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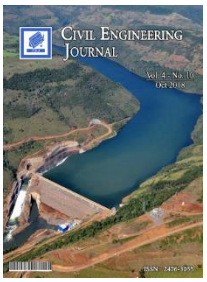

Characterizing Infrastructure Resilience in Disasters Using Dynamic Network Analysis of Consumers' Service Disruption Patterns

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Abstract

This study proposes a network analysis framework for characterizing infrastructure resilience in the aftermath of disasters through the use of consumers' service disruption information. In the presented framework, the notion of "peers" is used to construct the network models of consumers experiencing service disruption in the aftermath of a disaster to understand the type and extent of infrastructure damages and specify disruption patterns. Data related to electricity disruption in Bhaktapur, Nepal, in the aftermath of the 2015 Gorkha Earthquake is used to construct the network models of consumers' networks at different points in time in the aftermath of the disaster. The created models are then used in network analysis for examining the network topological characteristics (such as clustering) and specifying the attributes of service disruption. The contribution of this paper lie in: (i) the development and validation of a novel network from disruption information, (ii) identify the extent of infrastructure disruption, type of damage, and recoverability from changes in network topology over time.

Keywords: Disaster; Resilience; Infrastructure Systems; Network Analysis; 2015 Gorkha Earthquake.

1. Introduction

Resilience of Civil Infrastructure Systems (CISs) plays a crucial role in ensuring the viability of societies and performing the functions of daily activities, especially during extreme events and post disaster periods, with the aim of minimizing the adverse effects of disasters. Everyday life relies on the operation of different CISs, such as electric power, water and gas distribution, and transportation infrastructures. Disasters (such as Hurricane Sandy 2012, Hurricane Harvey 2017, or Northeast Blackout 2003) have shown vulnerability of civil infrastructures and emerged importance of having a resilient infrastructure. Recent planning work have focused on response and restoration and importance of this dimension of resilience, recoverability [1]. Despite the pervasive interest in disaster resilience assessment, risk assessment, network analysis, and vulnerability (disruption) of infrastructure systems, existing literature exhibit a lack of clarity in consideration of service disruption patterns and status of end-users in the assessment of the resiliency in CISs and mainly emphasis on components in the network. In addition, in an effort to evaluate the resilience of the CISs, scholars have tried to quantify the disruption period, response and recovery times and damages to the physical infrastructure networks, while striving to simplify the existing networks, which may lead to a number of errors in quantifying the disaster resilience of a CIS [2]. To address these issues and capture the real behavior of the CIS, the disruption characteristics of the infrastructure networks are implemented to assess the resilience of the infrastructure systems. This approach not only offers new insight regarding understanding the resilience of infrastructure and communities, but it also resolves the associated obstacles when obtaining data to create networks after any disruptive

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