Integrated flood hazard assessment based on spatial ordered weighted averaging method considering spatial heterogeneity of risk preference

Yangfan Xiao *, Shanzhen Yi, Zhongqian Tang
College of Hydropower and Information Engineering, Huazhong University of Science and Technology, NO. 1037, Luoyu Road, Wuhan 430074, China

HIGHLIGHTS
• An integration framework for flood hazard assessment is developed.
• The indicators regarding different characteristics of the watershed are selected.
• Fuzzy AHP method is applied to evaluate the relative weight of criteria.
• Spatial OWA model considering spatial heterogeneity of risk preference is developed.
• Flood hazard map is created and sensitivity of criteria weights is analyzed.

ABSTRACT
Flood is the most common natural hazard in the world and has caused serious loss of life and property. Assessment of flood prone areas is of great importance for watershed management and reduction of potential loss of life and property. In this study, a framework of multi-criteria analysis (MCA) incorporating geographic information system (GIS), fuzzy analytic hierarchy process (AHP) and spatial ordered weighted averaging (OWA) method was developed for flood hazard assessment. The factors associated with geographical, hydrological and flood-resistant characteristics of the basin were selected as evaluation criteria. The relative importance of the criteria was estimated through fuzzy AHP method. The OWA method was utilized to analyze the effects of different risk attitudes of the decision maker on the assessment result. The spatial ordered weighted averaging method with spatially variable risk preference was implemented in the GIS environment to integrate the criteria. The advantage of the proposed method is that it has considered spatial heterogeneity in assigning risk preference in the decision-making process. The presented methodology has been applied to the area including Hanyang, Caidian and Hannan of Wuhan, China, where flood events occur frequently. The outcome of flood hazard distribution presents a tendency of high risk towards populated and developed areas, especially the northeast part of Hanyang city, which has suffered frequent floods in history. The result indicates where the enhancement projects should be carried out first under the condition of limited resources. Finally, sensitivity of the criteria weights was analyzed to measure the stability of results with respect to the variation of the criteria weights. The flood hazard assessment method presented in this paper is adaptable for hazard assessment of a similar basin, which is of great significance to establish counterplan to mitigate life and property losses.

© 2017 Elsevier B.V. All rights reserved.

Keywords:
Flood hazard
Multi-criteria analysis
GIS
Fuzzy AHP
Spatial OWA
Spatially variable risk preference

* Corresponding author.
E-mail addresses: yf.xiao@hust.edu.cn (Y. Xiao), yisz@mail.hust.edu.cn (S. Yi), tangzhongqian@hust.edu.cn (Z. Tang).

http://dx.doi.org/10.1016/j.scitotenv.2017.04.218
0048-9697/© 2017 Elsevier B.V. All rights reserved.
1. Introduction

A large number of flood events around the world lead to thousands of deaths and tremendous losses of social economy. Recently, a study of 616 cities around the world indicated that floods endanger more cities than any other natural hazard, followed by earthquakes and storms (Lukas et al., 2014). Moreover, the prediction of future climate change and urban area expansion tendency indicates that flood risk will be aggravated in many regions (Muis et al., 2015). China is a country which has suffered a lot from flooding. According to statistical review, China ranks first in terms of the economic loss and the affected population caused by flooding in the world (Debarati et al., 2015). Therefore, the development of flood management strategies is urgently necessary.

Generally, flood management mitigation strategies and planning are based on the estimation of the flood hazard in terms of its location, magnitude and distribution. Flood hazard and risk analysis is usually performed using hydrologic and hydraulic model which can simulate flood inundation extent, water depth and velocity through one-dimensional (1D) or two-dimensional (2D) hydraulic model (Mazzoleni et al., 2014), such as 1D Saint Venant model for flood routing of the rivers and TELEMAC 2D for modelling of region (Japan). In a recent work (Kazakis et al., 2015), the flood management mitigation strategies and planning are respectively the biggest river in China and the biggest tributary of the Yangtze River and the Han River, which are respectively the biggest river in China and the biggest tributary of the Yangtze River.

The study area is located in the lower Han River region, as presented in Fig. 1a, which is a part of Wuhan, Hubei Province, China, spanning 113°41′6″-114°17′5″E and 30°11′7″-30°41′6″N. The watershed area is about 1268 km², and its elevation ranges from 16 to 244 m. The study area is wedged between the Yangtze River and the Han River, which are respectively the biggest river in China and the biggest tributary of the Yangtze River.

The climate characteristic of the study area is subtropical humid monsoon with dry winter and humid summer, which makes precipitation relatively concentrated in summer. As shown in Fig. 1b, the large monthly precipitation is mainly concentrated between April and August, and maximum monthly precipitation exceeds 250 mm in four of the nine years. Its mean annual precipitation is about 1170 mm, about 63% of which occurs in summer. Moreover, precipitation records have shown that the intensity of heavy rain can exceed 50 mm/24 h, with certain very heavy rain even exceeding 100 mm/24 h (Ding and Zhang, 2009).

During the past decades, the study area has been attacked by floods several times. The floods caused by intense rainfall, which occurred in May 2007, May 2008, July 2013, July 2015 and July 2016 were the most destructive disaster events on historical record. In each flood event...
دریافت فوری متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات