Response, Recovery, and Resilience

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RESILIENCE

THE ABILITYOF PHYSICAL SYSTEMS AND SOCIAL UNITS TO:

- Mitigate Hazards
- Contain the Effects of Disasters When They Occur
- Carry Out Recovery Activities in Ways That Minimize Social Disruption and Mitigate the Effects of Future Disaster Events

COMPONENTS OF RESILIENCE

- **ROBUSTNESS**

- **REDUNDANCY**

- **RESOURCEFULNESS**

- **RAPIDITY**

RESPONSE, RECOVERY, AND RESILIENBCE

Resilience

Functionality of Built and Social Environment

t_0 t_1 time

Improved Resilience

With More Effective, Timely Response

MCEER'S ULTIMATE GOAL

- DEVELOPMENT AND REFINEMENT OF A SUITE OF DECISION-SUPPORT TOOLS FOR RESPONSE AND RECOVERY, EMPLOYING ADVANCED TECHNOLOGIES AND EMPIRICALLY-GROUNDED SIMULATION METHODS

TOPICS FOR THIS DISCUSSION

- **REMOTE-SENSING TOOLS FOR RESPONSE, RECOVERY, AND RECONNAISSANCE**

- **RESEARCH-BASED DISASTER RECOVERY DECISION SUPPORT**

REMOTE-SENSING RESEARCH

- FOR PRE-DISASTER LOSS-ESTIMATION

- FOR POST-IMPACT DAMAGE AND IMPACT ASSESSMENT

- FOR POST-DISASTER RECONNAISSANCE, COLLECTION OF PERISHABLE DATA

POST-DISASTER REMOTE-SENSING RESEARCH

- **VARIOUS TECHNOLOGIES: IFSAR, LIDAR, OPTICAL IMAGERY, GPS**

- **TRIANGULATION OF MEASURES: COMPARISON OF DATA OBTAINED USING DIFFERENT TECHNOLOGIES AND DATA-COLLECTION METHODS**

EXAMPLES OF EVENTS STUDIED

- **1995 KOBE EQ**

- **1999 TURKEY EQ**

- **1999 CHI-CHI EQ**

- **2003 ALGERIA EQ**

- **2003 BAM, IRAN EQ**

- **2004 FLORIDA HURRICANES**

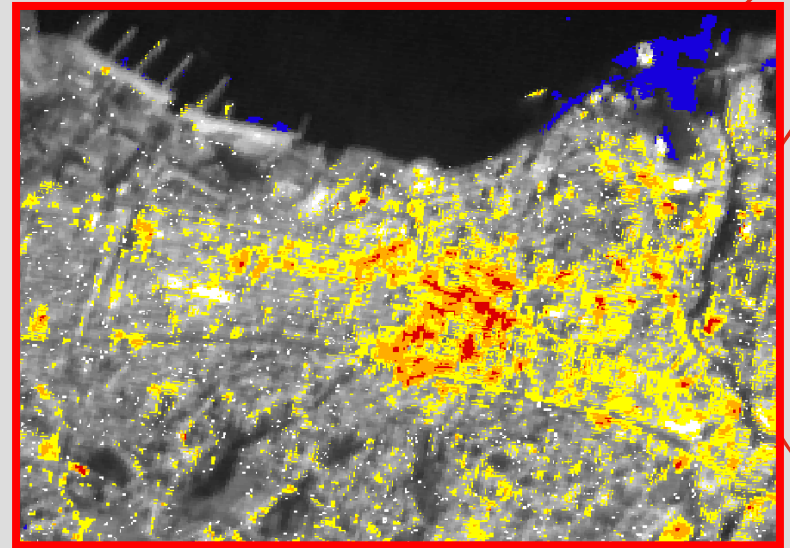- **2004 INDIAN OCEAN EQ AND TSUNAMI**
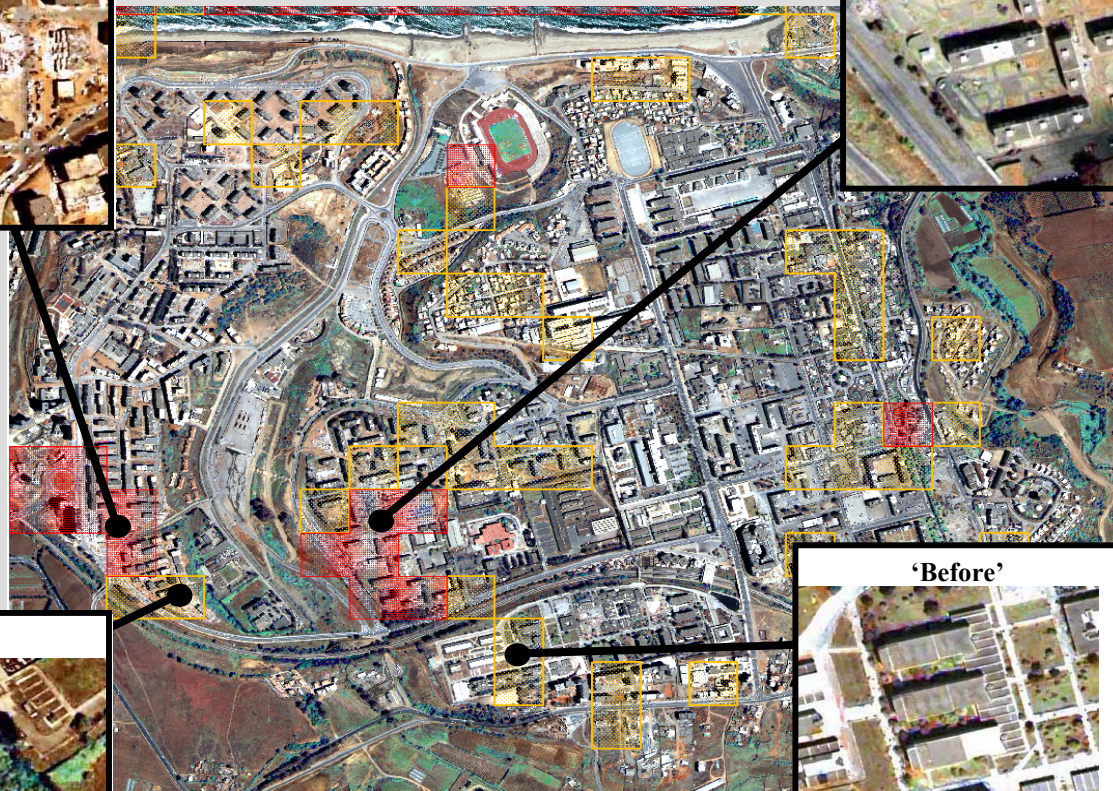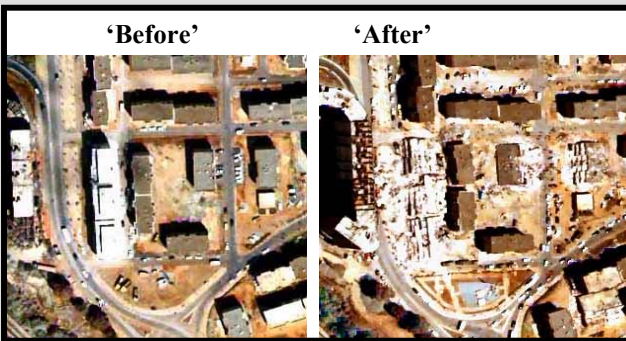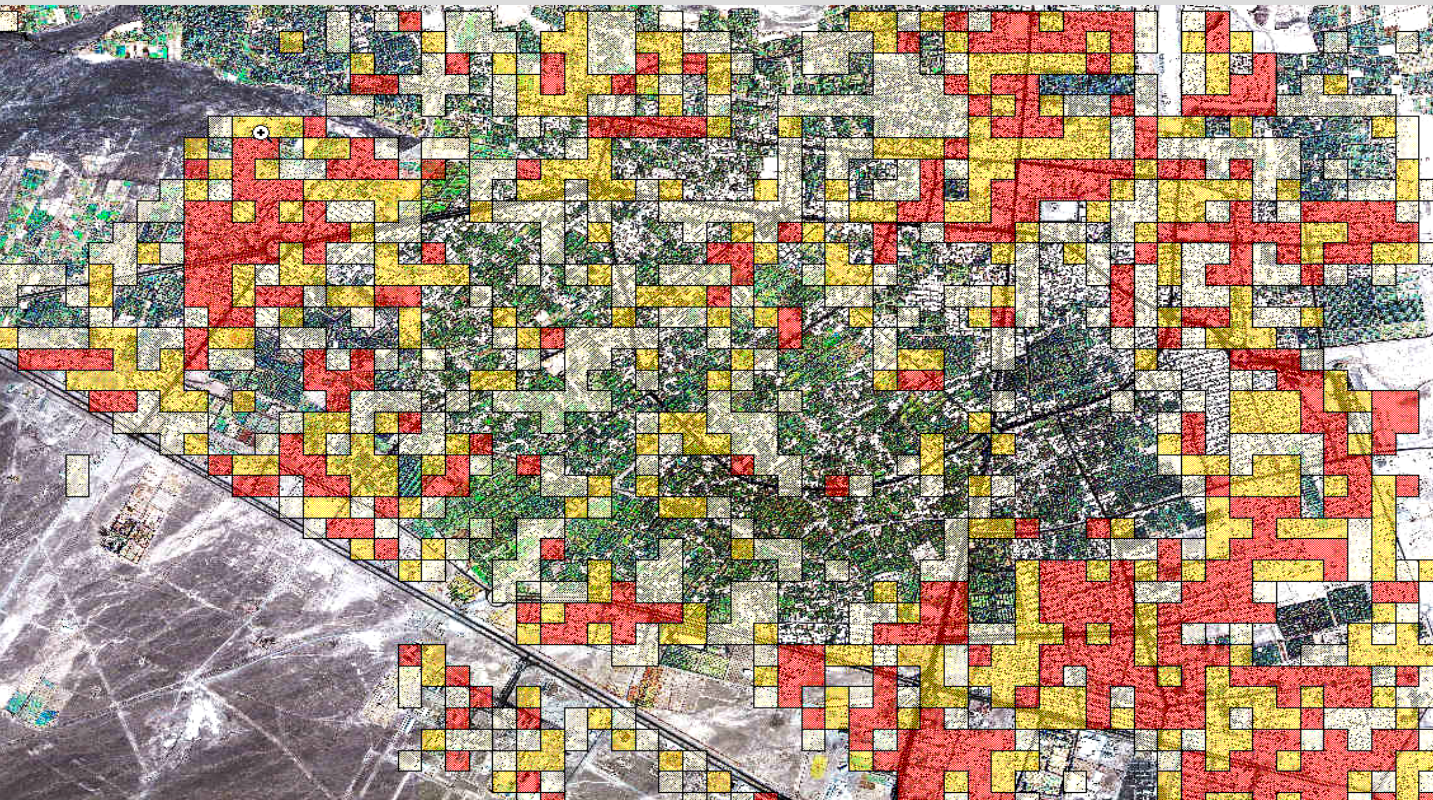
Regional Damage Assessment: Turkey 1999

SPOT PAN

Change Map

'Before'

'After'

Visual Inspection: Algeria 2003

'Before' 'After'

'Before' 'After'

'Before' 'After'

'Before' 'After'

Regional Damage Assessment: Iran 2003

LEGEND

Extreme change – complete building collapse

Widespread change – building collapse widesprea...

Some damage – localized pockets of collaps...

Widespread Devastation
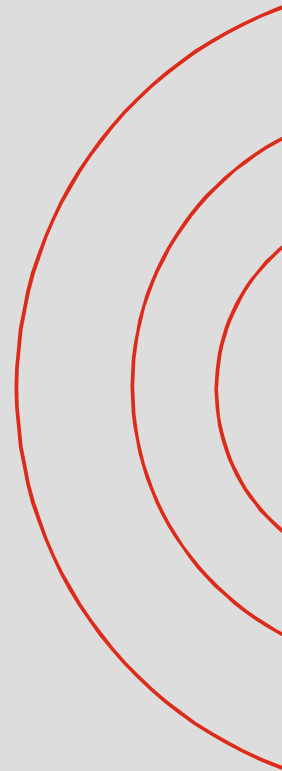
Visual Inspection: Iran Citadel

Before

After

SATELLITE IMAGE OF TSUNAMI FLOODING

RECOVERY MODELING AND SIMULATION

- COMPREHENSIVE COMMUNITY RECOVERY MODEL:

  ENHANCING RESILIENCE THROUGH IMPROVED RECOVERY DECISION-MAKING

MCEER'S RECOVERY MODEL

- **"CROSS-DOMAIN" ANALYTIC APPROACH**

- **EXTENSIVELY GROUNDED IN EMPIRICAL RESEARCH**

- **CONSIDERS BOTH PRE-EVENT AND POST-EVENT INFLUENCES ON RECOVERY TRAJECTORIES**

Objectives of the Model

To develop an interactive simulation of **how cities recover** from earthquake disasters
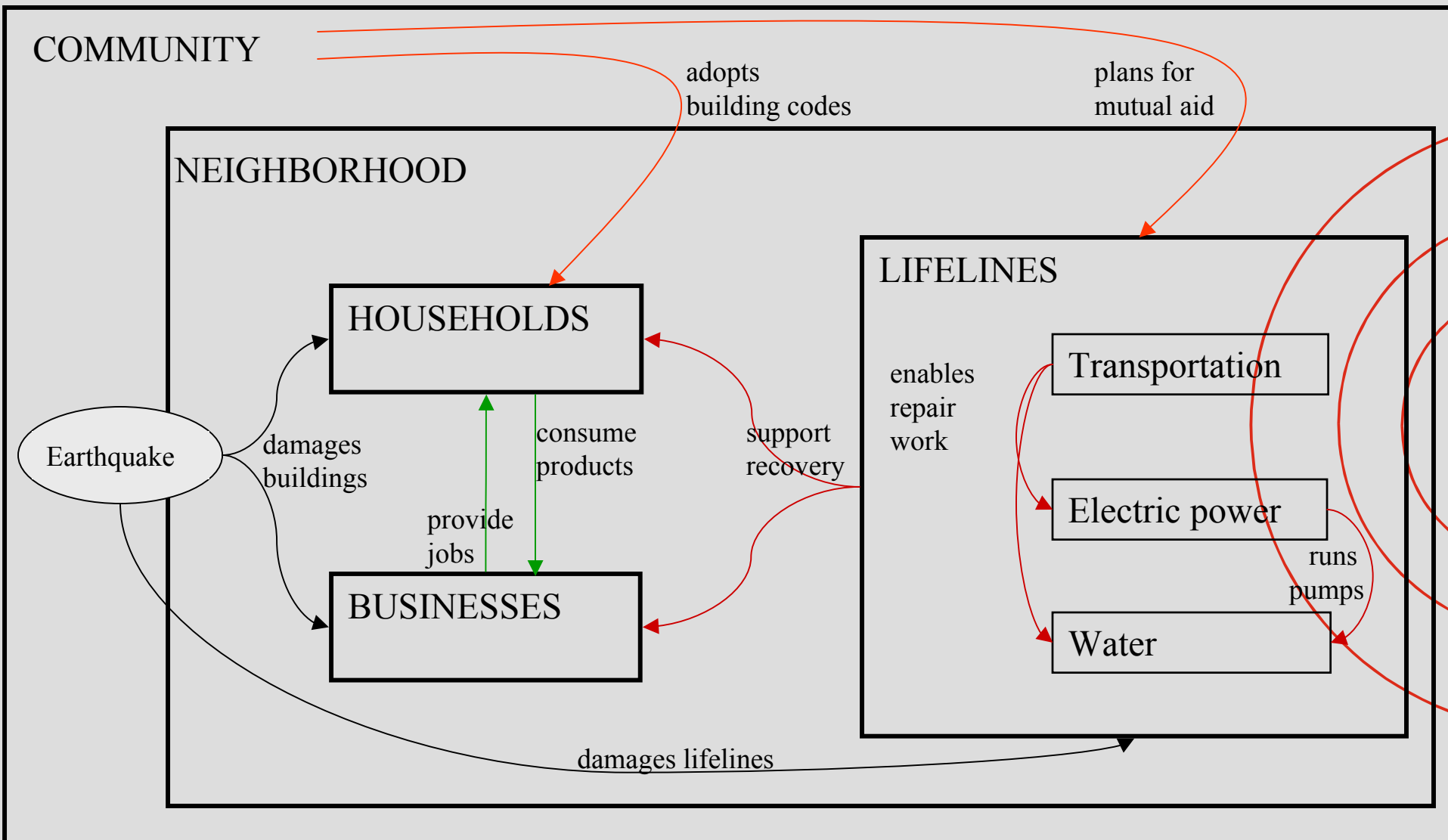
To extend loss estimation to recovery analysis

To support planning and decision-making

To facilitate interactive exploration of alternatives

Conceptual Model of Disaster Recovery

COMMUNITY

adopts building codes

plans for mutual aid

NEIGHBORHOOD

LIFELINES

HOUSEHOLDS

Earthquake

damages buildings

consume products

support recovery

enables repair work

Transportation

provide jobs

Electric power

runs pumps

BUSINESSES

Water

damages lifelines
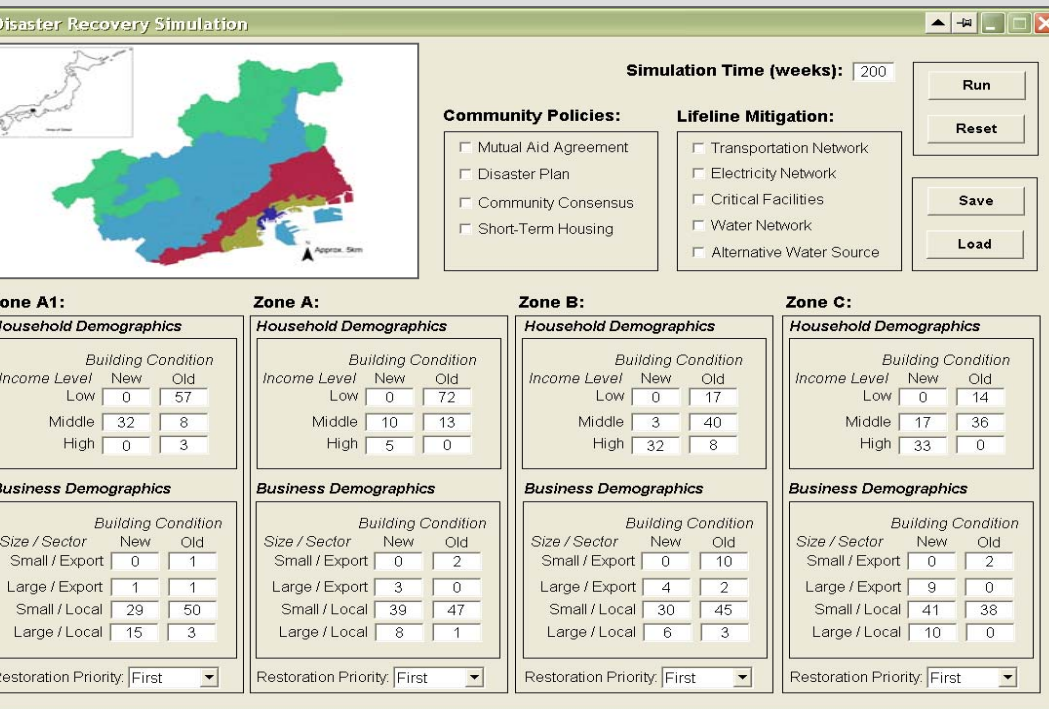
Questions the Model Can Address

- **What policies (e.g., mutual aid, disaster plan) can best speed recovery?**

  Graphical User Interface for Software

- **How will mitigation measures affect community recovery?**
- **Which neighborhood may lag in recovery?**
- **How do characteristics of households (e.g., income) or businesses (e.g., sector) affect neighborhood recovery?**

Disaster Recovery Simulation

Simulation Time (weeks): 200

Run
Reset
Save
Load

Community Policies:
- ☐ Mutual Aid Agreement
- ☐ Disaster Plan
- ☐ Community Consensus
- ☐ Short-Term Housing

Lifeline Mitigation:
- ☐ Transportation Network
- ☐ Electricity Network
- ☐ Critical Facilities
- ☐ Water Network
- ☐ Alternative Water Source

Approx. 5km

Zone A1:

Household Demographics

Income Level	New	Old
Low	0	57
Middle	32	8
High	0	3

Business Demographics

Size / Sector	New	Old
Small / Export	0	1
Large / Export	1	1
Small / Local	29	50
Large / Local	15	3

Restoration Priority: First

Zone A:

Household Demographics

Income Level	New	Old
Low	0	72
Middle	10	13
High	5	0

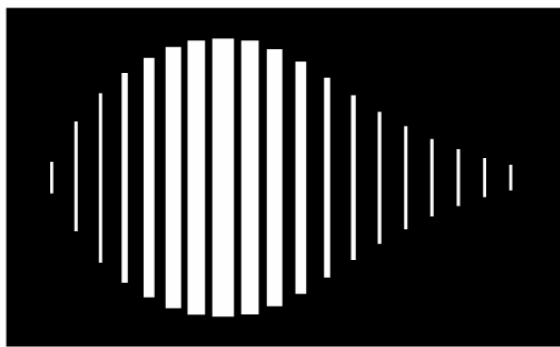*Business Demographics*

Size / Sector	New	Old
Small / Export	0	2
Large / Export	3	0
Small / Local	39	47
Large / Local	8	1

Restoration Priority: First

Zone B:

Household Demographics

Income Level	New	Old
Low	0	17
Middle	3	40
High	32	8

Business Demographics

Size / Sector	New	Old
Small / Export	0	10
Large / Export	4	2
Small / Local	30	45
Large / Local	6	3

Restoration Priority: First

Zone C:

Household Demographics

Income Level	New	Old
Low	0	14
Middle	17	36
High	33	0

Business Demographics

Size / Sector	New	Old
Small / Export	0	2
Large / Export	9	0
Small / Local	41	38
Large / Local	10	0

Restoration Priority: First

ASSESSING THE IMPACT OF PRE-DISASTER MITIGATION

RECOVERY TRAJECTORIES WITH AND WITHOUT MITIGATION