Sustainable Cities and Society 41 (2018) 170–179

Contents lists available at ScienceDirect

Sustainable Cities and Society

journal homepage: www.elsevier.com/locate/scs

A hierarchical pattern of urban social vulnerability in Shanghai, China and its implications for risk management

Honghuan Gu[a], Shiqiang Du[a,*], Banggu Liao[a], Jiahong Wen[a], Congxiao Wang[a], Ruishan Chen[b], Bo Chen[c]

[a] Shanghai Normal University, Guilin Road 100, Shanghai, 200234, China
[b] East China Normal University, Dongchuan Road 500, Shanghai, 200241, China
[c] Beijing Normal University, Xinjiekouwai Street 19, Beijing, 100875, China

ARTICLE INFO

Keywords:
Social vulnerability
Hierarchy
Urban sustainability
Floods
Risk management
Shanghai

ABSTRACT

Social vulnerability helps to identify the population groups who may disproportionally suffer from natural hazards. The social vulnerability index (SoVI) has equipped extensive efforts to assess social vulnerability over the past two decades. However, only a few studies have paid attention to the intra-city level social vulnerability, and knowledge gaps still exist in understanding the spatial patterns of urban social vulnerability. This paper presents a hierarchical pattern of urban social vulnerability by a SoVI assessment of the 5432 neighborhoods (residential committee, or *juwei* in Chinese) in Shanghai metropolitan, China. High SoVI occupies the city center; to its outside is a low SoVI belt, which is surrounded by medium–high SoVI in the vast suburbs and low SoVI appears in the local centers of the suburbs. This hierarchical pattern is highly significant for enhancing the understanding of urban social vulnerability. It can also facilitate urban risk management and enhance urban sustainability by identifying socially vulnerable communities and the vulnerable combination of social vulnerability and natural hazards. In this paper, an integration of the SoVI result and a flood scenario reveals vulnerable areas that should be high priorities on the agendas for mitigating flood hazards and social vulnerability.

1. Introduction

1.1. Social vulnerability and its measurement

Natural hazards cause significant death, injury, property damage, and economic loss annually (UNISDR, 2015; United Nations, 2015). Moreover, inequality exists widely among communities and individuals regarding the impacts of natural hazards (Hajra et al., 2017; Parry et al., 2018; UNISDR, 2015). Social conditions including demographic characteristics, industry structures, facility status, and prevention and relief measures play vital roles in determining how natural hazards affect society and produce economic damage and loss of life (Cutter, Boruff, & Shirley, 2003; Hajra et al., 2017; Otto et al., 2017).

Social vulnerability is a measure of the socio-economic characteristics that condition a place's capacity to cope with, resist, and recover from natural hazards (Aroca-Jimenez, Bodoque, Garcia, & Diez-Herrero, 2017; Cutter & Finch, 2008; Otto et al., 2017). It emphasizes how social conditions influence the potential of disaster loss (Holand, Lujala, & Rod, 2011). The development of a place-based social vulnerability index (SoVI) has equipped extensive efforts to assess social vulnerability at different spatial scales (Cutter et al., 2003; de Sherbinin & Bardy, 2016; Fekete, 2009; Holand et al., 2011; Zhou, Li, Wu, Wu, & Shi, 2014).

At national scales, Cutter and Finch (2008) comprehensively assessed SoVI in the United States; other examples include SoVI analyses in Norway (Holand et al., 2011), China (Zhou et al., 2014), and Italy (Frigerio & De Amicis, 2016; Frigerio, Strigaro, Mattavelli, Mugnano, & De Amicis, 2016). At subnational or regional scales, SoVI has been applied in the southern United States (Emrich and Cutter, 2011), the Yangtze River Delta in China (Ge, Dou, & Liu, 2017), the Brazilian Amazon (Parry et al., 2018), and the urban areas of northern central Spain (Aroca-Jimenez et al., 2017). These studies assumed that a spatial unit like a city is homogenous in SoVI. However, SoVI is probably heterogeneous within a city (Kates, Colten, Laska, & Leatherman, 2006) given that population, facilities, and industries typically vary across a city (Batty, 2008; Sampson, 2017; Scott & Storper, 2015). Therefore, an aggregation of SoVI variables on large-scale units (city and county) unavoidably omits the heterogeneity in urban social vulnerability, which should be based on a fine scale analysis.

* Corresponding author at: Department of Geography, Shanghai Normal University, Guilin Road 100, Shanghai 200234, China.
E-mail address: shiqiangdu@shnu.edu.cn (S. Du).

https://doi.org/10.1016/j.scs.2018.05.047
Received 6 March 2018; Received in revised form 25 May 2018; Accepted 27 May 2018
Available online 28 May 2018
2210-6707/ © 2018 Elsevier Ltd. All rights reserved.

1.2. Importance and challenges of social vulnerability at a local scale

Compared with studies at national and regional scales, however, less attention has been devoted to an intra-city investigation of social vulnerability (Armas & Gavris, 2013; Ebert, Kerle, & Stein, 2009; Roncancio & Nardocci, 2016; Zhang & Huang, 2013). Ebert et al. (2009) used satellite imagery and census data to assessed the urban SoVI in 87 units (a total area of 9 km^2) in Tegucigalpa, Honduras. Armas and Gavris (2013) investigated the SoVI of 154 census units (a total area of 285 km^2) in Bucharest, Romania. Zhang and Huang (2013) analyzed the SoVI of 333 sub-districts (*jiedao,* or town) (a total area of 16,800 km^2) in Beijing. Masuya (2014) conducted a flood vulnerability evaluation and risk zonation at a community level for 1463 communities (a total area of 878 km^2) in Dhaka, Bangladesh. These studies revealed that SoVI is inhomogeneous in cities. However, these studies had either limited spatial scopes (Armas & Gavris, 2013; Ebert et al., 2009) or coarse spatial resolutions (Zhang & Huang, 2013), both of which dampened a comprehensive understanding of SoVI in a metropolitan area. Moreover, spatial analysis techniques, which were widely applied at large scale studies (Frigerio, Carnelli, Cabinio, & De Amicis, 2018; Ge et al., 2017; Lin & Hung, 2016), have not yet employed to quantify a spatial pattern of urban SoVI (Masuya, 2014). Therefore, knowledge gaps still exist against a comprehensive understanding of urban SoVI.

On the other hand, there is an increasing trend to emphasize the importance of social vulnerability information at local scales (Barnett, Lambert, & Fry, 2008; Hinkel, 2011; Jacob, Weeks, Blount, & Jepson, 2013; United Nations, 2015; Wood, Burton, & Cutter, 2010). Barnett et al. (2008) and Hinkel (2011) argued that social vulnerability indicators can identify vulnerable people and communities much more effectively at local scales than at large scales. At local scales, social vulnerability information can facilitate development planning (Lee, 2014), promote resource allocation (Birkmann, 2007), and strengthen urban sustainability (Sampson, 2017). Local communities play an important role in disaster preparedness, response, and recovery as they are typically the basic unit of social organization (Hinkel, 2011; United Nations, 2015).

In China, the neighborhood, which represents residential committee and is named *juwei* in Chinese, plays a strong role in urban risk management (China National Commission for Disaster Reduction, 2010). First, neighborhood plays administrative functions as the basic administrative unit and is responsible for local risk management (Chen, Cutter, Emrich, & Shi, 2013). Second, the neighborhood is in charge of local emergency planning, plan exercise, shelter maintenance, and relief recourse management (China National Commission for Disaster Reduction, 2010). Third, it is also the basic unit of appraising emergency management performance (Zhang & Huang, 2013). However, social vulnerability has been seldom investigated at such local levels, which renders local risk management difficult.

1.3. Research objectives

This paper aims to reveal an urban social vulnerability at a fine scale and explore its spatial pattern. Shanghai is employed for a case study because of its significant disaster risk (Du, Gu, Wen, Chen, & Van Rompaey, 2015) and heterogeneous social environments (Liao & Wong, 2015). The framework of SoVI (Cutter et al., 2003) is applied to analyze social vulnerability at a neighborhood scale. Possible spatial patterns in SoVI are quantified using spatial statistics.

2. Study area

Shanghai is one of the largest metropolises in the world. It has a terrestrial area of 6340 km^2 (Fig. 1a) and a population of 23 million. Its special geography, such as low-lying coastal plains and a subtropical monsoon climate, renders Shanghai susceptible to hydro-meteorological hazards (Du et al., 2015). This city is one of the top 20 world coastal cities that are expected to experience rapidest growth (by more than 40%) of flood damage by 2050 (Hallegatte, Green, Nicholls, & Corfee-Morlot, 2013).

On the other hand, Shanghai has a complex demographic and economic pattern. This city was once a traditional town before 1845, was colonized between 1845 and 1943, and has developed and expanded rapidly in the past decades. The traditional downtown area, the former colonies, and the subsequently developed areas form a complicated urban structure. As a result, building styles (e.g. steel and wood structures) and population structures (e.g. migrants, elders, and females) are highly heterogeneous (Liao & Wong, 2015), which may cause SoVI to vary over space.

Shanghai is typically divided into two parts: the inner city and the suburbs (Liao & Wong, 2015) (Fig. 1b). The inner city is comprised of the city center (Huangpu and Jing'an) and its fringe area (Xuhui, Changning, Putuo, Zhabei, Hongkou and Yangpu) (Fig. 1b and c). The suburbs consist of the other nine districts (Fig. 1a and b). For purposes of this paper, in general, the suburb areas that are close to the inner city are called the inner suburbs and the peripheral areas of the suburbs are called the outer suburbs. The basic administrative unit in Shanghai is neighborhood, which is also the finest level for accessible census data. The 5432 neighborhoods have an average area of 1.25 km^2 and an average population of 4225 persons.

3. Materials and methods

We assessed urban SoVI in Shanghai through five major steps (Fig. 2). First, variables were selected from multi-source data, which were used to support a factor analysis to detect SoVI factors in the second step. Third, these factors were combined to calculate a SoVI score. Fourth, global Moran's I and local Gi* statistic were employed to quantify the patterns in the SoVI score. Finally, the SoVI score was overlaid with a flood map using a bivariate technique to identify the vulnerable combination of social vulnerability and natural hazards. The five-step procedure was performed at a neighborhood scale.

3.1. Variable selection and data sources

Four principles were employed to select variables for SoVI analysis. First, we followed previous SoVI studies (Cutter et al., 2003), particularly of local scale assessments (Armas & Gavris, 2013; Masuya, 2014; Zhang & Huang, 2013). Second, we considered socioeconomic characteristics of Shanghai. Third, we referred to the variables that are used for appraising paradigmatic neighborhoods of disaster governance in China (China National Commission for Disaster Reduction, 2010). Fourth, we had to select variables that are accessible at a neighborhood level. According to these principles, we employed 17 variables and grouped them into three categories (Table 1). These variables were mainly derived from the 2010 census data at the neighborhood level (Shanghai Municipal Bureau of Statistics, 2012).

3.1.1. Demographic variables

Four major aspects of population were selected to reflect inequalities in population regarding natural hazard impacts, namely, gender, age, education, and household structure. Females are typically more vulnerable to natural hazards than males due to their physiological and social disadvantages (Cutter et al., 2003; Morrow, 1999). Regarding age, children and elders were the vulnerable groups (Flanagan, Gregory, Hallisey, Heitgerd, & Lewis, 2011). Additionally, the number of school children was depicted using the number of primary schools and kindergartens as a proxy for each neighborhood.

Education level reflects a person's knowledge and skills and can significantly influence one's social vulnerability (Cutter et al., 2003; Holand et al., 2011). Three education levels were differentiated in the population for those aged ≥15, namely, the illiterate population, the low-education population with ≤ 9 years of education, and the high-

Download English Version:

https://daneshyari.com/en/article/6774921

Download Persian Version:

https://daneshyari.com/article/6774921

Daneshyari.com