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Resource mapping during a natural disaster: A case study on the 2015 Nepal earthquake

Moumita Basu[a,b,*], Saptarshi Ghosh[b,c], Arnab Jana[d], Somprakash Bandyopadhyay[a], Ravikant Singh[e]

[a] Social Informatics Research Group, Indian Institute of Management Calcutta, Kolkata 700104, India
[b] Department of Computer Science and Technology, Indian Institute of Engineering Science and Technology, Shibpur, Howrah 711103, India
[c] Department of Computer Science and Engineering, Indian Institute of Technology, Kharagpur, Kharagpur 721302, India
[d] Centre for Urban Science & Engineering, Indian Institute of Technology Bombay, Maharashtra 400076, India
[e] Doctors For You, 3, Hemu Castle, Dadabhai Road, Vile Parle West, Mumbai 400056, Maharashtra, India

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ABSTRACT

Any major natural disaster, such as an earthquake, is accompanied by an urgent need for various types of resources in the disaster-affected region, which primarily includes medical resources, human resources, and infrastructural resources. How quickly this need for resources can be satisfied might critically determine the extent of damage and human casualties in the aftermath of the disaster. Hence, knowledge about what type of resources are usually needed in the aftermath of a disaster is important for responding organizations for planning formative solutions, to be better prepared to mitigate any upcoming disaster. The goal of this study is to curate the resource needs during a major disaster – the earthquake in Nepal and parts of India in April 2015. This work has been carried out in association with Doctors For You (DFY), a humanitarian organization of medical professionals who work in various disasters-affected regions. A large set of WhatsApp messages exchanged among DFY members who were working in the disaster-affected areas of Nepal was collected and analyzed to identify the different resource requirements and the corresponding delay in the mobilization of such resources. The study revealed detailed phase-wise requirement of various types of resources and also suggested that for several resources, there was a significant delay between the requirement and the actual availability of the resources. The acumens from this study will not only help disaster risk management in Nepal but also help in preparedness planning in other earthquake-prone regions of the world.

1. Introduction

The recent years have seen several major natural disasters such as earthquakes, floods, and hurricanes in various regions of the world. Any major natural disaster is accompanied by an urgent need for various types of resources in the disaster-affected region, such as medical resources (e.g., medicines, surgical instruments), human resources (e.g., doctors and nurses) and infrastructural resources (e.g., tents, alternative sources of electric power). How quickly such needs for resources can be satisfied might critically determine the extent of damage and human casualties in the aftermath of the disaster. Especially, for disasters in developing regions of the world, minimizing the delay in meeting resource requirements can go a long way towards controlling the effects of the disaster.

One potential way to efficiently meet the urgent resource requirements in the aftermath of a disaster is to learn from prior disasters and develop knowledge about what type of resources are usually needed in the aftermath of a disaster. Such knowledge can help government agencies and other responding organizations for planning formative solutions, to be better prepared to mitigate any upcoming disaster. The present study aims to curate such knowledge through a case study on a major disaster in recent times.

On April 25, 2015, a severe earthquake struck Nepal with a magnitude of 7.8 M_w (Moment Magnitude scale). The devastating earthquake (also known as the *Gorkha Earthquake)*, killed nearly 9000 people, injured almost 22,300 people and left more than 80,000,00 people in desperate need of assistance [27]. Furthermore, around 7,55,549 residential buildings, 4000 government offices, and 8200 school buildings were damaged due to this earthquake [27]. The earthquake shattered numerous susceptible portions of the country's

* Corresponding author at: Social Informatics Research Group, Indian Institute of Management Calcutta, Kolkata 700104, India.
E-mail addresses: moumitabasu0979@gmail.com (M. Basu), saptarshi.ghosh@gmail.com (S. Ghosh), arnab.jana@iitb.ac.in (A. Jana), somprakashb@gmail.com (S. Bandyopadhyay), ravikant.singh@doctorsforyou.org (R. Singh).

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infrastructure and debilitated the local health care system and social welfare institutions. Hence, the Nepalese government issued an urgent request for urban search and rescue (USAR) teams, foreign medical teams (FMTs), emergency shelters, and other life-saving assistance from the global community [1]. Afterward, several UN Organizations and international non-Governmental Organizations (NGO) like WHO, UNICEF, QRCS, CISAR and others moved to Nepal to provide humanitarian assistance.

Doctors For You (abbreviated as DFY) was one of the NGOs, actively involved in the relief operations in the aftermath of the Nepal earthquake. DFY is a pan-India humanitarian organization with international presence that focuses on providing medical care to the vulnerable communities during crisis and non-crisis situation [22]. DFY operated in the earthquake-struck regions of Nepal from April 27 to November 26, 2015. Some of the members of this team were involved in the ground activity in Nepal while the other members stayed at their home station in India, planning for resource deployment and other associated works [2]. The members of DFY formed a WhatsApp group to communicate among themselves and plan the relief operations. In this study, we analyze the WhatsApp messages exchanged among the medical personnel of DFY.

The data of WhatsApp messages exchanged among DFY personnel is a rich repository of both temporal and spatial information reported from the earthquake-struck regions of Nepal, and contains valuable information on what resources were required, how long it took to meet the resource requirements, what problems were being faced by the rescue workers, and so on. This data comprises discourse among medical experts. Accordingly, it contains a noteworthy amount of micro-level information about the requirement and availability of different medical resources (including various types of medicines and medical infrastructure). In analyzing this data, we address the following research questions:

1. What resources are usually required in the aftermath of an earthquake?
2. Considering that the post-disaster relief operations have various temporal phases, what resources are required at what points of time?

In our present study, we attempt to address the aforementioned questions taking the 2015 Nepal Earthquake as a case study. Additionally, we have also calculated the delay in mobilizing various resources after the Nepal earthquake.

Though there have been several prior attempts to analyze resource requirements during disaster events (as discussed in Section 2), to our knowledge, no prior study has reported the requirement of resources, especially medical resources, in such detail as we do in this study. Further, since the data analyzed in this study was posted by medical experts who were actually present in the disaster-affected region, the insights obtained from the data are trustworthy and authoritative and can be reliably used to formulate strategies for coping with future disaster events.

Overall, the motivation of this study is to provide guidelines to government and non-government organizations about the requirements in the aftermath of an earthquake, which might help in better preparedness and resource mapping during future disaster events. Moreover, this study demonstrates that, if closed-group conversations among members of different responding agencies are collected and analyzed in real-time (i.e., during the disaster itself), such analyses can help in taking crucial and dynamic decisions regarding resource mobilization and allocation in an optimal way.

2. Related work

Different research communities including medical experts, urban scientists, computer scientists, etc. have carried out extensive research on preparedness planning and hazard mitigation strategies in the area of disaster management. Out of these, most of the studies by medical experts and urban scientists have mostly depended on user surveys and user-experiences [7–13]. Hence, the amount of information analyzed in aforementioned studies is often limited by various human factors (e.g., how much detail the relief workers remember at the time of the survey).

However, in today's society, we are globally connected through the Internet such that disaster managers in all countries can be benefited from the use of crowdsourcing through various social media platforms [26]. Social media data has been used by computer scientists for extracting situational information during disaster events [14–18]. For instance, several recent studies have utilized thousands to millions of microblogs posted on the popular Twitter social media (twitter.com) for extracting situational information. The amount of information analyzed in these studies is huge, but the data obtained from social media is mostly noisy and too unreliable to formulate future strategies. The combined use of social media and Social Media Analysis Tools (SMAT) can increase the effectiveness of their social media on disaster preparedness and disaster risk reduction. However, there are several issues associated with the selection and use of SMAT like the language of the user, social media data, and SMAT interface, the cost of the tool and much more [24]. Moreover, it poses a huge challenge in identifying the most significant information to protect human lives from these social media posts [23].

In contrast to the prior studies, the present work relies on social media (WhatsApp) data crowd-sourced from medical experts who were actually present at the site of the disaster. Hence the data is much more reliable (e.g., compared to data obtained from public social media like Twitter), and contains a detailed description of resource requirements, as observed by the DFY members during the relief operations. To the best of our knowledge, no prior study has reported the requirements of resources after a disaster event, and the time frame within which these requirements were addressed, in such diminutive details as in this study.

Further, there have been few prior studies on various aspects of the relief operations after the 2015 Nepal earthquake. For instance, Yang et al. [3] focused on the medical rescues by CISAR (China International Search & Rescue Team) in Nepal. The rescue and treatment of pediatric patients by the Chinese Red Cross medical team during the Nepal earthquake has been analyzed by Wang et al. [4] Few studies have also been conducted on identifying damage patterns (e.g., damage to buildings) to reduce the future earthquake risks in Nepal [5,6]. Another study on the 2015 Nepal Earthquake indicates strong governance and political will plays an important role in disaster risk reduction efforts at the national level [25]. Nevertheless, these prior studies have neither used WhatsApp chat logs nor reported the medical resource requirements and the delay in addressing the requirements, which is the primary contribution of the present work.

3. Methodology

This section describes the data analyzed in this study, and the methodology adopted for cleaning and analyzing the data. On April 27, 2015 (two days after the earthquake struck Nepal) the members of DFY formed a WhatsApp group for intra-organizational interactions. Around 35 individuals contributed to this group and approximately 3500 messages were posted during the first 3 months after the disaster, i.e., from April 27 to July 30, 2015. These messages were collected and analyzed by us. All the messages were in English and have varying length. The average length of the messages was calculated as 7 words. Each message includes the mobile number from which the message was posted, the timestamp when the message was posted, and the message text.

The flow of our work is illustrated in Fig. 1. The set of messages was initially cleaned and pre-processed by scripts written using the Python programming language. The images and videos shared during the