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ARTICLE

Place- and Age-Responsive Disaster Risk Reduction for Hong Kong: Collaborative Place Audit and Social Vulnerability Index for Elders

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Abstract This study reformulates the concept and contents of disaster risk reduction (DRR) in Hong Kong through an explorative study on collaborative place audit (CPA) and social vulnerability index (SVI) for elders. We believe that DRR should be place- and age-responsive. Accordingly, DRR needs to go beyond technical concerns and address vulnerability and risk encountered in the built environment where an individual is located. A place-centered DRR begins with an assessment of person–environment relations from an interdependent perspective. Community becomes a significant scale at which to address vulnerability and risks across a range of environmental, socioeconomic, and institutional factors. A CPA is a ground-level assessment tool that identifies vulnerability and risk in the built and social environment. The audit encourages collaboration in problem solving that uses social capital to effect decision-making change in hierarchies and policy networks. Age-responsive DRR facilitates distinguishing living-alone elders from the general population. This perspective addresses varying degrees of vulnerability due to social and communicational isolation, poverty, disability, being sent to hospital and/or receiving institutional care, as well as lack of access to primary care. Accordingly, SVI, based on compound indicators, is developed to assess the differentiation of vulnerability across the territory with particular reference to the elders. These two approaches, namely, CPA and SVI, build community capacity to develop a resilient city, as well as to provide evidence-based recommendations that improve government-led disaster preparedness and contingency plans.

Keywords Disaster risk reduction · Hong Kong · Place audit · Social capital · Social vulnerability

1 Introduction

Cities are places of prosperity, where successful, flourishing, or thriving conditions prevail (UN-HABITAT 2013). At present, over half of the world population lives in cities. By 2050, rapid urbanization and population growth will add another 2.5 billion people who will become urban dwellers; the developing economies of Africa and Asia will eventually account for nearly 90% of such population increase (United Nations 2014). Quality of life of urban dwellers is one of the critical challenges for urban sustainability. Intense land development, decreased vegetation cover, and substantial climate variability also have immense impact on the physical activities and health of people (Dickson et al. 2012). If these issues cannot be tackled, urbanization will be vulnerable to the natural and human-made disasters that leverage severe effects to large cities and inhabitants. This will eventually weaken building up of resilient communities. A holistic approach of disaster preparedness and management is very much needed, which will help enhance the well-being of citizens and their active involvement of urban life.

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Globally, the promulgation of the Hyogo Framework for Action 2005–2015 paves the way for an international commitment to disaster risk reduction (DRR). Management of disaster risks is now a component of a global effort that is in parallel to sustainable development and poverty reduction. Particularly prominent is the effort to mitigate vulnerability and strengthen disaster preparedness in ways that will lead to sustainable urbanism (UNISDR 2007). Pragmatic evidence has uncovered several drawbacks in the midst of these global endeavors. For example, in terms of collaboration, integrated efforts among various stakeholders are difficult due to the differences in language and the institutional turf wars (Schipper and Pelling 2006). Likewise, communication among stakeholders is also impeded by asymmetric power relations and imperfect knowledge exchange between actors at various levels.

Locally, the discussion of DRR is necessary in Hong Kong due to its substantially dense urban environment. Currently less than one-fourth of the total land in Hong Kong is built-up area, which accommodates over seven million people. This is partly because the new town development did not commence until the 1970s and most of the population, particularly after the post-war boom in the 1950s, had to be accommodated in the main urban areas along the waterfront of the Victoria Harbor on Hong Kong Island. Moreover, the high price of land leads to high density since the low- and middle-income resident can only afford to live in high-rise buildings (Yeh 2011). High density poses challenges due to large population, exposures to hazards, and concentrated construction of infrastructure and housing. In the past, Hong Kong has experienced substantial losses and casualties following various weather-related disasters (Wong 2015). From 1884 to 2002, Hong Kong experienced strong typhoons every 5.7 years (Hoi 2003). A single typhoon in 1937 claimed 11,000 lives. One typhoon in 1957 destroyed approximately 900 temporary shelters, thereby rendering 10,000 people homeless. Moreover, the annual rainfall in Hong Kong surpasses 2221 mm and is highly seasonal; hence, this territory is particularly vulnerable to landslides in the summer. From 1947 to 2002, over 470 people were killed due to landslide-related hazards. Victims of heavy rainstorms constituted a significant number annually, and a single rainstorm in July 1994 affected 20,000 people. Although disaster mitigation has been generally improved due to the enhanced management and construction in the fields of electricity supply, building construction, transportation infrastructure, and civil engineering, among others, Hong Kong is not completely immune to the negative effects of natural and human-made disasters. The official report published by the Hong Kong government stated that climate change adaptation should be addressed by understanding every vulnerability and all the risks that the city faces (HKSARG Environment Bureau 2015). These risks include the increasing number of extremely hot or cold days, extreme rainfall events, extremely dry seasons due to lack of rainfall, sea level rise, and the frequency and intensity of storms. Apart from natural hazards-induced disasters, Hong Kong has experienced public health emergencies, such as the SARS epidemic and avian influenza (Chan et al. 2015), which resulted in significant health and social impacts across the entire territory.

Discussion of DRR is often technically oriented. This study reformulates DRR by highlighting the need to invite community engagement so that the social values of the populace can be taken into account and vulnerable members of the population (that is, the elderly, disabled, and disadvantaged) can be heard. A study of vulnerability in urban living enables an in-depth understanding of the "causes of the causes"—those social factors that result in a vulnerable urban population (Marmot and Wilkinson 2006). This study commences with a critical analysis of DRR and highlights the significance of "place" and "age" in order to align DRR with the extensive discourses of sustainability and resilience. Community is discussed next and is considered a significant measure for gaining context specific knowledge on disaster preparedness and risk management. With a better understanding of a community and its specific social and physical environment, community dwellers are likely to develop a high level of disaster literacy and higher motivations for living a healthier life. Hong Kong's disaster preparedness and contingency response is benchmarked in Sect. 3 with a place-responsive DRR framework—a collaborative place audit (CPA). The comparison between Hong Kong's disaster preparedness and the framework expresses an urgent need for both a place- and an age-responsive DRR. Those social factors that are relevant to a high level of vulnerability among the elderly are discussed in the penultimate section, which develops the social vulnerability index (SVI) for elders of Hong Kong. The results of SVI, which are based on the most updated data available, are reported in Sect. 4. The final unit summarizes the essential ideas of DRR in Hong Kong and discusses their policy implications.

2 Reformulating DRR: A Conceptual and Pragmatic Framework

DRR refers to "the systematic development and application of policies, strategies and practices to minimise vulnerabilities, hazards and the unfolding of disaster impacts throughout a society, in the broad context of sustainable development" (UNISDR 2004, p. 3). Beyond merely maintaining the status quo, DRR comprises a set of transformative and aggressive efforts to critically revisit the

social and cultural realms of a community in the areas of disaster preparedness and response (Pelling 2010). A hazard cannot produce a disaster unless it interacts with human habitat and vulnerable infrastructures (Cannon 2008). Disasters are socioeconomic and political in origin, and the contextual factors, such as the social, ecological, and economic environment where a hazard is situated, are critical (Mercer 2010). Factors within the built environment (for example, demographics, location, living condition, building conditions, and means of communication) constitute the major causes for the substantial exposure of human settlements to disasters or public health emergencies (Cruz 2007; Schwab et al. 2007).

People's embeddedness in various social and environmental contexts creates vulnerabilities that lead to different levels of disaster proneness and influence. Vulnerability resides in the social, institutional, and political aspects of everyday life and is defined as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard" (Wisner et al. 2004, p. 11). The manner by which people interact with the built environment, as well as the particular forms these social acts assume, is essential for such capability. Lack of knowledge about disaster, absence of a well-designed course of action, and the inability to deal with disaster-related information constitute primary components of the social causation of vulnerability (McEntire 2011).

Environment comprises various scales (micro-, meso-, exo-, and macro-levels) in relation to an individual (Shaffer and Kipp 2010). Environment consists of a set of stimulations or stresses that can lever changes in behavior that amplify or minimize exposure to risks. Given that the person–environment relationship is conducive to people's positive functioning, DRR should be place-responsive. Gustafson (2001) explained that an individual is embedded in the environment; and the social relations that a certain place encapsulates are constructed for human actions and life-world experience. The characteristics of the environment upon which people develop an improved understanding to cope with environment stressors should be identified. Once known, this information can lead to a high level of disaster literacy and associated changes in behavior.

To begin with, community is a significant site for place-responsive DRR measures (Gaillard and Mercer 2012). A community plays an intermediate role between an individual and a broad environment context: the physical and social aspects of a community affect an individual's access to various health-related resources, thereby determining exposure to and influences from different environment stressors (Schulz and Northridge 2004). Through meeting basic needs, enhancing awareness, and acquiring capability and disaster knowledge, community-based initiatives simultaneously intervene to "push up" against the fundamental factors in a broad social and political context that are conducive to socio-spatial injustice and health disparities.

It is therefore very important to analyze place-specific characteristics and community features that are closely related to the activities and lived experience of people. Such an assessment is conducive to identifying the advantages and barriers in both the built and social environment where an individual is located. The CPA concept was initially developed by town planners with an aim of initiating collaborative place-making on top of a better local knowledge about a community (Project for Public Spaces 2006). In Singapore, town audits are used to identify physical defects and hazards in those neighborhoods that may be unsafe for residents (Singapore 2014). The form taken by town audits in Singapore is the "walkabout," which is organized for the residents, particularly the elderly, with the involvement of planners and place-making professionals. In Hong Kong, a place audit was conducted to identify barriers to age-friendly communities (Ng 2015a). Existing literature on disaster management adopts a similar approach, albeit different terms are used for CPA. In general it comprises a collaborative place audit and a community planning workshop (Fig. 1), whose aim is to raise awareness, facilitate risk communication, and strengthen community resilience. The place audit offers a medium for collective social learning because community members are key informants who possess extensive local knowledge. By employing the proper methods of community engagement and social learning, a place audit will eventually formulate integrated measures to reduce risk and promote well-being.

In the pre-audit stage, DRR professionals and planners work with residents to collect as much information as possible on the past disaster events and areas that are prone to being affected severely (the so-called "blackspots"). It is important to understand, for example, under the extreme weather events, natural disasters, or public health emergences, what are the usual evacuation routes, where the shelters are, who seems to be most vulnerable, and which places are destroyed or greatly affected. Local community members will be consulted whose life experience is very essential to understating the status quo of community environment as well as evaluating community's conventional practices under disaster emergencies and the level of disaster literacy. The routes should cover destinations that meet local residents' basic needs under the emergency conditions (for example, evacuation routes and the access to shelter, gathering place, healthcare facilities, local district council offices, local schools, and district auditorium that could accommodate a good number of local residents

Fig. 1 Framework of collaborative place audit (CPA). *Source* The authors

and help disseminate information quickly). Also, residents' daily life routines should be noted which constitute the social and activity spaces for community dwellers. They are conducive to psychological well-being of community. The formation of auditing groups shall cover different types of local residents with different ages and levels of vulnerabilities, with a premise that people in different stages of life have different demands. Their capabilities to deal with environmental and social stressors vary as well. Community participants will be recruited from local residents on a voluntary basis, who will be trained with basic skills to collect opinions from people living in communities and conduct questionnaires. These community participants can approach more local residents who are otherwise not able to be identified by "outsiders."

In the second stage, a place audit enables comparative assessments of disaster resilience at the local and community levels (Cutter et al. 2008). The audit serves as a ground-level assessment tool that revisits neighborhood characteristics and assesses whether the environment fits the capabilities of people well enough to have popular support and function positively. The process revisits neighborhood and environment characteristics and collects both objective and subjective data about the status quo of the built and social environment. Usually, apart from community dwellers who are interested in the place audit process, the audit group consists of town planners and DRR professionals, who help collect objective data like the quality of public spaces, evacuation space, barrier-free facilities, and accessibility to healthcare and emergency resources. Subjective data is obtained through questionnaires or interviews during the audit process. An on-site community seminar is an important source by which to understand what is needed with particular reference to the daily life routines of community members. Mapping is an instrument to highlight facilities and spaces essential for evacuation and promotion of strong social ties among neighborhood. Local residents are asked to mark spaces and facilities that are important for physical activities and social participation. Specifically for DRR, they will draw their trips to different destinations, from home base, that they deem important under emergency conditions on a basemap provided by the auditing team. It should be noted that the social space is essential for health and emergency preparedness since literature has confirmed that the accumulation of social capital (that is, a set of social relationships that produce positive outcomes for individual members through broadening the access to health-related resources) through intense social interactions is conducive to developing trust and mutual help (Ng 2016). These visualized data (through making marks, notes, and posts) also help trigger dialogues and discussions among different

stakeholders with different expertise and life-course experience (Gaillard and Pangilinan 2010; Cadag and Gaillard 2012).

Post-audit discussions collate the identified vulnerability and risk and highlight the major causes for them. Solutions are discussed for the different types of vulnerability and risk that have been identified. Priority is given to issues that are of wide concern among community members and professionals. Community planning workshops open a platform for the discussion of solutions through face-to-face interaction. This mutual dialog emphasizes the importance of community engagement since, according to Chatterjee (2017), people have the right to obtain the requisite resources, skills, and services by engagement in processes that result in the upholding of their rights. The community planning workshop is not exclusive to DRR professionals. It facilitates mutual understanding between planners and community members and generates knowledge about those local practices that translate disaster preparedness into frameworks understandable to and actionable by the community's members. Interactive disaster planning also consolidates a community's commitment to collective problem solving, and nurtures long-term capacity for a DRR plan's implementation and future review. The participatory nature of CPA enables a community to frame adaptive actions and change practices as well as institutions that are closely connected to the root and proximate cause of vulnerabilities in the daily life routines of community dwellers (Pelling et al. 2015). In community planning workshops, different expectations, knowledge, and tools should be discussed to enable every participant to obtain an improved knowledge about the built environment. Through discussions and negotiations, CPA enables agencies, governments, and professionals outside a community to "immerse themselves with communities and work in partnership with individuals through conversation, interview, workshop, focus groups, and participatory learning and actions" (Mercer et al. 2014, p. 9).

Facilitative leadership is important. Sensitive and empathetic facilitators can drive the dynamics of collaboration and make continuous efforts to ensure that collaboration covers an entire array of issues—from learning the social and built environment to problem solving—instead of maintaining a narrow focus on contingent variables and recovery measures (Hochrainer and Mechler 2011). Facilitative leadership is also useful to prevent technocratic decision making and to acknowledge that the community exhibits an improved understanding of local resources and knowledge (Chan 2013). The process should also allow for a high degree of flexibility so that contingency measures and community plans can be monitored, evaluated, revisited and revised in a timely fashion.

The merits of the CPA framework are threefold. Implementation of a CPA process nurtures a high level of disaster literacy. Disaster literacy refers to an individual's "ability to read, understand, and use information to make informed decisions and follow instructions in the context of mitigation, preparing, responding, and recovering from a disaster" (Brown et al. 2014, p. 267). Moreover, disaster literacy exists in different degrees, which range from a basic level of awareness and communication, to managing disaster related experience, and eventually developing resilience. Resilience capability empowers people to analyze disaster information, identify the risks, and take personal control to remain safe (Brown et al. 2014). Improved disaster literacy achieves these goals by promoting an increased understanding of the contextual factors that develop positive behavioral patterns and social relations. The development of advanced disaster literacy is challenging. Risk communication cannot be constantly effective due to different values, perceptions, and power relations. Lack of communication—either at the horizontal level among associated stakeholders or at the vertical level with different government officials—and diminished means of collective learning impede the integration of actors (government, NGOs, and community), knowledge (scientific knowledge from expert groups and indigenous knowledge generated by the community), and effective actions in risk assessment and preparedness (Mercer et al. 2010; Gaillard and Mercer 2012). Collaboration-oriented place audits and community planning workshops help offset the unbalanced power relations (Ng 2015b). Mutual interactive learning facilitates an effective information exchange and enables incorporation of complexities and heterogeneities among community members with regard to culture, knowledge, cognitive styles, ability to access resources, and so on.

The CPA process strengthens the horizontal links between the community and associated stakeholders, and emphasizes the collective ownership of knowledge, action, and participatory framework. The shift of the decision-making mode from hierarchy to networks enables CPA to maximize community resources that enhance the quality of life "…in an environment characterized by change, uncertainty, unpredictability and surprise" (Magis 2010, p. 401). Nurturing positive partnership conditions and cooperative relationships enables opportunities to arise that maximize interfaces between knowledge, expertise, tools, and technologies (Edwards et al. 2012).

The CPA framework also emphasizes the use of social capital, which is conducive to developing mutual help and collaboration (Sun 2015). The more social interactions a place generates, the higher the level of self-identity that people develop. This process consolidates self-esteem and self-worth, which results in personal growth and living a

purposeful life. Two types of social capital are addressed in the CPA. Bridging social capital consolidates the horizontal connections between community members and institutions as well as establishes the different stakeholder networks as resources sharing and mutual support. Linking social capital connects communities with institutions and individuals who have relative power over them in order to improve access to services, assistance, and resources (Hawkins and Maurer 2010).

3 Disaster Preparedness and Contingency Plan in Hong Kong

The pragmatic framework of place-responsive DRR offered by CPA at the community level can also serve as a benchmark by which to assess current disaster preparedness and contingency planning in Hong Kong. CPA and its place-responsive focus add an extra value to DRR because a community is considered an asset for substantial discussions on resilience and capacity building. The Hong Kong case also links DRR with broad initiatives whose goal is to build sustainable, livable, and inclusive communities that promote the health and well-being of the people.

A review of Hong Kong's traditional disaster preparedness and contingency response reveals little room for the role of community. It also lacks a special consideration of place-specific vulnerability and risks. Given the introduction of a storm warning system in 1993, the Hong Kong Disaster Plan (HKDP) was promulgated in 1994 by the security branch of the Hong Kong government. The HKDP is the designed structure of authority under which emergency plans and personnel operate. The HKDP also delegates the roles and responsibilities of different agencies. Apart from information dissemination and an emergency alert system, the entire crisis management system was divided into three stages: rescue, recovery, and restoration. The HKDP is a top–down approach, envisages centrally and administratively the needs of society, and designates performance duties to pertinent departments (Huque 2014). No particular type of hazard was articulated; the plan is a generic, one-size fits all document. Thus the HKDP is vague and lacks a detailed consideration of emergency scenarios for different types of hazards. Since 2007, the Security Bureau issued the Contingency Plan for Natural Disasters and till 2015 the Plan has been revised several times.

CPND summarizes the government's warning systems and organizational framework for responding to natural hazard-induced disasters. Functions and responsibilities of government departments and other bodies in the event of such disasters—including those resulting from severe weather conditions—are also set out (HKSARG Security Bureau 2015). Tropical cyclones, rainstorms, flooding, and other natural hazards are identified, and disaster management comprises rescue, recovery, and restoration. The CPND exerted considerable effort in authority organization and interdepartmental coordination (Chan et al. 2015). But this plan considered neither the demographic characteristics and socioeconomic status of urban dwellers, nor spatial inequality to access DRR and medical resources. Equally neglected was consideration of the different capabilities in risk communication and response of the elderly or citizens with disabilities.

Although there has been considerable agency-based DRR in Hong Kong, a rapidly ageing population adds significant vulnerability factors to the current contingency preparedness and response system. The elderly in urban settings are vulnerable in various ways. They may suffer from "mobility, cognitive, sensory, social, and economic limitations that can impede their adaptability and ability to function during disasters" (Hoffman 2009, p. 1501). The elderly often comprise a large percentage of the death toll from extreme weather events (Chau et al. 2008, 2009, 2012; Woo 2013). According to the literature, an elderly person living alone may not be the only indicator to identify the population at risk: it is important to "distinguish, among those older persons who live alone (and not exclude those who do not), how many are vulnerable due to social isolation, poverty, disabilities, lack of access to primary care, linguistic isolation, or inadequate housing, e.g., living in walk-up apartments without elevators" (Gusmano and Rodwin 2006, p. 3).

In 20 years, one-third of the population of Hong Kong will be aged 65 or above. This rapid demographic change poses immense challenges for sustainable urban development and public health (Woo 2013). The elderly may experience difficulty achieving a good quality of life due to encroachment on their life spaces by high density buildings and environmental degradation (Sun et al. 2017). Moreover, the percentage of persons aged 65 and above, who belong to one-person domestic households, accounted for 14.8% of all households in 2014 (HKCSS 2016). The elderly tend to stay socially segregated. One in three elderly residents in Hong Kong is living in poverty (HKSARG Census and Statistics Department 2015), and Hong Kong's world ranking for psychological well-being for the elderly is low (CUHK Jockey Club Institute of Ageing 2017). We conclude that current disaster preparedness in Hong Kong is neither place-responsive, nor is it responsive to a growing ageing population.

4 Social Vulnerability Index (SVI) for the Elders

Given that the CPA process has yet to be put into practice in Hong Kong, risk information at the community level remains a vacuum. It is important to develop an alternative

means whereby geographically differentiated risk factors and vulnerability can be reported and used for the government's contingency planning at district level. A preintervention assessment suggested that community dwellers exhibited a very passive attitude toward their own capacity to cope with stressors. During mid-July to August 2016, community dwellers aged 65 and above who live in or close to Lek Yuen Estates were approached in a nearby public space. A total of 20 semistructured interviews were conducted with the participants aged 65 and above. They were asked to rate, based on a five-point Likert scale (from strongly disagree to strongly agree), nine statements on disaster preparedness and response. The questionnaire was developed based on the scale presented by Tuladhar et al. (2015) to explore disaster-related knowledge and disaster preparedness and readiness. The results show that the participants we approached tend to believe government can provide everything necessary when disaster happens. Also, most interviewees were confident about reconstruction activities from government after disasters. This is in line with a previous study, which confirms that the possibility of future disasters is overlooked and the disaster literacy of the general population is quite low (Chan et al. 2016). There is a gap between current government practices and the expectation of the public in disaster preparedness.

Compound indicators may provide a comprehensive and reliable description of the differentiation of vulnerability across the territory. An elderly-based SVI is particularly useful in Hong Kong given the rapid ageing of the city's population. A SVI for elders would test whether assertions that areas where substantial impacts of natural disasters and health-related emergencies tend to aggregate are characterized by a high percentage of older population, often with a relatively lower coping competence (Baker and Cormier 2014). This association occurs because older people are more likely to suffer from physical disability, sensory loss, and a relatively slow reaction time to the need for contingency response.

The SVI for elders developed in this study is an instrument based on a retrievable data set, and is used to assess disaster vulnerability with the premise that the elderly, particularly those with low socioeconomic status, who often live alone or are institutionalized, need significant and specific attention in disaster preparedness and heightened efforts to promote disaster literacy. A deductive approach was used to generate a set of variables from theoretical and empirical studies. Although SVI was initially proposed for western world cities (Gusmano et al. 2006), local adaptations to the Hong Kong population were proposed that created a SVI applicable in the Hong Kong context. For example, a new domain was added to address the high elderly institutionalization rate in Hong Kong. A linguistic isolation domain was replaced by education level to address the fact that the absolute majority of the Hong Kong population are Chinese. The seven selected variables, featured by high percentage of older population, are likely to reflect the adverse impacts of natural disasters and health-related emergencies to the corresponding populations (Table 1).

The basic geographic unit of the study was set at the District Council Constituency Areas (CAs) level to ensure homogeneity of the unit sample. The territory of Hong Kong is divided into 18 district councils, which are further divided into CAs. The number and shape of CAs are reviewed before the district council elections and there are 431 CAs as of 2016. Each CA contains a similar population size and is represented by a directly elected councilor who sits in the district council. The selected councilor is responsible for advising the government on matters (including services and facilities provision) related to the area each councilor represents. The population composition is quite homogeneous (mainly in terms of socioeconomic status) within a CA, and a CA-based SVI can provide councilors with a reference on the vulnerability level of their respective areas. Hong Kong is a place where reliable official statistics are available in CA breakdown for most components in the SVI for elders. This makes the SVI particularly useful since there is a regular source of data for updating the index. To tally with the 2011 census data breakdown, the boundary of CAs in this study is based on the 2011 district council election CA boundaries.

The CA-level statistics on the sociodemographic characteristics (for example, size of the elderly population, institutionalization, living alone, poverty, and communication obstacle) of the population aged $\geq$75 were obtained from the 2011 Hong Kong Population Census (HKSARG Census and Statistics Department 2013). As of December 2011, the disability statistics for the population aged $\geq$75 were obtained through special tabulation from the Central Registry for Rehabilitation under the Labour and Welfare Bureau (HKSARG Central Registry for Rehabilitation 2012). Access to primary care was measured using the avoidable hospital conditions (AHCs); the AHC rates in 2009 were calculated for the general population aged $\geq$15 based on the hospital discharge data from the Hong Kong Hospital Authority (Chau et al. 2013). Given that only district-level statistics of disability and access to primary care were available, we assume that CAs within the same district have the same values on the respective items.

For each CA, the data collected for every variable were ranked by deciles (from 1 to 10, the smallest to the largest). A mean score across 7 variables (with equal weight) is used to represent the SVI score, the value of which ranges from 1 to 10. High scores indicate the substantial vulnerability of a CA. A map was produced by geographic information system (GIS) to visualize the SVI distribution across the territory by

Table 1 Summary of variables for SVI for Hong Kong elders. *Source* Adapted from Gusmano et al. (2006)

Variable	Rationale	Data descriptions
1. Older population size	The degree of frailty increases with age, thereby leading to physical and cognitive decline and limited competence [that is, physical and mental health, intellectual capacity or ego strength (Lawton 1977)]. The absolute number reflects the actual number of people who need support	Number of people aged ≥75
2. Institutionalization	Hospital patients and institutional care residents are extremely vulnerable and constitute a large segment of death toll during disaster	Percentage of institutionalized older population aged ≥75[a]
3. Living alone	Living alone is prone to damaging psychological well-being. This slows evacuation and rescue under emergency scenarios	Percentage of community dwelling older population aged ≥75 living alone
4. Poverty	Poverty is associated with low socioeconomic status, which will limit older people's capability to obtain resources and maintain well-being	Proportion of community dwelling older population aged ≥75 living in poverty[b]
5. Communication obstacles	Communication is essential in community capacity building, which is also important under contingency situations. Communication obstacles are commonly associated with lower education attainment	Proportion of community dwelling older population aged ≥75 who had education level less than lower secondary (Grade 9)
6. Disability	Disability develops in the advanced stage of frailty. It is often related to physical, cognitive, and sensory impairment as well as difficulties in speech and hearing. It is the direct indicator of vulnerability	Proportion of community dwelling older population aged ≥75 with disability
7. Access to primary care	An easier access to primary care system has a direct bearing on disease prevention and treatment. Conversation with medical practitioners enhances disaster literacy and health literacy, preventing the complications of chronic diseases	Rate of avoidable hospital condition per 1000 people aged ≥15[c]

[a] Statistically, institutionalized older population is calculated as the total older population minus domestic older population

[b] Local adaptation of the 2005 US Department of HHS Poverty Guidelines was used to adjust the dollar value by a purchasing power parity of five

[c] AHC rates were adjusted using the WHO's age standardization method (Ahmad et al. 2001). It is a proxy of the provision of primary care services. Therefore, we do not restrict the age to the elderly

using ArcMap version 9.2 (ESRI 2006). To aid the presentation, the SVI values of all CAs in Hong Kong were categorized into four SVI clusters using the Jenks natural break algorithm. The number of clusters was determined by the Hierarchical Agglomerative Clustering (HAC) using Ward's linkage method. In the absence of outlying SVI values, this method grouped the SVI values of all CAs into four clusters (this is confirmed by dendrogram) in which the total within-cluster variance was minimized while the significance of differences between clusters was maximized (Ward 1963; De Smith et al. 2009).

Figure 2 shows the SVI across the CAs of Hong Kong in 2011. The most vulnerable CAs were Fortune (SVI = 8.71), as well as Shek Kip Mei and Nam Cheong East (SVI = 8.57) in Sham Shui Po. By contrast, the least vulnerable CAs were Wan Po (SVI = 1.43) in Sai Kung and Discovery Bay (SVI = 1.71) in Islands.

Although a SVI at the CA level can be used in practice, the summary statistics of SVIs developed at the district level are also provided in this article in order to illustrate how the SVI varies across the 18 council districts. The district expression of SVI provides useful data with which to inform the making of district based plans and to propose district/community-specific planning and design guidelines. If a district contains many areas with high vulnerability, the district will have a higher mean SVI, and more resources should be allocated to the district. Resource distribution within the district at the CA level can also take the SVI data into account. One-way ANOVA was used to compare the difference in SVI across the districts. SPSS version 23 (IBM Corp 2015) was used.

Table 2 summarizes the SVI statistics within each district of Hong Kong in 2011. On average, Sai Kung (mean = 3.70, SD ± 1.01), Islands (mean = 3.81, SD ± 1.53), and Sha Tin (mean = 3.86, SD ± 1.08) had the lowest SVI. By contrast, Sham Shui Po (mean = 6.90, SD ± 1.46), Wong Tai Sin (mean = 6.83, SD ± 0.98), and Southern (mean = 6.44, SD ± 1.30) districts had the highest SVI. The mean SVIs of CAs were significantly different across the 18 districts using ANOVA ($p < 0.001$).

Overall, districts with the highest SVI scores are located in the New Territories, namely, North, Yuen Long, and

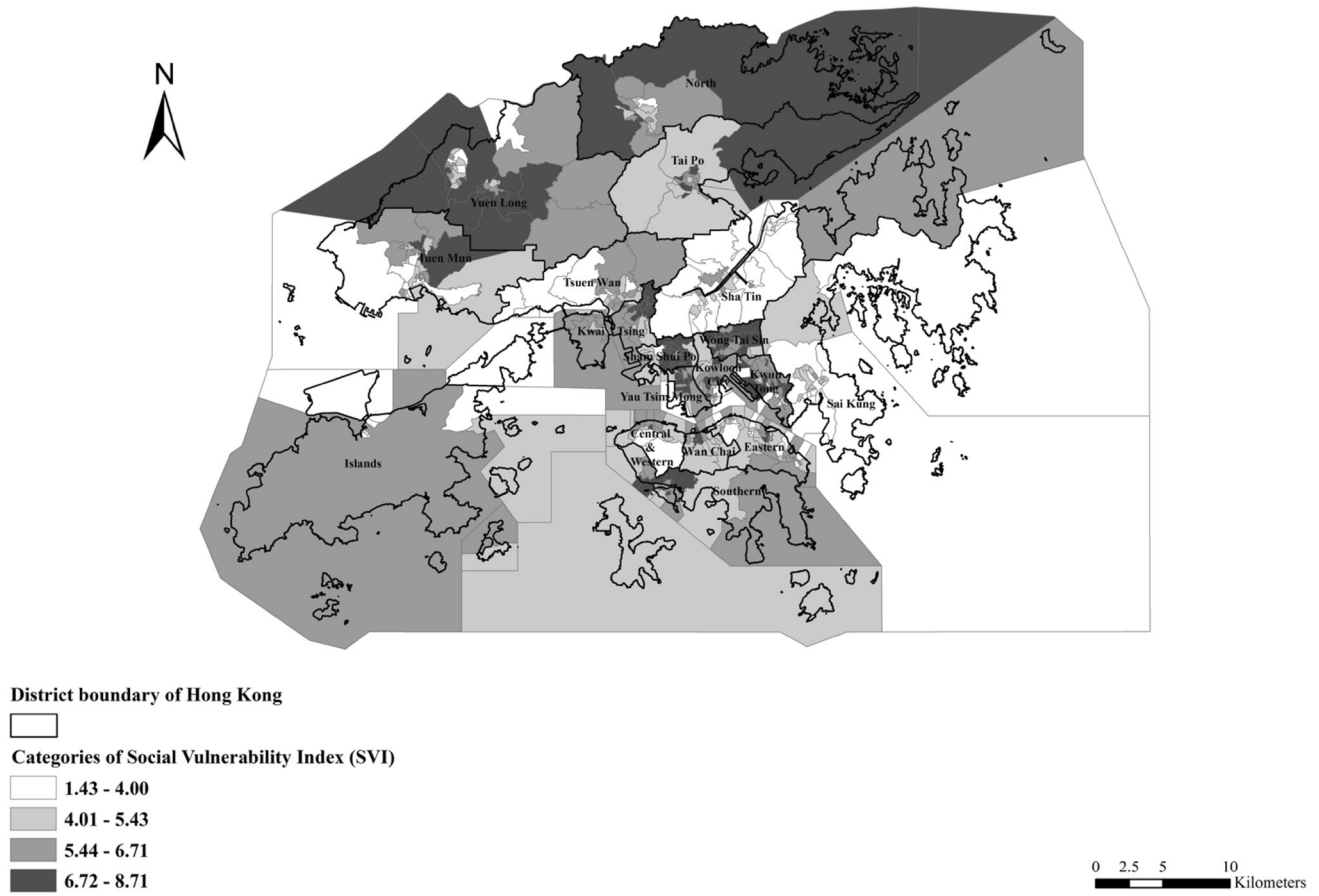

Fig. 2 SVI for elders across constituency areas of Hong Kong, 2011

Tuen Mun. The New Territories are home to indigenous villagers and comprise a large segment of woodlands and non-government owned lands used as village-type development. This condition results in distinct rural landscapes that are different from Hong Kong's urban areas. In the case of Yuen Long, live-alone elderly, poverty, and access to primary healthcare services generally produce high SVI scores compared with other domains. A few CAs feature a high percentage of institutionalized elderly. In the north district, six factors (excluding disability) are relevant to high SVI outcomes. In Tuen Mun, the size of the elderly population, number of institutionalized elderly, and obstacles to communication constitute key factors that make for CAs with greater social vulnerability. In urban areas (Hong Kong Island and Kowloon), CAs with high SVI scores are dispersed in Sham Shui Po, Wong Tai Sin, and Kwai Tsing. Sham Shui Po and Wong Tai Sin have a large percentage of elderly residents. Poverty remains a significant factor in Sham Shui Po. Moreover, Sham Shui Po also has been home to poor new immigrants from mainland China, and is also the site of the first public housing projects that aimed to resettle homeless victims who were displaced by the 1953 fire in the Shek Kip Mei slums. The high SVI scores are from all seven domains. In Wong Tai Sin, the presence of a large segment of residents who are elderly, often afflicted with a disability, and frequently encounter obstacles to communication are the three factors that differentiate high SVI CAs from others. In Kwai Tsing, access to primary care remains critical, compounded by a relatively large ageing population and obstacles to communication. Area-based intervention programs are significant given that urban areas comprise communities with different levels of vulnerability. The neighborhood should be carefully selected before community programs are launched.

By contrast, our analysis indicates that Sha Tin has limited vulnerability. It is a first-generation new town that adheres nearly entirely to the British planning principle that a balanced allocation of public and private housing units (leading to mixed social composition of community dwellers), as well as enough social and recreational facilities, green spaces, and secure pedestrian social space, is essential for people-friendly communities and self-sustained development (den Hartog 2010). Our analysis shows the low SVI score is particularly derived from an easier and better access to primary care, as well as a healthier group of elderly residents in terms of less disability and

Table 2 Summary statistics of the SVI for elders within each district in Hong Kong, 2011

District	Number of constituency area	Social Vulnerability Index (SVI) for elders					
		Mean	SD	Median	IQR	Min	Max
Central and Western	15	5.04	1.20	5.00	1.86	3.00	7.14
Wan Chai	11	5.45	1.02	5.14	1.86	4.43	7.14
Eastern	37	4.94	1.22	4.57	2.14	2.71	6.86
Southern	17	6.44	1.30	6.43	1.93	4.29	8.43
Sham Shui Po	21	6.90	1.46	7.29	2.71	4.00	8.71
Kowloon City	22	5.90	1.16	5.79	1.61	3.86	8.00
Wong Tai Sin	25	6.83	0.98	7.00	1.57	5.00	8.29
Kwun Tong	35	5.97	1.09	6.00	1.57	3.43	7.86
Yau Tsim Mong	17	6.25	1.09	6.57	1.43	3.29	7.57
Kwai Tsing	29	6.33	0.93	6.43	1.21	4.57	8.29
Tsuen Wan	17	4.81	1.43	5.14	2.50	2.43	6.71
Tuen Mun	29	5.17	1.31	5.43	2.36	2.71	7.57
Yuen Long	31	5.98	1.36	6.57	2.29	3.29	8.14
North	17	5.77	1.30	5.71	2.00	3.00	7.86
Tai Po	19	6.23	1.03	6.29	1.71	4.14	7.86
Sha Tin	36	3.86	1.08	3.79	1.50	2.00	6.43
Sai Kung	24	3.70	1.01	3.79	1.61	1.43	5.57
Islands	10	3.81	1.53	3.50	2.29	1.71	6.29

SD standard deviation, *IQR* interquartile range, *Min* minimum, *Max* maximum

institutionalization. We can deduce that town planning is successful as the district's ageing population does not pose a critical challenge to the area's level of social vulnerability. This calculation also reflects the fact that a good economic profile may not be necessarily linked with a low SVI ranking. For example, communities in the southern district reflect a high-level SVI score. But poverty plays a minimal role in the high SVI areas in the southern district.

A major strength of SVI is its use of official statistics, which are the most reliable data sources. The shortcoming of relying on official data is that the official statistics are not available every year, and frequent update of SVI may not be supported. The current SVI has the limitation of unavailable disability statistics and AHC rates at the CA level. At any given time, the SVI may not reflect all the variations in vulnerability in CA level. In future, available statistics with a breakdown at CA level should be explored to improve the SVI.

5 Conclusion

This study addresses DRR by developing a pragmatic framework at the community level as well as the SVI for elders in response to the emergence of a rapidly ageing population and the reality that older people are mentally, physically, and socially vulnerable to a variety of hazards and public health emergencies. DRR is reformulated to be place- and age-responsive. The articulation of place-responsive DRR highlights the importance of gaining local knowledge to identify vulnerability and risk factors at the community level, as well as generate place-specific risk reduction measures. CPA is an essential instrument that facilitates ground-level assessment of the built and social environments as well as initiates collaborative problem solving for the best DRR outcomes. Particularly, a place-responsive DRR creates the supportive knowledge and motivation to reduce vulnerability and improve well-being. It empowers citizens to use disaster literacy to reduce community vulnerability and respond positively to risk. By facilitating dialogue and collective learning, our CPA framework increases citizen competence to cope with environmental, social, and economic stressors.

We use this conceptual framework to reexamine the current disaster preparedness and contingency plans in Hong Kong. We conclude that current disaster preparedness in Hong Kong is neither place-responsive, nor sufficiently attentive to the special needs of an ageing population that should be considered as a particularly vulnerable social group. Potential vulnerability is often dismissed by the general public, which tends to develop a very firm, positive opinion on government capability in rescue and restoration. This creates a gap between current government-led disaster preparedness and the expectations of the public. For Hong Kong, the current conventional contingency plan, which perceives the community as a

passive recipient of top-down intervention policies, should be modified. Although social capital is a significant resource with which individuals and their families to earn a living, partake in culture, and benefit from social relationships (Bernard et al. 2007), this powerful resource is largely untapped in Hong Kong's DRR planning. Social capital is a missing link in disaster response, but it can be effective in connecting different stakeholders for integrated and timely action (Nakagawa and Shaw 2004).

Given a rapidly ageing population, the age-responsive lens (a SVI for elders) not only enriches our conceptualization of DRR but also develops a humane approach. This targeted perspective takes into account an older population—particularly those individuals with a lower socioeconomic status, socially isolated activity pattern, and limited access to primary care services. The district based vulnerability scores will inform the government's contingency plan at the smaller geographic units. The most vulnerable areas across the 18 districts of Hong Kong are either located in the New Territories or dispersed in old urban downtowns. Our study also presents a more comprehensive understanding of vulnerability because conventional measures of socioeconomic status—average income—may be an ineffective indicator of risk exposure. Both strengths and weaknesses of contemporary DRR planning are revealed using SVI as a measurement for vulnerability. The flexible modification strategy of the SVI tool enables its application to different urban settings. Use of official statistics (mainly census data) permits regular update and follow-up. But the lack of statistics on small geographic units (for example, block level data on disability and access to primary care) limits an accurate description of social vulnerability at the CA level. Further research should focus on the relationship between the level of social vulnerability and the extent of biophysical risk because vulnerability is a compound of both factors (Cutter et al. 2003). The integration of the physical and social dimensions of vulnerability will facilitate the application of effective DRR measures to different scales.

Our study has several policy implications. First, the effort to achieve a place- and age-responsive DRR is not self-insulated but rather is closely related to other policy initiatives on social inclusion and urban sustainability. Our DRR approach is particularly significant for the New Urban Agenda (UN-HABITAT 2016), which calls for humane and sustainable urbanism with no one left behind. The proposed two policy instruments are not oriented toward managing hazard events but the deeply rooted social causes for unequal access to health-related resources or exposure to environmental and social risks. In particular, CPA aims to repair the technocratic means of decision making by championing the collective ownership of knowledge and collaborative problem solving. By focusing on rapid demographic aging, the SVI offers evidence-based recommendations that improve the current contingency plan and risk preparedness. This situation is particularly beneficial given that population ageing is a critical issue in Hong Kong. Reference to disaster preparedness in building up age-friendly communities will be extremely useful for the city's long-term resilience and sustainability.

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