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REVIEW ARTICLE

EXPOSURE ASSESSMENT OF RAINSTORM WATERLOGGING IN URBAN COMMUNITIES: A CASE ON JINSHA COMMUNITY, SHANGHAI OF CHINA

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ABSTRACT

In this paper, with a case on Jinsha Community in Putuo District in Shanghai, 32 rainstorm water logging disaster risk scenarios were simulated and analyzed using PGIS and scenario analysis methods. The exposure analysis results showed that: (1) under various scenarios, the exposed families were mainly concentrated in the central region of the study area; (2) under the same drainage scenario, the number of exposed families increased with the increase of storm return period; (3) the number of exposed buildings decreased with the displacement increasing, but the degree of decreasing was in inverse trend with the return period.

INTRODUCTION

In recent years, foreign scholars had done a thorough study in community-based disaster risk theory, assessment methods and application of the results. But in China, the research in this area was just at the beginning. Although it had yielded some findings (**Jie *et al.,* 2009; Jiahong *et al.,* 2012**), there still lied some problems such as ignoring local knowledge and residents participation, difficulties in data collection and sharing, lack of dynamic simulation of risk etc, which made research findings difficult to provide a solid foundation for urban disaster risk management decisions.

Exposure is the interaction result of hazards and bearing bodies, and reflects the value and number of bearing bodies exposed to disaster risk. The purpose of exposure assessment is to determine the values and numbers of the population, property, and resources exposed to disaster risk, is the important step of risk assessment. Therefore, taking Jinsha Community of Putuo District of Shanghai of China (**Introduction of study area see Zhenguo *et al.,* 2014**) as an example, the exposure of study area was analyzed with PGIS (Participatory Geographic Information System, PGIS) and scenario analysis method in different water logging scenarios, which provided the basis for risk assessment and management of the urban community-scale disasters.

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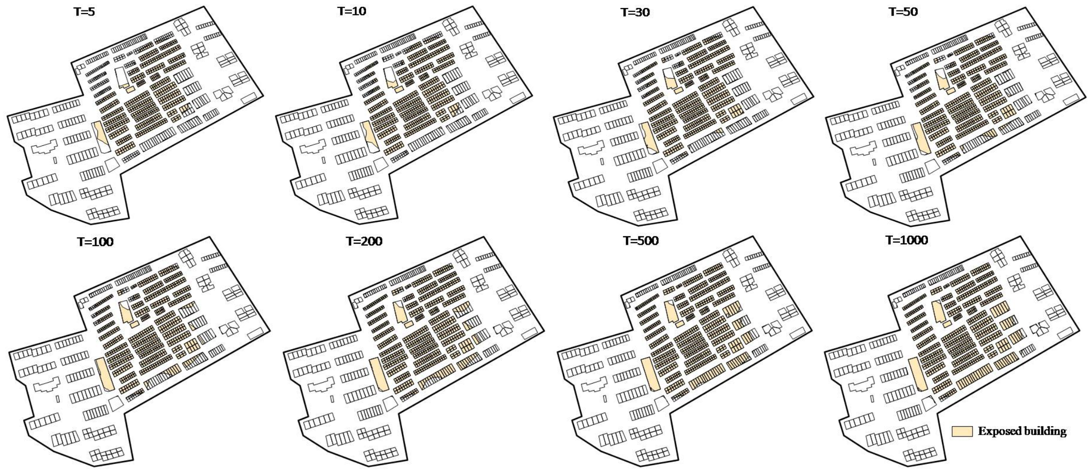
Methodology and Data Sources

Methodology

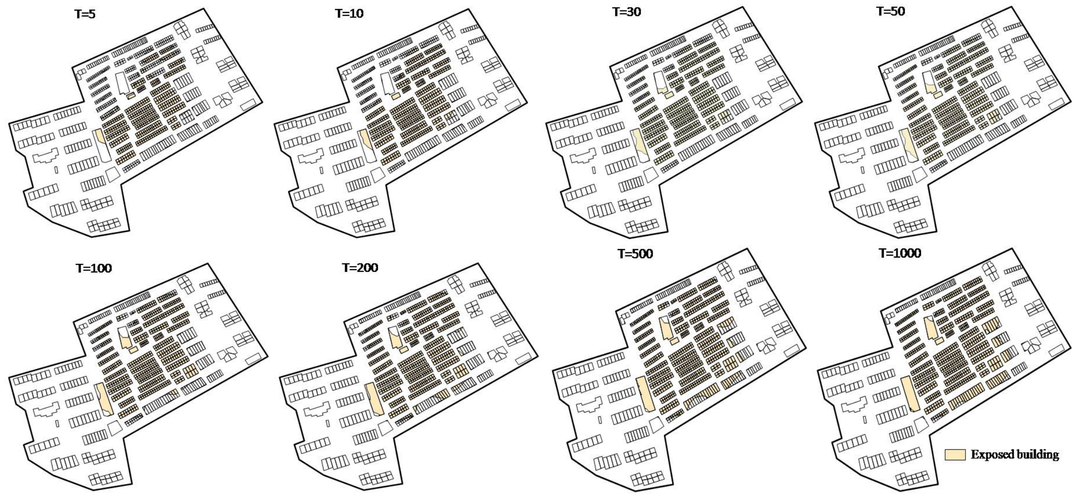
The purpose of exposure analysis was to determine the elements of the population, property and economic resources under the impact of disasters which was an important step in the risk assessment. On the basis of the data of topography, construction and residents risk perception collection by using PGIS, the research considered the natural and artificial factors of waterlogging in study area, set 32 rainstorm waterlogging scenarios which were combined by 4 drainage conditions (0mm / h, 18mm / h, 36mm / h and 50mm / h) and 8 return period (5a, 10a, 30a, 50a, 100a, 200a, 500a and 1000a).

First, the 32 waterlogging scenarios were simulated by using scenario analysis method and urban community waterlogging model (**Zhenguo *et al.,* 2014**). Then, 977 families on the first floor in study area were analyzed.

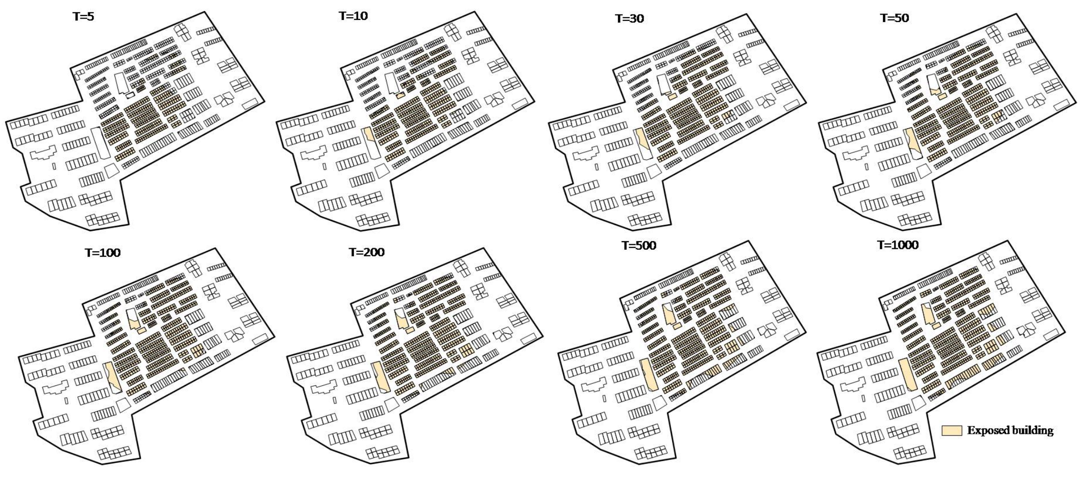
The households were exposed when the submerged value was greater than 0 which could be calculated by water level elevation of the raster maps subtracted by flooded houses elevation from the ground (Fig 1 and 2).



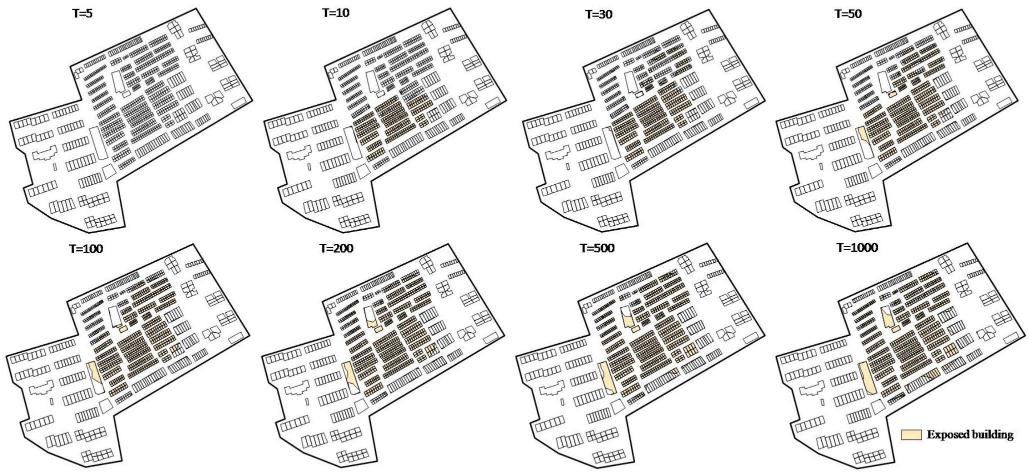
(a) The results under the condition of 0mm/h



(b) The results under the condition of 18mm/h



(c) The results under the condition of 36mm/h



(d) The results under the condition of 50mm/h

Fig.1. The spatial distribution map of exposed buildings under four drainage scenarios

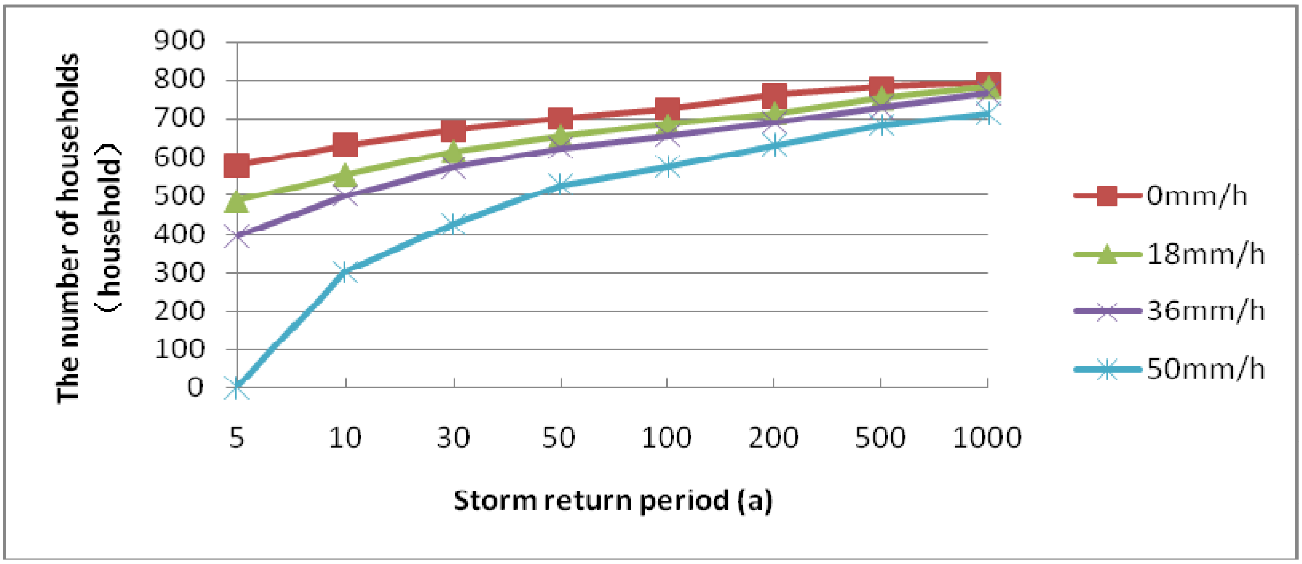


Fig.2. The numbers of exposed buildings of different rainstorm return period under four drainage scenarios

Data Sources

Topographic Data

The relative elevations of the study area were measured using standard gauge. The data was collected a little more in the area of building-intensive and the area easy to water, while relatively less in the area of building-sparse and the area no or less affected by the water. All were collected from 117 elevation points.

Building Distributed Data

Using 5m resolution aerial photographs of the study area in 2009 and combined with field research, residential spatial distribution map of the study area was obtained through human - computer interaction interpretation. Building structure, functional properties and housing ground clearance were obtained from the field survey.

Rainfall data

Considering that the scope of the study area was small, assuming that spatial distribution of precipitation in the region was uniform, supposed the storm for an hour, rainfall, runoff and water volume under the four drainage conditions and eight return periods were calculated using urban community water logging model (**Zhenguo *et al.*, 2014**).

Exposure analyses

From Figure 3 and 5, it could be obtained: under different rainstorm water logging scenarios, the exposed households mainly showed the following three characteristics:

(1) Under various scenarios, the exposed families were mainly concentrated in the central region of the study area, which were brick structure and brick-concrete structure buildings, other families in the east and west of the study area were not exposed, which were steel structure buildings.
(2) Under the same drainage scenario, the number of exposed families increased with the increase of storm return period. Among them, it increased from 578 to 791 under 0mm / h drainage scenario, from 555 to 780 under18mm / h drainage scenario, from 394 to 767 under 36mm / h drainage scenario, from 0 to 715 and under 50mm / h drainage scenario.
(3) The number of exposed buildings decreased with the displacement increasing, but the decreased degree was in inverse trend with the return period. Of which, it decreased from 578 to 0 under 5a return period, from 619 to 304 under 10a return period, from 660 to 424 under 30a return period, from 687 to 543 under 50a return period, from 695 to 565 under 100a return period, from 701 to 585 under 200a return period, from 729 to 116 under 500a return period, and from 760 to 701 under 1000a return period.

DISCUSSION

The reasons of urban water logging were mainly low design criteria of drainage system, increasing proportion of impervious urban surface, increasing storm peak flow, widespread rain and sewage mixed drainage system, increasingly serious ground subsidence and lack of communication and cooperation between the relevant departments and professional etc, of which poor design criteria of drainage system was an important but not the only cause. To prevent and govern water logging only by improving the design standards needs huge investment and has implementation difficulties and not obvious effect (Wei *et al.,* 2012).

This research was only a preliminary study on the exposure analysis of waterlogging in urban communities under different drainage scenarios. And there were some other factors which were not considered including urban underling surface, storm peak flow, duration and management which all need to be completed in future studies so as to improve the evaluation precision and reflect more objectively urban community waterlogging disaster risk and variation.

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