

Post-Earthquake Lifeline Service Restoration Modeling

Zehra Çağnan and Prof. Rachel Davidson



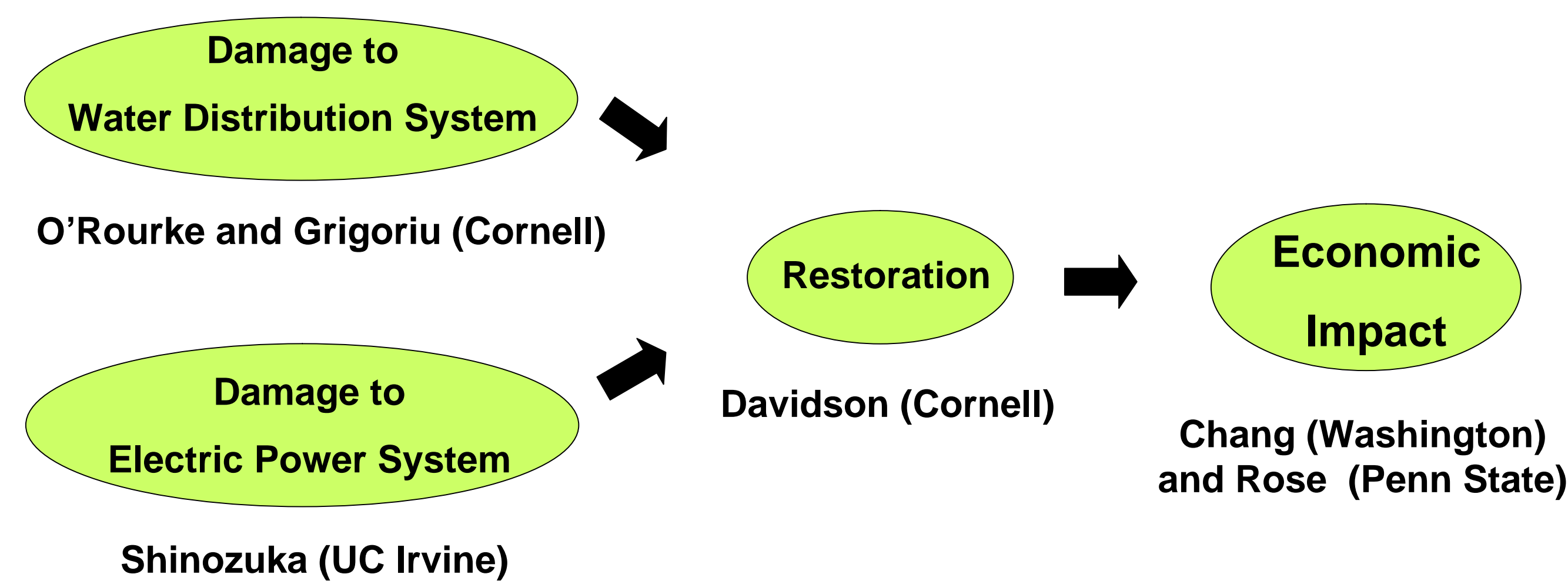
School of Civil and Environmental Engineering, Cornell University

ABSTRACT

This poster describes a simulation based methodology being developed to model post earthquake restoration processes as part of the MCEER research on the Los Angeles Department of Water and Power's (LADWP's) electric and water supply systems. Post earthquake restoration models play an important role in estimating the economic impact of earthquake damage to lifeline systems. The focus of the current study is to model restoration processes for electric power and water distribution systems separately but in the future the proposed methodology will be extended to take into account the effects of infrastructure interdependencies on the restoration processes.

BACKGROUND

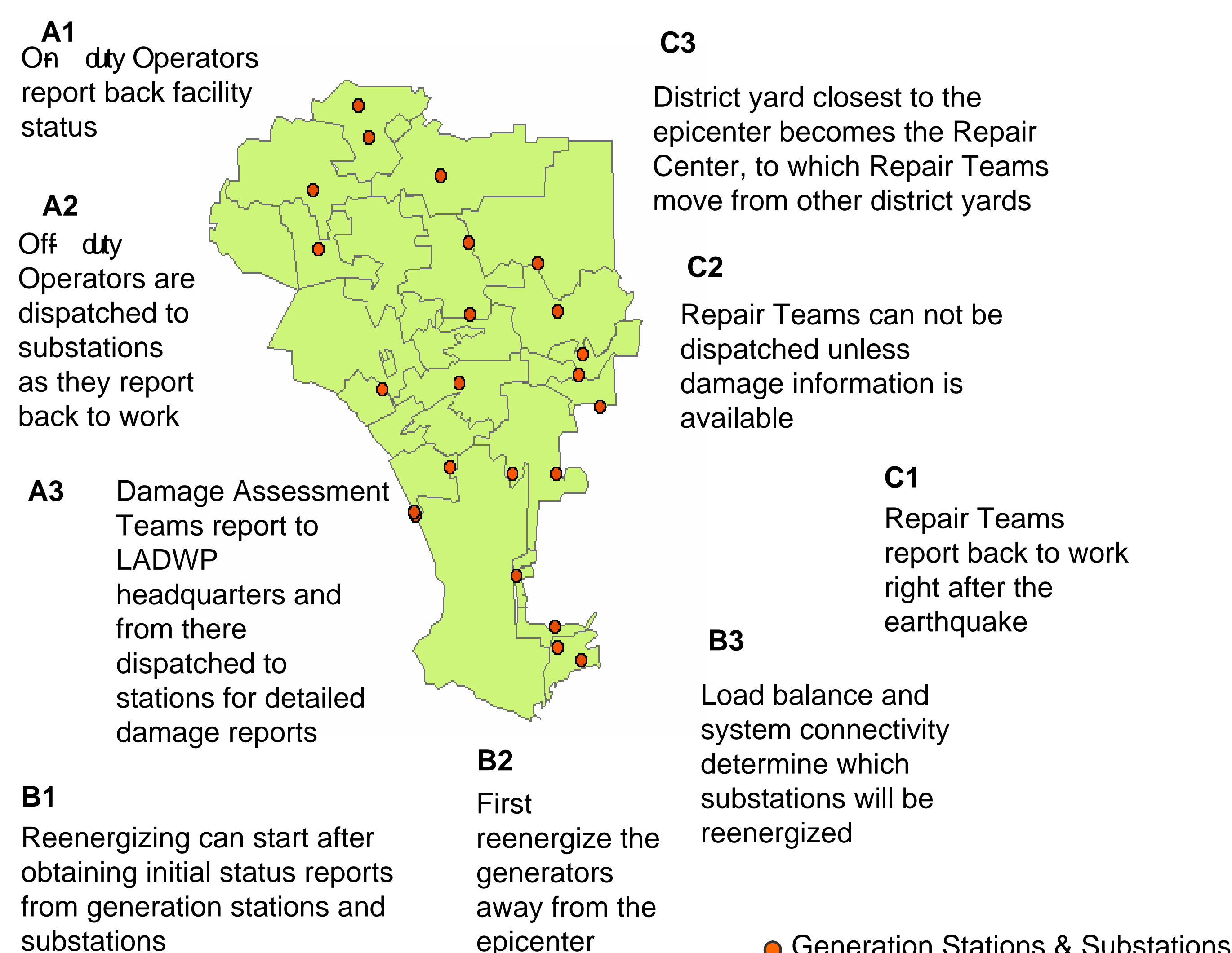
The aim of the MCEER research on the LADWP's electric and water supply systems is to assess the economic and societal resilience of a community. The proposed restoration models will serve between the damage estimation models and the models that aim to measure economic impact of an earthquake.



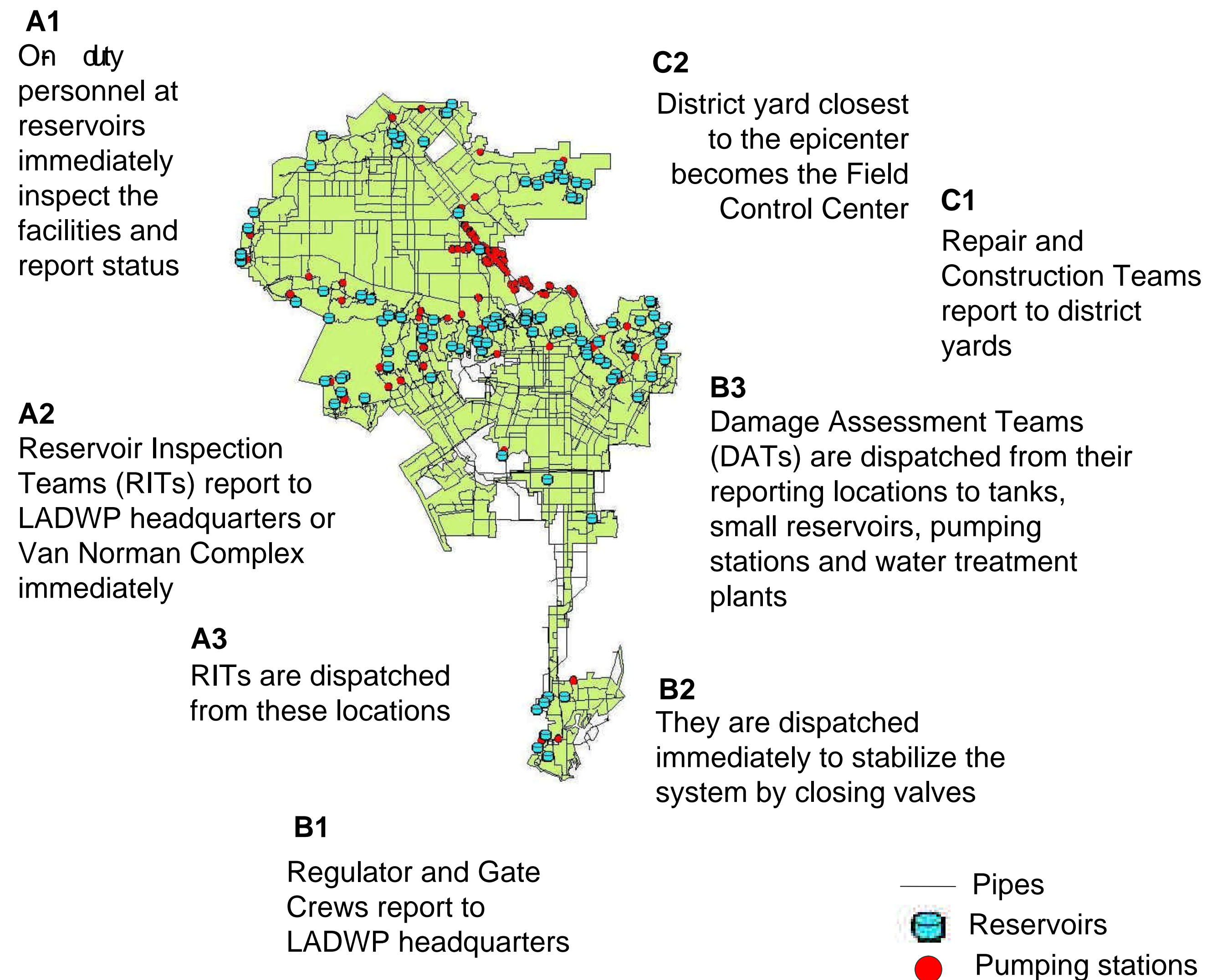
OBJECTIVES

The objective of this study is to develop improved models of the post earthquake restoration processes of the electric power and water distribution systems. The models use estimates of physical damage to the systems and an understanding of the repair and recovery operations to estimate expected restoration times, as well as the uncertainties surrounding these estimates.

RESTORATION PROCESS - ELECTRIC



RESTORATION PROCESS - WATER



DISCRETE EVENT SIMULATION

The post earthquake restoration processes are modeled by a methodology that combines **resource constraint approach** and **discrete event simulation**. Discrete event simulation bases simulations on the events that take place in the simulated system and then recognizes the effects that these events have on the system state. This approach helps one to follow the model's evolution over time by defining simple rules.

MODELING DETAILS

- Each substation, generation station, pipe, pumping station etc is an **entity**
- **Attributes** define damage state, status etc of each entity
- **Restoration** teams and restoration material are **resources**
- **Basic rules** define the order with which resources are used as time progresses
- Each substation gets resources depending on its priority
- Priorities are defined as a function of attributes
- Available resources are limited
- Number of restoration teams increases with time
- Team shifts are taken into account
- Station inspection and restoration durations are random variables
- Travel time of restoration teams is taken into account

EXPECTED SIMULATION OUTPUTS

Currently, this study is still under progress. The following is the expected output of the restoration models being developed:

Restoration curves (% functional vs. time):

- Temporally and spatially disaggregated
- Explicit consideration of decision variables
(*num. of repair crew, amount of repair resources, repair prioritization plans*)
- Quantification of uncertainty

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