

## Field Damage Assessments as a Design Tool for Information and Communications Technology Systems that are Resilient to Natural Disasters



- Introduction
- Damage Assessment Process
  - Questions objective
  - Data Collection
  - Data Examination
  - Analysis
  - Reporting
- Case Study
- Conclusions





- Importance of communications during and after a disaster:
  - Emergency services
  - Social
  - Interdependent infrastructures
- Study typically follows two approaches
  - Anecdotal: More common but more unreliable, too. It also considers government inquiries.
  - Scientific: Relies on hard data from damage assessments coupled with outage data and other quantifiable information.

**AP** Associated Press

Oct. 24, 2011 10:20 AM ET

## 5 quake survivors saved from rubble in Turkey

**SELCAN HACA OGLU**, Associated Press

**SUZAN FRASER**, Associated Press

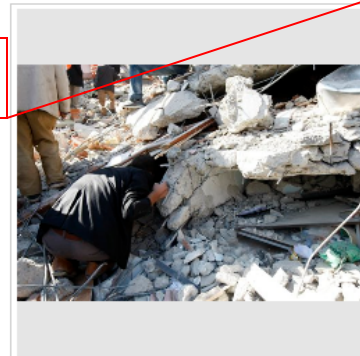
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ERCIS, Turkey (AP) — Five people were pulled out alive Monday from the rubble in eastern Turkey after a 7.2-magnitude quake leveled buildings and killed some 272 people. Four of them were rescued after one managed to call for help with his cell phone.

Dozens of people were trapped in mounds of concrete, twisted steel and construction debris after hundreds of buildings in two cities and mud-brick homes in nearby villages pancaked or partially collapsed in Sunday's earthquake.

Worst-hit was Erzis — an eastern city of 75,000 close to the Iranian border that lies in one of Turkey's most earthquake-prone zones — where about 80 multistory buildings collapsed.

Yalcin Akay was dug out from a collapsed six-story building with a leg injury after he called a police emergency line on his phone and described his location, the state-run Anatolia news agency reported. Three others,



A man looks through debris for family members trapped under a collapsed building as rescuers work to save people from debris in Erzis, Van, eastern Turkey, Monday, Oct. 24, 2011. A survivor of the 7.2-magnitude quake that has killed at least 239 people in

7.2-magnitude quake leveled buildings and killed some 272 people. Four of them were rescued after one managed to call for help with his cell phone.

- Communications indeed save lives. Critical view from a forensics perspective.....It was a good thing that:
  - Cell phone and network kept working.
  - It was not an ad-hoc network.
  - There was no call prioritization.

- Part 1: Preparation and Planning

- Outcome: Plan with a list of activities and locations to visit each day with details about specific things to look at each location.
- Must consider logistical details (food, lodging, fuel for transportation....) and plan to be self sufficient.
- Needs to identify data sources and if possible start collecting information (as much as possible because in many cases the piece of data may disappear). Due to interdependencies it is important to collect power outage data.
- Local contacts are a good source of information but it is important to be sensitive to their situation. Media outlets may be a good source of information but this information needs to be considered in context.
- Scheduling is a critical component of the planning process.

- Part 1: Preparation and Planning (scheduling)
  - Factors affecting schedule decisions:
    - Information value
    - Data volatility
    - Effort
  - Priority should be given to visit least damaged areas first.
  - Needs to considered information availability (closed areas).
  - Starting date 3 to 5 weeks after intense disasters (as soon as a couple of days for milder disasters). Duration: 1 to 10 days depending affected area.
  - Needs to consider sun-light. What is not documented and recorded may not be considered to exist.

- Part 2: Execution

- Flexibility is important. Decisions on the spot may take advantage of buffer times built into the plan.
- If possible begin damage assessment with meetings with network operators.
- Two approaches:
  - Fast area sweep (maximizes covered area and visited locations by minimizing the time spent at each site)
  - Targeted focus (fewer locations are examined but with each site evaluated in more detail).
- The goal at each location is to document the condition of not only the ICT network infrastructure but also of other infrastructures that may influence the operation of ICT systems.

# Data Examination

- The goal of this step is to extract relevant information from the evidence collected during the damage assessment trip.
- Examination needs to examine data and information provided by each photo and by all photos as a whole (to identify common issues).
- Those examining the data must be very qualified experts with experience in planning and operating ICT networks and interdependent infrastructures so they can extract the information provided by the documented data and they can be able to find clues and follow evidence not evident to untrained eyes.
- This is a very time consuming and tedious step as it typically requires examining thousands of photos and other sources of information.



- The objective of this step is to answer the questions of what did or did not fail and what were the restoration means.
- It builds on the data and information yielded by the previous step.
- Analysis should focus on component-level issues (e.g. a site) and system level issues (e.g. logistical operations).
- Requires to study interdependencies:
  - Physical: when two infrastructures share the same components
  - Functional: when an infrastructure requires in order to operate adequately that another infrastructure operates well.
- Quantified data helps to analyze functional interdependencies.

# Reporting

- The report details all the collected information and the process that was used to collect such information.
- It also examines the collected data and presents the observations made from the analysis of the information.
- Mapping of the information is also an important technique that is usually necessary to apply to most reports.
- Some information may need to be kept out of public reports due to security issues.
- The general structure of the report may vary but a executive summaries and a section with recommendations is usually necessary in most cases.

# Case Study

## • March 11, 2011 Japan Tohoku Region Earthquake and Tsunami

- Damage assessment performed from April 17th to April 23<sup>rd</sup> (mostly due to gasoline availability and the stabilization process in the nuclear power plant).
- Fast sweep approach (a focus trip followed in early June).
- Water and food taken from U.S. due to radiation contamination concerns).



- Dosimeter carried to monitor radiation levels.
- Road planned to stay at least 50 miles away from the Fukushima Daiichi nuclear power plant.



# Case Study

- March 11, 2011 Japan Tohoku Region Earthquake and Tsunami

- Major issues in ICT networks was dependence on power grids and transportation infrastructure (functional interdependencies).

- Dependency on roads

- Dependency on power grid



# Case Study

- March 11, 2011 Japan Tohoku Region Earthquake and Tsunami

- Example of data examination
  - Location: 100 m from Kamaishi central office

No grid power  
Physical interdependence  
(power and telecom)

Relief center

Pole damaged by tsunami  
carried debris



- Photo taken on 4/20 Potential for local power



- Photo taken on 4/21. Serves to quantify restoration process

# Case Study

- March 11, 2011 Japan Tohoku Region Earthquake and Tsunami
- Examples of things that performed well:
  - watertight doors limited the amount of water that entered some central offices



Watertight door

# Case Study

- March 11, 2011 Japan Tohoku Region Earthquake and Tsunami
- Examples of things that performed well:
  - Central office buildings well designed. In many towns was one of the few buildings standing after the tsunami.
  - Damage to equipment was caused by water immersion (notice the house on top of the building), not by shacking.
  - Service restored with digital loop carrier cabinets.



# Case Study

- March 11, 2011 Japan Tohoku Region Earthquake and Tsunami
- Examples of things that had performance issues
  - In coastal areas many cell sites were destroyed by the tsunami.
  - Service restored with micro-cells linked through satellite





# Conclusions

- A scientific approach to the analysis of the effects of natural disasters on ICT networks is presented. The goal is to answer basic questions that may contribute to improve design of ICT network.
- The analysis is based on damage assessments and it is inspired by forensic pathology and computational forensic analysis.
- Four basic steps are enumerated and detailed: Data Collection, Data Examination, Analysis and Reporting.
- The data collection step is divided in a planning phase and an execution phase.

**Thank you very much**

**Questions?**

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- Damaged equipment and additional generators despite the existence of a fixed generator indicates the latter was damaged.
- But the site has watertight doors.
- Water entered through other means (air conditioning openings and windows on the second floor).