Follow the $$$: Networks and Flows of Disaster Recovery Funding

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ABSTRACT

Recovery funding from disasters is a complex system of cooperation between formal and informal stakeholders. Network analysis can shed light into the underlying mechanisms that occur during the post-disaster recovery phase. In this study, we apply a data-driven approach on online news articles and other publicly available information about the 1989 Loma Prieta earthquake to construct networks of capital flow and organizational coalitions that are formed in the aftermath of the disaster. Studying the interactions and the public investments exchanged between the stakeholders provides insight into the networks and flows underlying disaster recovery funding.

1. INTRODUCTION

The cost of funding recovery efforts after a major disaster will be in the multi-billions dollars range depending on the severity of the destruction from the event. With an increase in numbers and severity of natural disasters in the past two decades, the issue of who pays and who manages the expenditure of disaster recovery funds becomes an important public policy issue. After Super Storm Sandy, for example, some members of Congress began to question whether the federal government should continue to bear the burden of funding long term recovery efforts because of escalating costs.

The phrase *money spill* has been used to describe the large amounts of money available to places following a major disaster. Naomi Klein coined the term 'disaster capitalism' [2] to describe the process by which the money spill is allocated to different groups and locations. Her argument is that the allocation is purposefully directed to increase the corporate profitability of firms and organizations involved in recovery efforts. Disaster capitalism is fueled in most instances by the very large amounts of public dollars in play after an event. Disasters also enable major stakeholders to restructure property ownership, public systems, and public contracting to their benefit, thus creating sizable profits for those engaged in establishing and implementing recovery efforts. Empirical verifications of Klein's characterization have been minimal.

Our study represents an initial step in ascertaining whether data mining can begin to make more transparent the financial networks and money flows involved in disaster recovery and thus, to understand how disaster capitalism functions after a major event. To better understand public funding efforts for major disasters, we consider the Loma Prieta earthquake of 1989 as a case study. Our goal is to: (i) identify agencies and organizations engaged in the allocation and receipt of public dollars; (ii) analyze the flow of those dollars between funding and recipient groups; and (iii) analyze network connections between groups to ascertain communities of interest as they pertain to public funding of recovery efforts The results of such an analysis can help more fully understanding the network of organizations involved in recovery efforts funded by public dollars.

2. BACKGROUND

The Loma Prieta earthquake of 1989 registered a 6.9 on the Richter scale. In strength it was second only to the San Francisco quake of 1906. The event resulted in 56 deaths, approximately 3800 injured, and by some estimates left nearly 12,000 homeless. Property damage was in excess of $6 billion. Major infrastructure elements of the Bay Area were destroyed or closed for an extended time because of severe damage. The magnitude of the recovery efforts makes it a good case for analyzing recovery funding. As a natural disaster, as opposed to a socio-technical event such as the Deep Water Horizon oil spill, public rather than private funding of recovery constitutes a higher share of the recovery costs. Finally, its size and notoriety (occurring as it did in the midst of a World Series baseball game) meant public media extensively covered it. Consequently, a large number of newspapers and other public accounts were available for analysis.

In recent years, computing for disasters has emerged as a critical theme of research, with a Computing Research Association's Computing Community Consortium (CCC) workshop devoted exclusively to this topic [1]. This workshop was intended to encompass the study of preparedness and resilience in the wake of natural disasters (e.g., earthquakes, hurricanes) as well as socio-technical disasters. Much of the work in this space is primarily aimed at crisis management, which allows transformation of data into usable forms, covering the four phases of *prevention, preparedness, response,*

and *recovery* of a disaster lifecycle. The access to timely and accurate information is critical during the entire disaster lifecycle. During such events, both the stakeholders and public may turn to a variety of information sources such as social media and mainstream news [3] for real-time crisis mapping and communication.

In the realm of prevention and preparedness, forecasting systems that use social media such as Twitter and Facebook are available. For example, Sakaki et al., [5] used Twitter users as sensors to develop a probabilistic spatio-temporal model for real-time detection and reporting of earthquakes. In the response realm, both social media and traditional news media have been used extensively. In order to build better situational awareness, real-time information sources such as Twitter have been used [7]. Social media has also been used to offer support and help find missing people, as well as to contribute to the recovery phase. In the post-disaster recovery period, both short-term impact and long-term consequences of such major events need to be assessed. Several research studies have been conducted to analyze economic repercussions on niche industries such as tourism [6] and retail [4]. Planning and funding for recovery is a complex system of cooperation between formal (federal, state, local government, non-governmental organizations) and informal stakeholders (insurance companies, construction and private charitable firms).

3. ANALYSIS

The study described in this paper uses data mined from newspaper articles, Wikipedia, and other web pages that were relevant to the Loma Prieta earthquake. We primarily focused on news coverage of the quake, beginning in the immediate post recovery stage to the following years. Using the Wikipedia article[1] on Loma Prieta as our starting point, we harvested citied articles and other references found in those citations. We also collected web links from automated Google searches with keywords relevant to recovery such as: *recovery planning*, *investments*, *money donated*, *contracts awarded/completed*, and *private investments* in Loma Prieta earthquake reconstruction. In total, we harvested 198 web pages for our case study. Note that this is a rather small sample but nevertheless yields very useful insights. We then applied the Rosette Language Processing (RLP) suite of tools from Basis Technology to identify named entities involving organizations, people, locations, and money.

To identify prominent locations and organizations involved in the post-quake recovery period, we generated word clouds from text. Among the key formal stakeholder organizations (Fig. 1), we were able to find several logical sub-groupings of these entities:

- **Reconstruction**: Bay Area Rapid Transport (BART) and California Department of Transportation (Caltrans).
- **Emergency Response**: American Red Cross and Federal Emergency Management Agency (FEMA).
- **Reporting and Surveying**: Earthquake Engineering Research Institute (EERI), United States Geological Survey (USGS), and California Seismic Safety Commission.

[1] `http://en.wikipedia.org/wiki/1989_Loma_Prieta_earthquake`

Figure 1: Word cloud of most frequently occurring organizations in our dataset.

We were also interested in identifying the informal stakeholder organizations such as private companies and non-profit organizations that were either involved with reconstruction or helped donate money towards the recovery. We generated another word cloud by giving more emphasis to organizations that were less frequently mentioned in our dataset. In Fig. 2 we can observe the following classes of entities:

- **Corporate donors**: automotive (Chrysler, Ford Motor Co., and Mitsubishi), technology (Novell Computers, IBM, and Sony Corp.) and consumer (Procter & Gamble) companies.
- **Private donors**: Stanford Restoration Fund, William & Flora Hewlett Foundation.
- **Insurance & Claims**: (Fireman's) Fund Insurance Companies and Association of California Insurance Companies.
- **Reconstruction**: FyFe Associates, Inc. and Guy F. Atknison Construction Co.

Figure 2: Word cloud of smaller organizations involved in recovery.

Among the frequently mentioned locations we were able to identify several neighborhoods and counties in the greater San Francisco Bay Area region which were most affected by the Loma Prieta earthquake. In Fig. 3 we can spot the most prominent counties of San Francisco, Santa Cruz, Oakland that were affected by the earthquake. Further, sev-

eral bridges (Bay Area bridge, Carquinez bridge), and freeways (Embarcadero Freeway, Cypress Viaduct) and buildings (City Hall, Stanford) also populate the word clouds indicating that these were among the key structures that suffered critical damage.

Figure 3: Word cloud of most frequently occurring locations in our dataset.

Next, we aimed to understand the flow of money from different organizations to affected locations. From the news articles, we mined co-occurrence relationships between locations, money and organizations. For example, in Fig. 4 we can observe the flow of money from larger organizations (black arrows) that include both federal and state agencies in to different locations, specifically in the reconstruction of several Bay Area bridges. In Fig. 5, we study the groups and coalitions that were instrumental in recovery from development investments. Here we can observe several groups of private (automotive and technology) companies which donated money in the immediate aftermath of Loma Prieta earthquake to Red Cross. Also, observed is the funding coalition to rebuild and restoration of American Conservatory Theater (A.C.T) where several philanthropic organizations can be seen to be involved, viz. Mellon Foundation, Kresge Foundation, and William & Flora Hewlett Foundation.

In understanding the timeline and structure of investments, we found several examples of contracts awarded to different private companies to complete retrofit of bridges, rebuilding of damaged transportation infrastructure, and inspecting property damage claims in Bay Area (see Fig. 5). Few of those examples are listed below:

- Guy F. Atknison Construction Co. was awarded a contract by Caltrans, in 1992, for $8.4 million.
- FyFe Associates, Inc. completes a retrofit contract for $73 million in 1991.
- Condon Johnson & Associates, Inc. was awarded a construction contract by BART for $9.7 million.
- Bechtel National, Inc. was contracted to inspect homes, building and other transit structures for damage after the 1989 earthquake.

We also analyzed how different organizations were involved in post-quake response and recovery. The subnetworks shown in Fig. 6 have the following characteristics:

- Several first response (FEMA, Red Cross, San Francisco Fire Department), state transportation (BART, Caltrans) and housing (HUD) agencies are active during the initial years (1989 – 1995) following the quake.

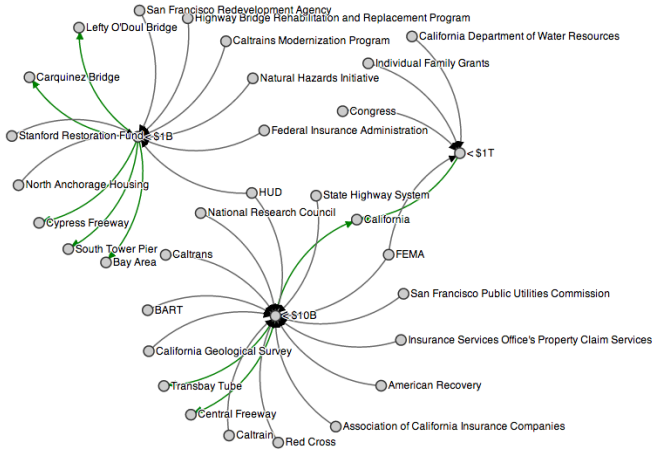


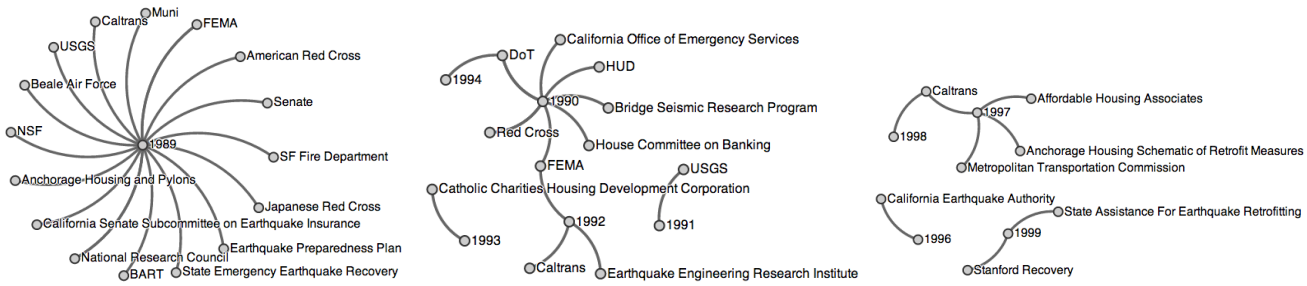
Figure 4: Flow of money from (black arrows) organizations to affected locations (green arrows).

Figure 5: Money flow network between organizations and locations. Here, the different colored edges indicate money being provided by private or public groups for rebuilding infrastructure at different locations due to the damages. In some cases organizations received money either because they were contracted or money was loaned by them.

- In later years (1996 – 1999) of recovery show a majority of agencies involved with redevelopment of housing (Affordable Housing Associates) and retrofitting and inspection of transportation infrastructure (Caltrans, California Earthquake Authority)

4. DISCUSSION

Capitalism is a system that allocates costs and benefits unequally. It places a premium on efficiency and aggregate prosperity rather than equity or individual well-being. As such, capitalism by nature is also destructive, destroying en-



(a) 1989 (b) 1990 - 1995 (c) 1996 - 1999

Figure 6: Timeline: Organizations involved during response and recovery.

terprises or regions deemed inefficient or where the highest use value is not attained. Destruction, however, has a financial and social cost that investors have to assume within their investment calculus. Disasters create a tabula rasa, a clean state, thus reducing both the financial and social cost to investors. How investors use that clean slate is a critical issue for society as a whole and for regions impacted by disasters in particular. The concept disaster capitalism used by Klein implies that reinvestments after disasters are frequently used to change local economies in ways that diminish the role of public goods and elevate the level of private interests in regions impacted by major events. Moreover, she argues that governments have an active role in guiding those investment decisions. Thus, for example, in the aftermath of Katrina the public school systems were diminished and eventually replaced by private charter schools. Both public and private interests are guided by this transformation. In another case, the Deep Water Horizon disaster, the money associated with the cleanup of the oil spill appears to be concentrated in locales outside of the communities impacted most heavily, resulting in a major regional reallocation of investment. Here the investments decisions were primarily privately directed but with minimal public efforts to redirect them.

The value of data mining and network analysis in the mitigation and response phases of disasters has been well established and their uses are increasing. We argue that these tools are also important to understanding the dynamics of the post-disaster recovery stage. Specifically, they can be used to address the following issues or questions.

- What are the sources of funding for different sectors of recovery?
- Who - agency, individual or network of decision-makers - determines how, where, and to whom investments will be allocated?
- What are the spatial patterns of investments and how do they impact local economies? Who are the winners and losers in the recovery process?
- To what extent are the voices of the residents of a disaster location heard in making the decisions?

With billions of dollars involved in the recovery phase after major events like Hurricane Sandy, it is in the public's interest to receive answers to these and other dimensions of the recovery stage.

In this preliminary study involving flow of dollars between organization and locations we were able to find several patterns of involvement of formal (FEMA, BART, Caltrans), informal stakeholders (Red Cross, insurance, and construction companies of California), and smaller, private organizations. For example, size of these organizations can be correlated to the dollar amount involved. The physical nature of the disaster and the Bay area relevance is a possible factor behind why only the technology and automotive companies were the primary donors. Although our dataset is relatively small, we believe we have established a case for use of data mining and network analysis in analyzing financial patterns in the post-Loma Prieta recovery stage. Access to more information from public sources and the use of social media will add significant value to our understanding of these post-disaster allocation schemes. However, we need to create a structure to detect and analyze recovery decisions and allocations as they are occurring so these tools can help shape policies rather than analyzing them after they occur. Real time analysis is something that should be encouraged and an organizational structure established to achieve this.

Our next steps are several fold. First, we aim to integrate additional information sources such as land sale records, county discussions, planning council hearings to overlay damaged areas against land parcels and better understand the effect of disaster recovery and funding efforts on the underlying region. Other data sources we plan to harvest include emergency bills passed by the state legislature during this period. Second, we aim to prototype this analysis to other disaster and recovery efforts to determine if networks of funding are similar or if they differ (and why). As we generalize the scope of such analysis to less well known events (e.g., the recent oil spill in West Virginia) we will understand broader patterns in the funding agencies' priorities and commitments. Finally, the nature of data mining methods used here has been limited to entity extraction and relationship extraction. More sophisticated methods of network analysis, including mining of directional and quantitative-attributed relationships, and overlaying inferred networks are key techniques that can be explored.

5. REFERENCES

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