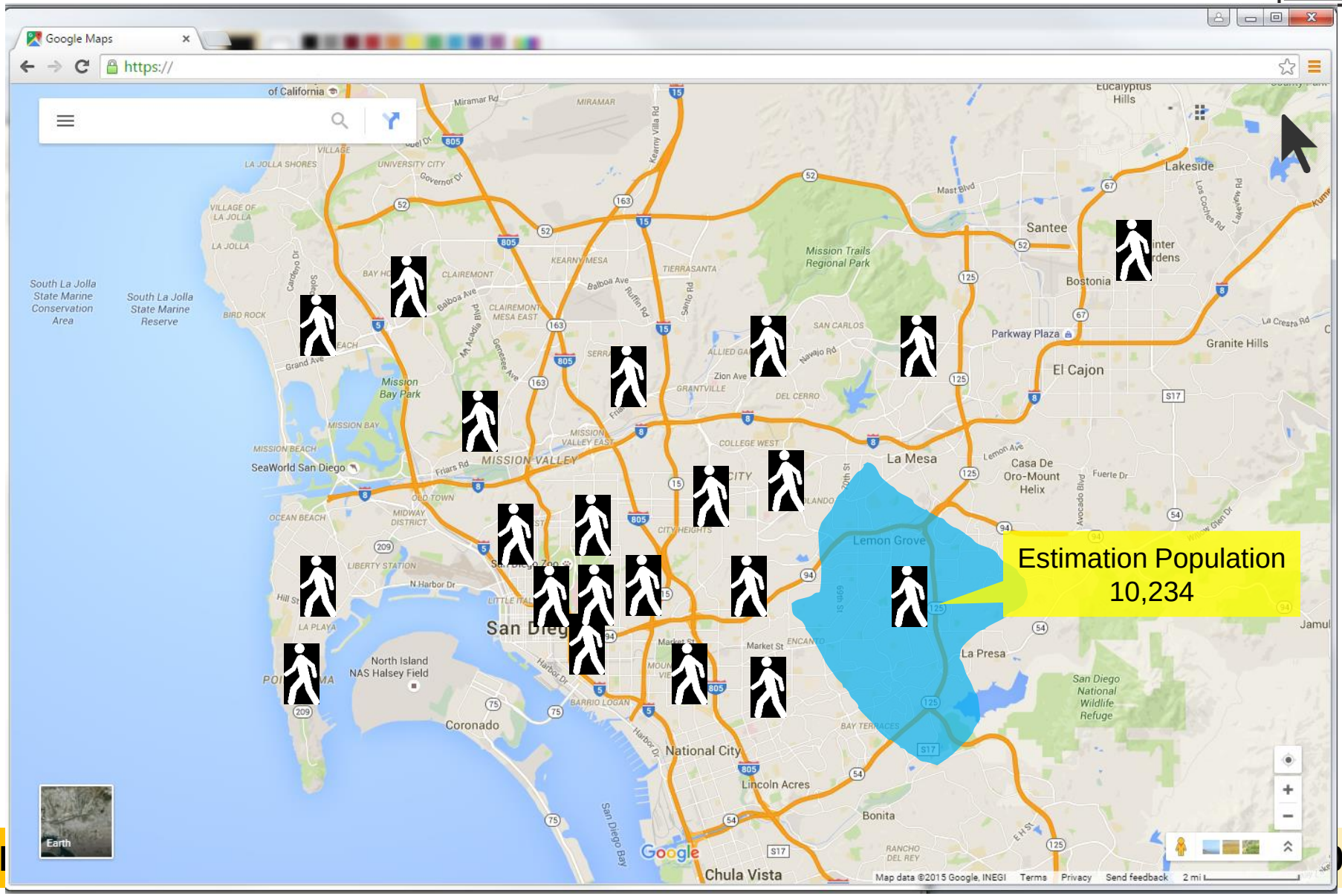


Twitter message distribution in San Diego downtown between Weekday (left) and Weekend (right) from 12am to 1am within the July of 2015

Task 1B

- We will use dasymetric mapping methods to build a comprehensive GIS model for population distribution estimation by overlaying the grid-based social media data output (task 1A) with census data, land use/cover, LandScan, and other ancillary data sources

Task 1B


Google Maps
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Estimation Population
10,234
Mission Bay Park
SeaWorld San Diego
MISSION VALLEY
La Mesa
Lemon Grove
La Presa
Casa De Oro-Mount Helix
El Cajon
Santee
Lakeside
Bostonia
Parkway Plaza
Granite Hills
Mission Trails Regional Park
San Diego
North Island NAS Halsey Field
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Goal 2

- **Design stage-based evacuation plans with population density distributions and develop robust optimization models to account for demand uncertainties**
  - ***Task 2A:*** *Develop a stage-based evacuation strategy based on the predicted extent and intensity of wildfire.*
  - ***Task 2B:*** *Build a robust optimization model to design dynamic evacuation routings.*

Task 2A

- Determine the impact areas;
- Predict the spread of wildfire over time (Wildfire Analyst™);
- Determine the evacuation risk zones (ERZ);
- Optimize the evacuation time of each ERZ.

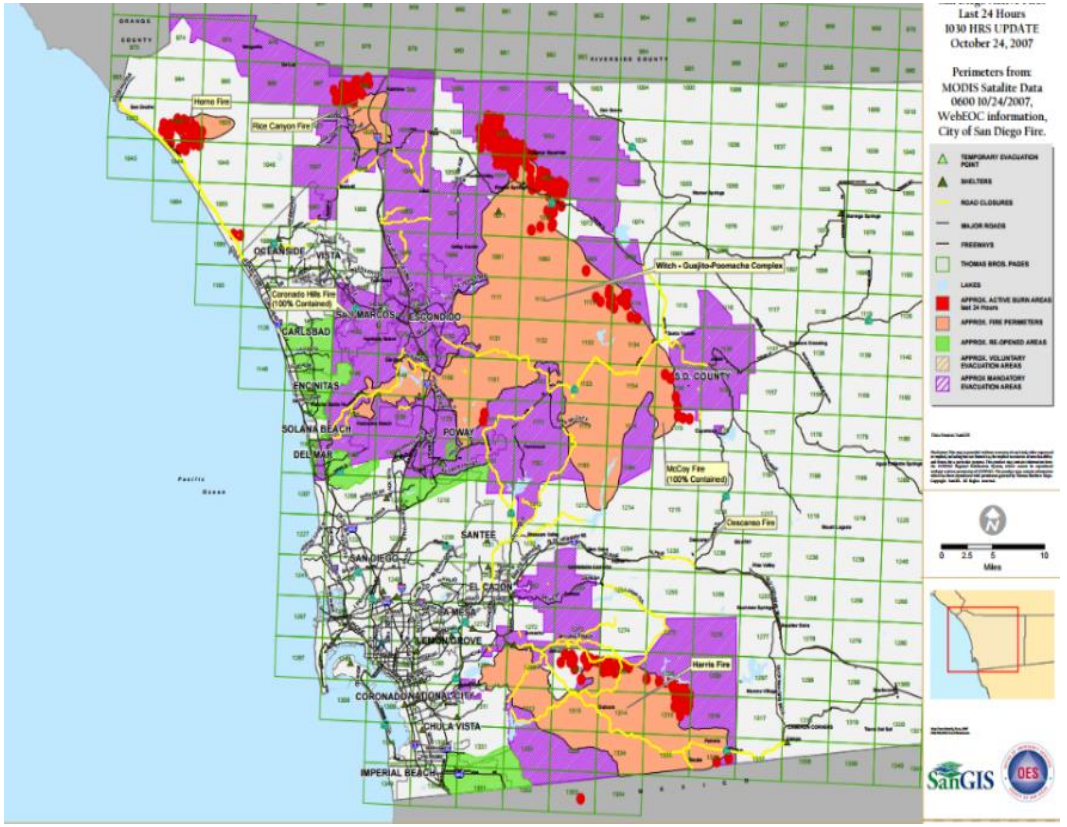


Figure 4. A map of San Diego County Wildfire Evacuation Plan at 3:30 AM, October, 25 of 2007.

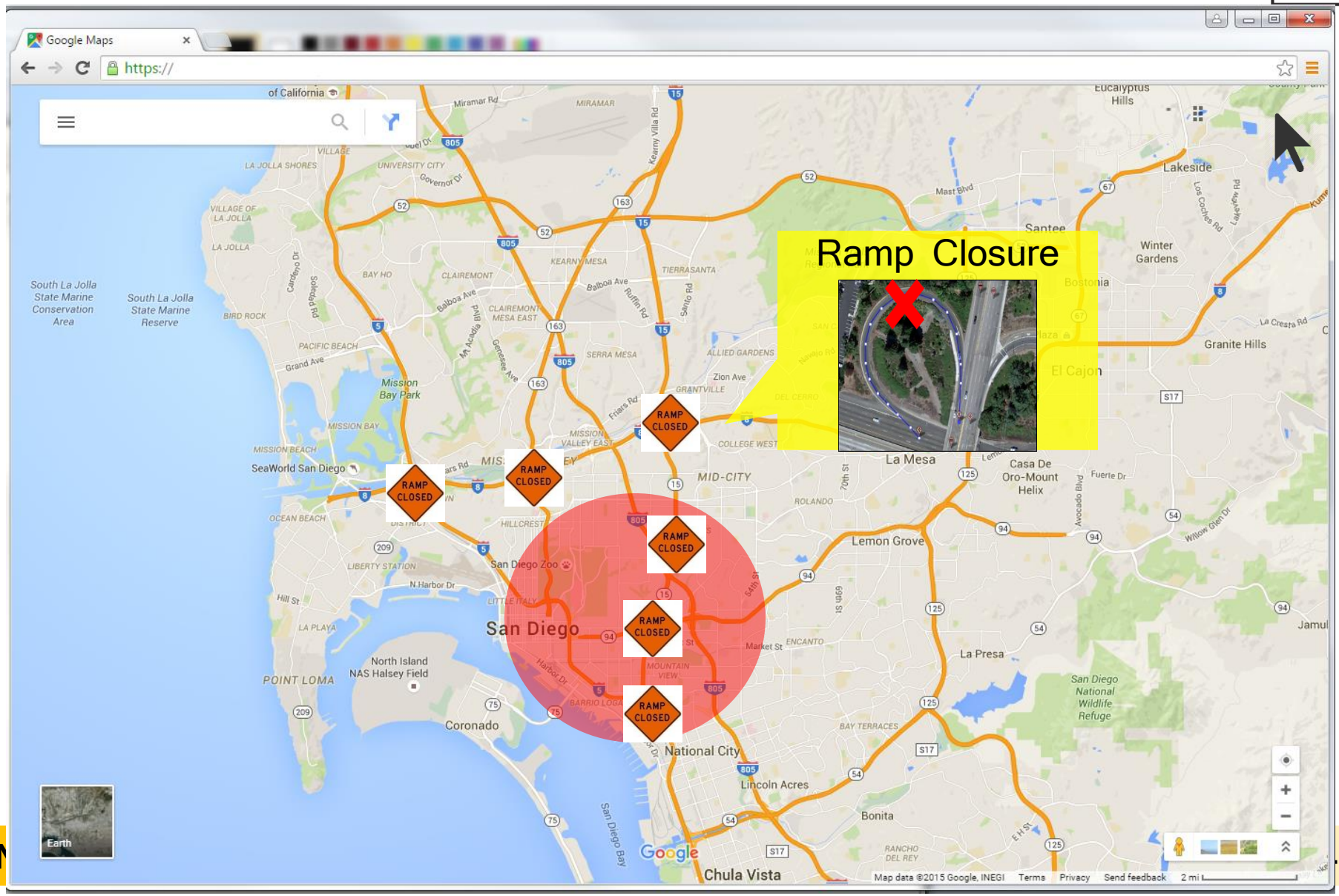
Task 2B

- One feature that many disasters have in common is their uncertain nature, in which exact data are unlikely to be available combined with a high likelihood of social disruption;

- Use of unreliable estimated data as the input of an evacuation planning system may require much more effort for plan changes in real-time operations;

- This project will develop a robust optimization function, along with the state-based evacuation strategy, to account for the input data uncertainties.

Task 2B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San Diego
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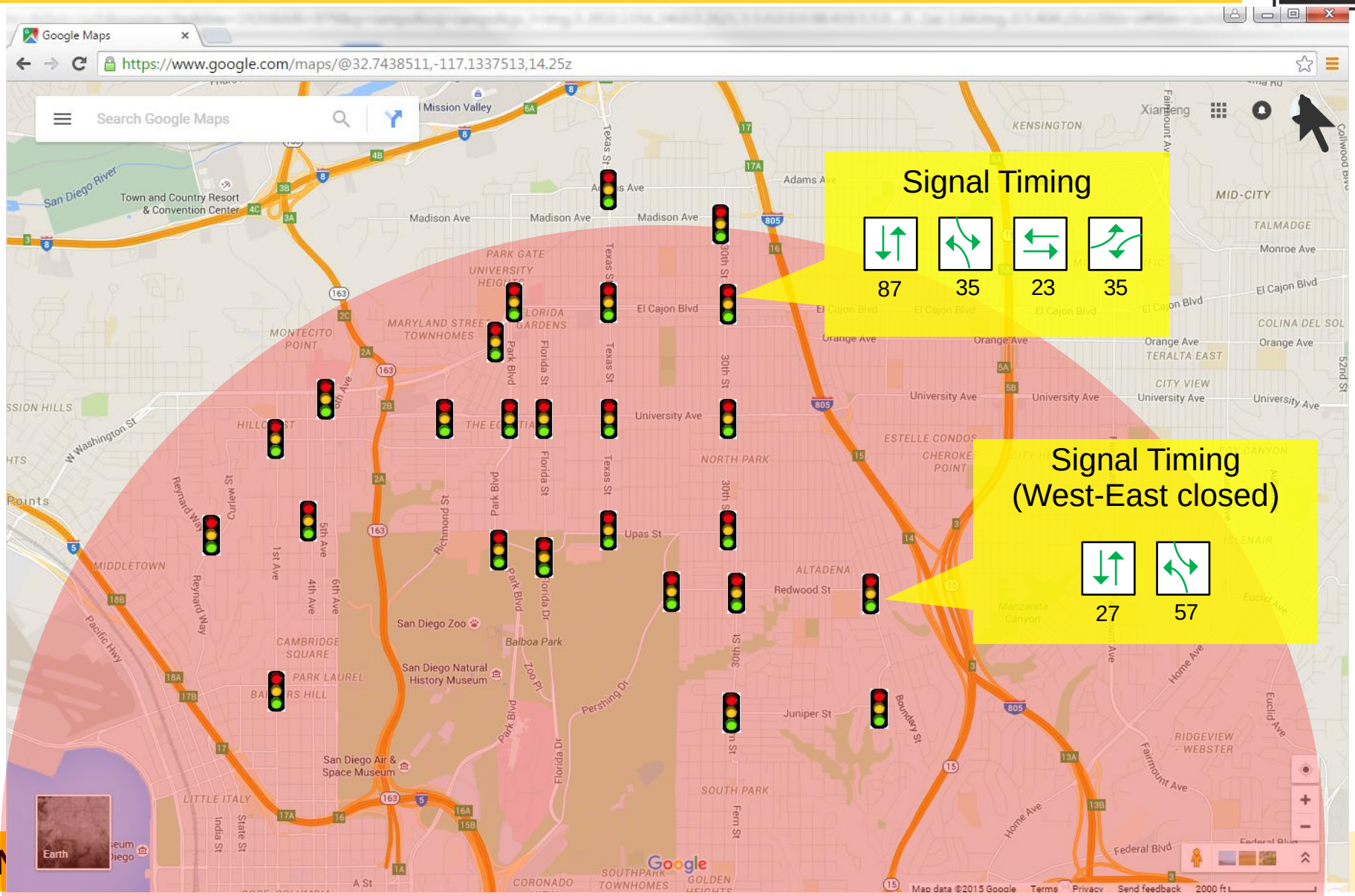
National City
Chula Vista
Coronado
Mission Bay Park
SeaWorld San Diego
San Diego Zoo
North Island NAS Halsey Field
Earth

Task 2B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Search Google Maps
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Signal Timing
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El Cajon Blvd
University Ave
Upas St
Redwood St
Juniper St
Madison Ave
Adams Ave
Orange Ave
Park Blvd
Florida St
Texas St
30th St
Balboa Park
San Diego Zoo
San Diego Natural History Museum
San Diego Air & Space Museum
Mission Valley
Town and Country Resort & Convention Center
San Diego River
KENSINGTON
MID-CITY
TALMADGE
NORTH PARK
ALTADENA
SOUTH PARK
MIDDLETOWN
LITTLE ITALY
CAMBRIDGE SQUARE
PARK LAUREL
MONTECITO POINT
MARYLAND STREET TOWNHOMES
PARK GATE UNIVERSITY HEIGHTS
FLORIDA GARDENS
THE ESPLANADE
ESTELLE CONDOS
CHEROKEE POINT
COLINA DEL SOL
TERALTA EAST
CITY VIEW
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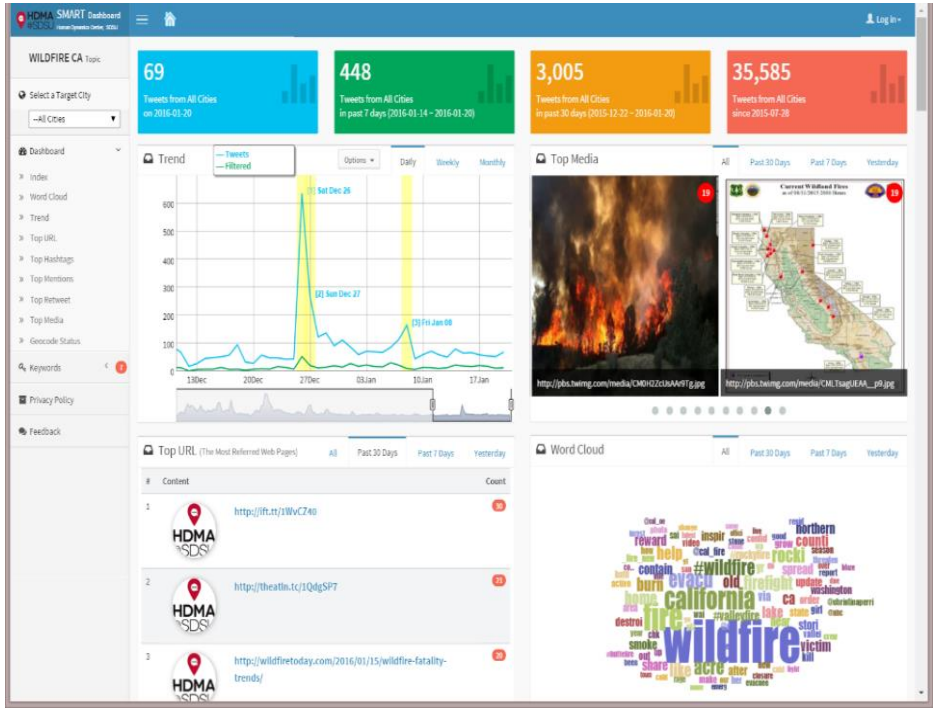
Goal 3

- **Create a public opinion monitor and a resident feedback network to improve evacuation plans by understanding social perception of the disasters in local communities through the real-time analysis of social media and volunteer suggestions**
  - ***Task 3A:*** *Build a public opinion monitor (SMART dashboard 2.0) with a social perception analysis model*
  - ***Task 3B:*** *Create a resident feedback network with registered local volunteers using a mobile application (SD-RT).*

Task 3A

- **Build a public opinion monitor**
  - Social Media Analytics Research Testbed (SMART) dashboard

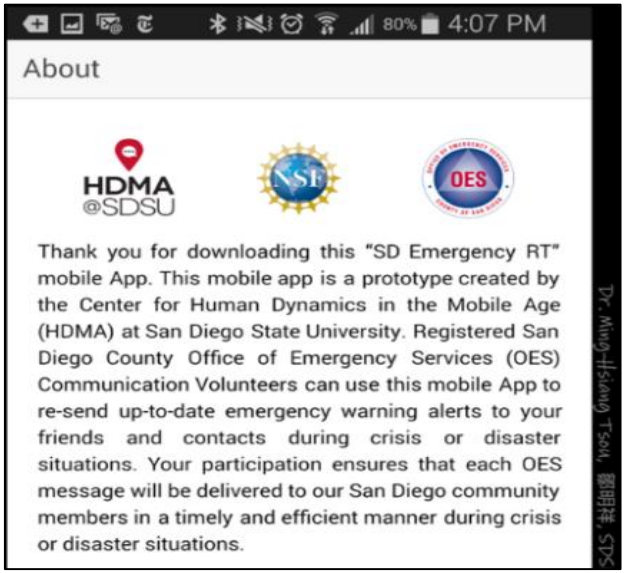


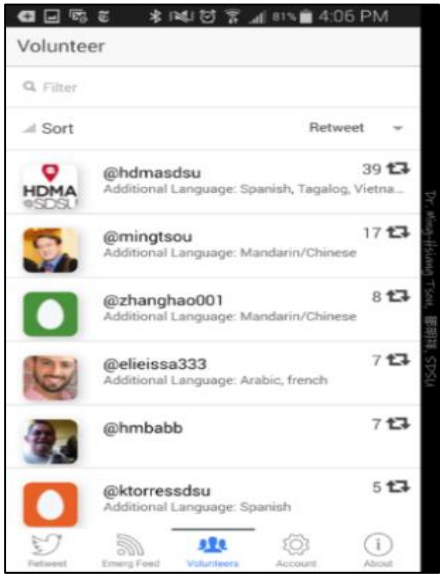
Task 3A

- **SMART dashboard 2.0**
  - More analytic functions
    - hourly updates
    - multi-level geocoding methods for local regions
    - dynamic keyword search
  - Social perception analysis model
    - using San Diego wildfire historical data (e.g., San Diego wildfire 2014)
    - understand evacuees' general perception, sentiments, and attitude toward evacuation-related subjects
    - extent of social confirmation of the official warnings and recommendations

Task 3B

- **Create a resident feedback**
  - SD-RT mobile app
    - for broadcasting emergency information in San Diego





Task 3B

- Extend the function of SD-RT
- Update and improve social perception analysis model
  - 1000 volunteers
  - analyzing direct feedback and comments from registered volunteers
- Supporting tool to assist with evacuation planning

Goal 4

- **Build a web-based geospatial analytics platform and provide interactive decision support tools for decision makers, emergency resource managers, and public officers**
  - scientifically-based tools
  - provide decision makers and public entities actionable knowledge
  - fostering the understanding of the impacts of hazards on their communities of interest
  - measuring the effectiveness of mitigation strategies before, during, and after a wildfire event.

Goal 4

- ***Task 4A**: Build an integrated computational modeling environment.*
- ***Task 4B**: Build a web-based interactive decision support system for disaster mitigation planning*

Task 4A

- **Build an integrated computational modeling environment**
  - Three core components
    1. space-time databases
    2. analytical models
    3. high performance computing (HPC)

Task 4B

- **Build a web-based interactive decision support system for disaster mitigation planning**
  - provide geospatial tools and user-friendly graphical user interfaces (GUIs)
  - allow users to interactively explore and simulate “what-if” scenarios to assess spatial, temporal, and social vulnerabilities before, during, and after a disaster event
  - capable of quantifying community functionality, evacuation effectiveness, and system dynamics to evaluate community resilience.
  - using feedback from the survey and focus group participants to improve tools and develop new geo-spatial tools to better meet users’ needs.

Project Schedule and Yearly Work Plan

TASKS	Year 1	Year 2	Year 3
1A: Integrate social media data for population density estimation.			
1B. Develop GIS models (dasymetric mapping methods).			
2A. Develop a stage-based evacuation strategy.			
2B. Build a robust evacuation model with vehicle routings.			
3A: Build a public opinion monitor (SMART dashboard 2.0)			
3B: Create a resident feedback network with volunteers			
4A: Build an integrated computational modeling environment.			
4B: Build a web-based decision support system.			

Thanks & Questions?