Hazard Assessment of Rainstorm Waterlogging in Urban Communities Based on Scenario Simulation : A Case on Jinsha Community,Shanghai

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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 in 8 return periods (5a, 10a, 30a, 50a, 100a, 200a, 500a and 1000a) and 4 drainage conditions (0mm / h, 18mm / h, 36mm / h and 50 mm / h) are simulated,analyzed and evaluated using scenario analysis method. The results shows that: (1) rainstorm water logging hazard under different return periods and drainage conditions are mainly concentrated in Jinsha new village and Jiefang village which are all in the middle of research area. But the degree of risk and influence range are decreasing with displacement increasing and increasing with storm intensity increasing; (2) According to the rainstorm water logging hazard matrix, in these 32 water logging disaster scenarios at research area, the high-risk water logging disasters are 21 which account for 66%; the middle- risk water logging disasters are 9 which account for 28% and only 2 are the low-risk water logging disasters which account for 6%; (3) With the increasing of storm intensity, the high-risk acreage shows an increasing trend in all these 4 drainage conditions; the middle-risk acreage shows a continuously increasing tread except under the drainage condition of 0 mm / h with a continuously decreasing trend; and the low-risk acreage shows a continuously decreasing trend under the drainage conditions of 18mm/h and 36mm/h, a continuously increasing tread under the drainage conditions of 0mm/h, and a increasing firstly and then decreasing trend under the drainage condition of 50mm/h; (4) With the increasing of the displacement, the high-risk acreage shows a continuously decreasing trend in a variety of return periods, of which the return period of 200a is a turning point where the decreasing trend slow down; the middle-risk acreage shows both continuously decreasing trend and increasing firstly and then decreasing trend, of which the return period of 100a is a point where the trend turns from decreasing to increasing, and there is no significant change in trend of the low-risk acreage; (5) According to rainstorm water logging hazard curve, with the increasing of displacement, the occurring probability of the middle-risk water logging (over 15cm) is reducing from 100% to 6.8% , and the occurring probability of the high-risk water logging (over 30cm) is reducing from 26% to 0.8%.

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With global climate change and acceleration of urbanization process, waterlogging has become a frequent occurrence of the major natural disasters in many cities in China, especially in Shanghai which is located in low-lying coastal areas. Rapid urbanization and continued land subsidence exacerbate the risk of waterlogging disaster[1-4]. On August 7, 2012 affected by Typhoon "sea anemone" , nearly 400 road segments were flooded 10-30 cm, more than a thousand households were flooded 5-20 cm and 80,000 acres of farmland was inundated in Shanghai. Meanwhile, more than 500 flights in Pudong and Hongqiao Airports were canceled and about one hundred rails were closed down. All these had serious impact on the city's normal operation, production, residents life and city image. Urban waterlogging disasters has become the hot issues and arouse high concern of China's government, academics and public.

As the city's basic unit, community is the subject to bear disaster and risk and the basis to prevent and mitigate the disaster. Community-based disaster risk management is currently widely recognized as and is proven to be effective concepts and means of disaster management in the world. And risk assessment has become a hot topic of academic attention as a prerequisite and an important base for community-based disaster risk management[5-7]. 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 is just at the beginning. Although it has yielded some findings [8-9], there still lies some problems such as ignoring local knowledge and residents participation, difficulties in data collection and sharing, lack of dynamic simulation of risk etc, which make research findings difficult to provide a solid foundation for urban disaster risk management decisions.

As the first step in disaster risk assessment, risk assessment intended to simulate and analyze hazard characteristics to obtain the potential scope, intensity, duration and other risk data of the hazard. The reliability and accuracy have the direct impact on the scientific risk assessment [4,10].Therefore, this paper intends to take Jinsha Juwei Community, Putuo District as the study area, simulates and analyzes waterlogging risk with PGis and scenario analysis method, in order to provide the basis for risk assessment and management of the urban community-scale disasters.

I. Brief Introduction of the Study Area

Jinsha Juwei Community is located in Changfeng Street of Putuo District, Ningxia Road to the north, Bailan Road to the east, Shunyi Road to the south, Kailv Road to the west, Suzhou River tributaries to the Southwest, Jinshajiang Street Station of Shanghai Urban Rail transport No. 3 to the northwest and with a total area of about 110,000 square meters (Figure 1). the Conde apartment at the southwest side which is built in the 1990s is the multi-layer residential buildings of reinforced concrete structures, Baiyu Court at the northern side which is built in the early 21st century is high-rise residential buildings of reinforced concrete structures, Nan Linjia Gang and Zhonghua New Village at the northwest side which is built in 1950s are the old public house of brick-concrete structure, Sands New Village and Jeifang village which are built in the end of 19th century and the early 20th century are"Old City" of brick-wood structure (mainly one or two-story brick-wood tile houses), all which makes the region a basin morphology of "surround high and middle low" and the old houses in the middle are relatively low-lying state. Jinsha Juwei Community is small, but large population. There are currently 6,891 people in addition to a lot of mobile population and more concentrated in the central low-lying "Old City" which are affected by stormwater all the year around and become the hardest-hit area of waterlogging .
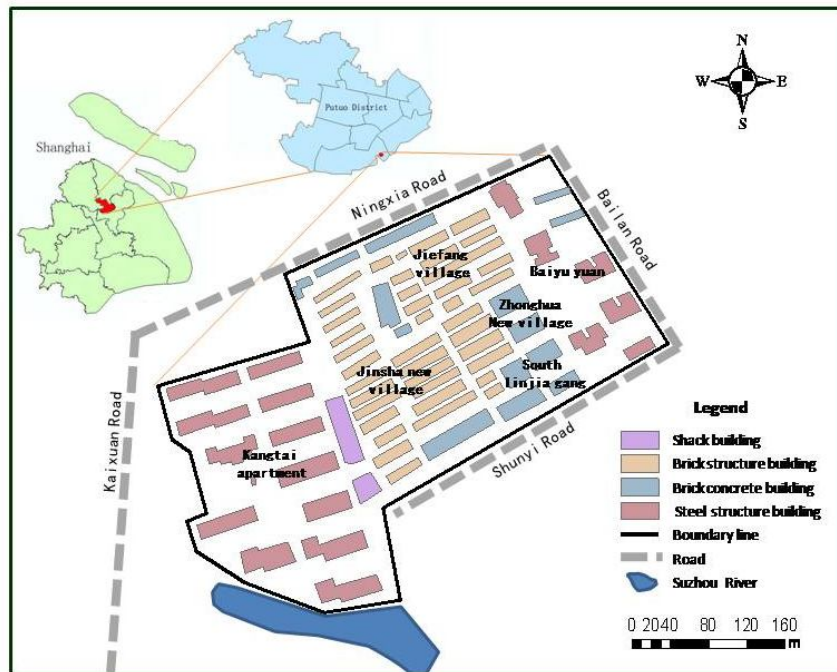
Fig.1 The location and distribution of building structures at study area

2. Methodology and Data Sources

2.1 Methodology

In the field of disaster research, scenario analysis method is commonly used to evaluate disaster risk and also a research focus at present which build a disaster scenarios model of the future according to genetic mechanism, based on historical disaster data and assuming that several key factors of disaster events are always likely to occur. The model can carry out scenario simulation of natural disasters in order to predict future disaster situations which greatly improve the accuracy of disaster risk assessment [15-16]. Therefore, considering natural and artificial factors of the waterlogging at study area, 32 rainstorm waterlogging disaster scenarios are set which are a combination of 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). The risk of these 32 waterlogging disaster scenarios is analyzed and assessed with use of scenario analysis method.

In the detail, it would be calculated of storm intensity, runoff and total water volume of catchment areas under different scenarios at study area with the use of urban community waterlogging model, and then based on Gis "Law of equal volume",with the use of "area and Volume" tool of 3D Analysis module in ArcGis9.3, it would be calculated of flooded area and maximum water depth of 1 hour rainfall of the catchment area under different return periods; next it could be graphed of waterlogging risk spatial distribution under various scenarios with the use of ArcGis mapping function. On this basis, according to waterlogging hazard level standards, the risk of waterlogging disasters for each scenario is graded and comparatively analyzed and evaluated.

(1) Urban Community waterlogging model

With the reference of existing urban waterlogging model and related research[11-14], Urban Community waterlogging model at study area is built with the integration of terrain model, rainfall model, runoff model, drainage model, mathematical model and Gis spatial analysis. Among them, the terrain model (DEM) is to carry out Universal Kriging spatial interpolation based on relative elevation data coming from field measurements with the use of Geostatistical Wizard Tool of Geo-statistical Analyst module of ArcGis9.3, meanwhile conduct depressions elimination pretreatment and amendments of building height above ground. The results is shown in Figure 2.

Rainfall model is to use the corrected Shanghai storm intensity formula:

$$q = 1995.84\left(p^{0.30} - 0.42\right)\bigg/\left(t + 10 + 7\lg p\right)^{0.82+0.071\lg p} \qquad (1)$$

p is storm return period; q is rainfall intensity (mm / h) and t is rainfall duration. Runoff model is to use the corrected SCS model from U.S. Soil Conservation Service which is:

$$Q = \left(p - \frac{1270}{98 - 0.24x} + 12.7\right)^2 \bigg/ \left(p + \frac{24130}{98 - 0.24x} - 241.3\right) \qquad (2)$$

Q is runoff volume (mm); P is rainfall volume (mm) and x is permeable area ratio (%).
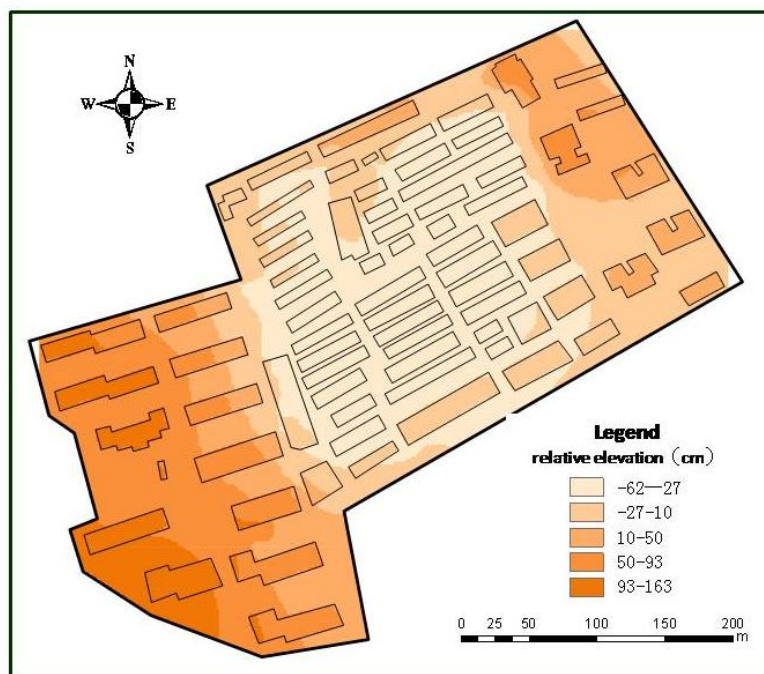
Fig.2 Relative elevation interpolation maps of the study area

In the runoff process, the drainage capacity need to be considered. And It's necessary to take the effect range of underground drainage pipe network to ground drainage into account in order to get access to the actual drainage capacity at study area[13-14]. In the case of unable to get the data of drainage network, considering the scope of the study area is small, it is assumed that spatial distribution of catchment drainage network is the same to drainage capacity. Then according to the actual situation and Shanghai drainage system planning, supposed that displacement volume at study area are four drainage conditions including 0mm／h, 18mm／h, 36mm／h and 50mm／h, the total water volume can be got through the difference between runoff and displacement multiplied by the acreage of study area which is calculated as:

$$W = (Q-V) \times S \qquad\qquad (3)$$

Here, W represents the total water volume；Q represents runoff volume; V represents displacement volume and S represents catchment acreage.
(2) Risk Level Evaluation Criteria

Waterlogging risk assessment aims to let city managers and local residents understand the degree of danger of waterlogging and variation feature on the overall. In the field survey, it is acknowledged that the depth of water has varying impact degrees on the population lives. Therefore, in order to facilitate evaluation and reflect directly the degree of hazard of waterlogging at study area, on the basis of considering the impact of different water depth on families , it is determined of evaluation criteria of risk of waterlogging (see Table 1).

Table 1 Evaluation Criteria of the Degree of Risk of Waterlogging

Degree	Water depth（cm）	Impact on families	danger
1	＜15	No effect on the production and living	low
2	15-30	Have damage on part walls, furniture	medium
3	＞30	Have Damage on part walls, furniture and appliances and seriously affecting transport	high

2.2 Data Sources

2.2.1 Topographic Data

The relative elevation of the study area are measured using standard gauge. The data are 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 are collected from 117 elevation points.

2.2.2 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 is obtained through Human - computer interaction interpretation. Building structure, functional properties and housing ground clearance are obtained from the field survey.

2.2.3 Rainfall Data

Considering the scope of the study area is small, assuming that spatial distribution of precipitation in the region is uniform, supposed the storm for an hour, rainfall, runoff and water volume under the four drainage conditions and eight return periods are calculated using the formula (1) - (3).Results are shown in table 2.

Table 2 The rainfall run off and ponding amount of different return periods of heavy rain

| Return period（a）	Rainfall volume （mm/h）	runoff （mm/h）	Total water volume （m³）			
			displacement0mm/h	displacement 18mm/h	displacement 36mm/h	displacement 50mm/h
5	57	44.38	4828.677	2870.223	1999.799	0
10	67	53.99	5874.274	3915.82	3045.396	869.336
30	81	67.58	7352.907	5394.453	4524.029	2347.969
50	91	77.36	8417	6458.546	5588.122	3412.062
100	101	87.17	9484.358	7525.904	6655.48	4479.42
200	113.5	99.47	10822.63	8864.18	7993.756	5817.696
500	129.6	115.38	12553.69	10595.24	9724.812	7548.752
1000	144	129.64	14105.22	12146.77	11276.34	9100.283

3. Waterlogging Risk Assessment

3.1 Waterlogging Simulation Results Analysis

Waterlogging water depth distribution diagram of a variety of scenarios could be generated through urban communities waterlogging model with ArcGis(see Figure 3). And meanwhile its storm water depth and acreage are counted and comparatively analyzed (Table 3). From Figure 3 and Table 3, it can be obtained: under different drainage conditions, storm water depth and water acreage have significant differences and mainly show the following three characteristics:
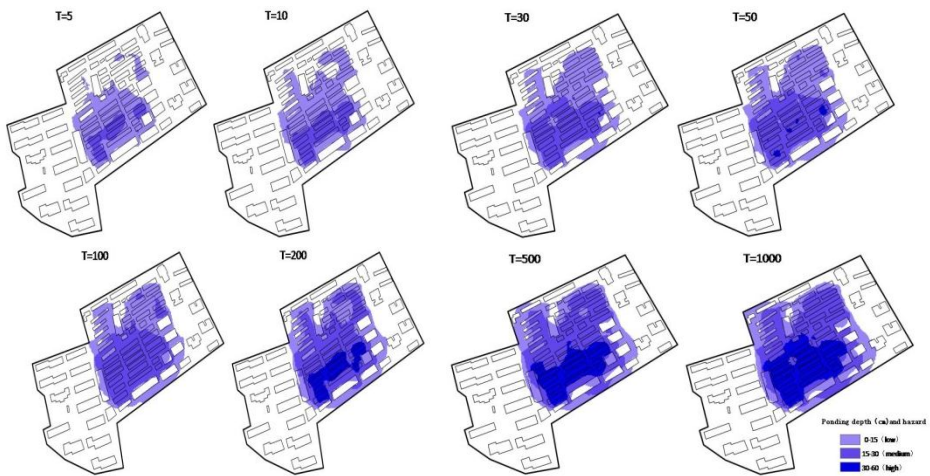
(1) Rainstorm waterlogging risk under four drainage conditions and the various return periods is mainly concentrated in "Old City" buildings of brick-wood structure in the middle of the study area. From Figure 3, it can be obtained that rainstorm waterlogging water are mainly concentrated in the central region of the Jin Sands New Village and Jeifang village that are both the "Old City" brick-wood buildings under four drainage conditions and 8 return periods .
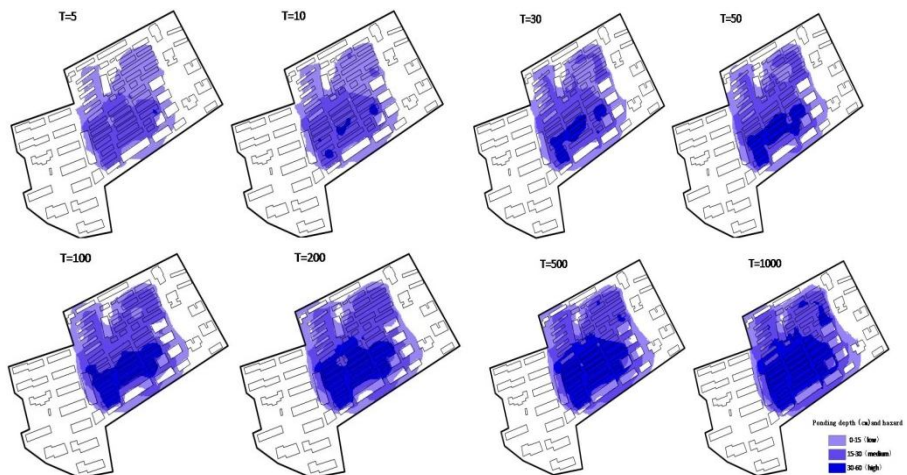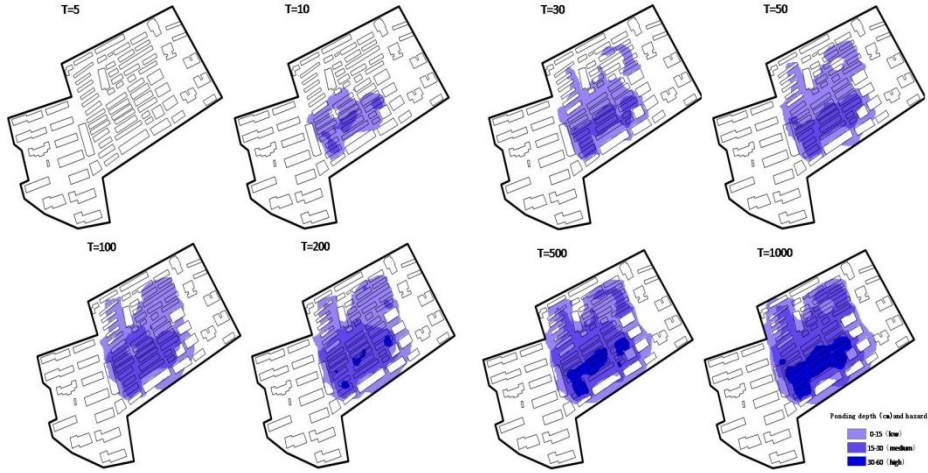

a the results under the condition of 0mm/h

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.3 The waterlogging dangerous space distribution of rainstorm under four drainage conditions and eight return periods

Table 3 rainstorm waterlogging data of rainstorm under four drainage conditions and eight return periods

Rainfall volume （mm/h）	Return Period （a）	The different levels waterlogging hazard area ratio （%）			waterlogging hazard area ratio （%）	Maximum water depth （m）
		低	中	高		
0	5	7.73	23.88	0	31.61	0.31
	10	8.07	24.58	1.73	34.38	0.34
	30	8.71	19.30	8.49	36.50	0.38
	50	8.50	16.07	14.63	39.20	0.40
	100	8.52	14.41	16.69	39.62	0.43
	200	9.48	11.63	21.62	42.73	0.45
	500	9.86	14.62	20.30	44.78	0.49
	1000	8.92	12.41	26.49	47.82	0.52
18	5	16.93	7.07	0	24.00	0.25
	10	17.24	11.00	0	28.24	0.29
	30	16.60	15.31	0.31	32.22	0.33
	50	16.30	15.80	2.52	34.62	0.36
	100	14.85	17.35	4.82	37.02	0.38
	200	12.88	18.87	8.02	39.77	0.41
	500	12.05	18.63	12.62	43.29	0.45
	1000	12.16	18.41	15.62	46.19	0.48
36	5	15.06	3.64	0	18.70	0.22
	10	17.13	7.72	0	24.85	0.26
	30	16.68	13.23	0	29.91	0.30
	50	16.45	15.58	0.58	32.61	0.33

	100	16.21	15.81	3.02	35.04	0.36
	200	14.12	17.84	6.02	37.98	0.39
	500	12.34	19.20	10.03	41.57	0.43
	1000	12.24	18.44	13.98	44.67	0.46
	5	0	0	0	0	0
	10	12.77	0	0	12.77	0.16
	30	15.98	4.92	0	20.90	0.23
	50	17.49	8.97	0	26.45	0.27
50	100	16.74	13.17	0	29.91	0.30
	200	16.41	15.68	1.07	33.16	0.34
	500	14.85	17.38	4.867	37.10	0.38
	1000	12.60	19.01	8.53	40.13	0.42

（2）With the increasing of return period, rainstorm waterlogging acreage and maximum depth have continued to increase under every drainage condition. From Table 3, under the drainage condition of 0mm／h , with the increasing of rainstorm return period, water acreage percentage increases from 31.61% in return period of 5a to 47.82% in return period of 1000a that is an increase of 16.21%; and the maximum water depth correspondingly increases from 0.31m to 0.52m that is an increase of 0.21m. Under the drainage condition of 18mm／h, with the increasing of return period, water acreage percentage increases from 24% in return period of 5a to 46.19% in return period of 1000a that is an increase of 22.19%; and the maximum water depth correspondingly increases from 0.25m to 0.48m that is an increase of 0.23m. Under the drainage condition of 36mm／h, with the increasing of rainstorm return period, water acreage percentage increases from 18.7% in return period of 5a to 44.67% in return period of 1000a that is an increase of 25.97%; and the maximum water depth correspondingly increases from 0.22m to 0.46m that is an increase of 0.23m.

Under the drainage condition of 50mm/h , with the increasing of rainstorm return period, water acreage percentage increases from 0% in return period of 5a to 40.13% in return period of 1000a that is an increase of 40.13%; and the maximum water depth correspondingly increases from 0 m to 0.42m that is an increase of 0.42m.

(3) As the displacement increases, rainstorm waterlogging maximum water depth and water acreage under every return period are reduced, but the reducing trend is lower with the increase of the rainstorm return period. In the detail, the return period of 200a is the turning point for which rainstorm maximum water depth reduces and \return period of 100 year is the turning point from which water acreage ratio reduced. From Table 3, with the drainage increasing from 0mm / h to 50mm / h, rainstorm maximum water depth of rainstorm in return period of 5a reduces from 0.31m to 0m, reducing 0.31m; that in return period of 10a reduces from 0.34m to 0.16m, reducing 0.18m; that in return period of 30a reduces from 0.38m to 0.23m, reducing 0.15m; that in return period of 50a reduces from 0.40m to 0.27m, reducing 0.13m; that in return period of 100a reduces from 0.43m to 0.30m, reducing 0.13m; that in return period of 200a reduces from 0.45m to 0.34m, reducing 0.11m; that in return period of 500a reduces from 0.49m to 0.38m, reducing 0.11m; and that in return period of 1000a reduces from 0.52m to 0.42m, reducing 0.10m.

With the drainage increasing from 0mm / h to 50mm / h, water acreage ratio of rainstorm in return period of 5a reduces from 31.61% to 0%, reducing 31.61%; that in return period of 10a reduces from 34.38% to 12.77%, reducing 21.61% ; that in return period of 30a reduces from 36.50% to 20.90% , reducing15.60%; that in return period of 50a reduces from 39.20% to 26.45%, reducing 12.75%; that in return period of 100a reduces from 39.62% to 29.91%, reducing 9.71%; that in return period of 200a reduces from 42.73% to 33.16%, reducing 9.57%; that in return period of 500a reduces from 44.78% to 37.10%, reducing 7.68%; and that in return period of 1000a reduces from 47.82% to 40.13%, reducing 7.69% .

3.2 Waterlogging Risk Degree Analysis

In order to analyze variation features of waterlogging risk degree at study area, according to perception of community residents on the level of waterlogging risk (Table 2), it will be divided into three levels of low risk (0-15cm), medium risk (15-30cm) and high risk (> 30cm) based on the water depth(Figure 3).

And the distribution area of different level of waterlogging disaster risk under different drainage conditions and return periods is counted using ArcGis software (Table 3, Figure4-5). On this basis, the variation characteristics of waterlogging risk levels under various scenarios are analyzed, as follows:
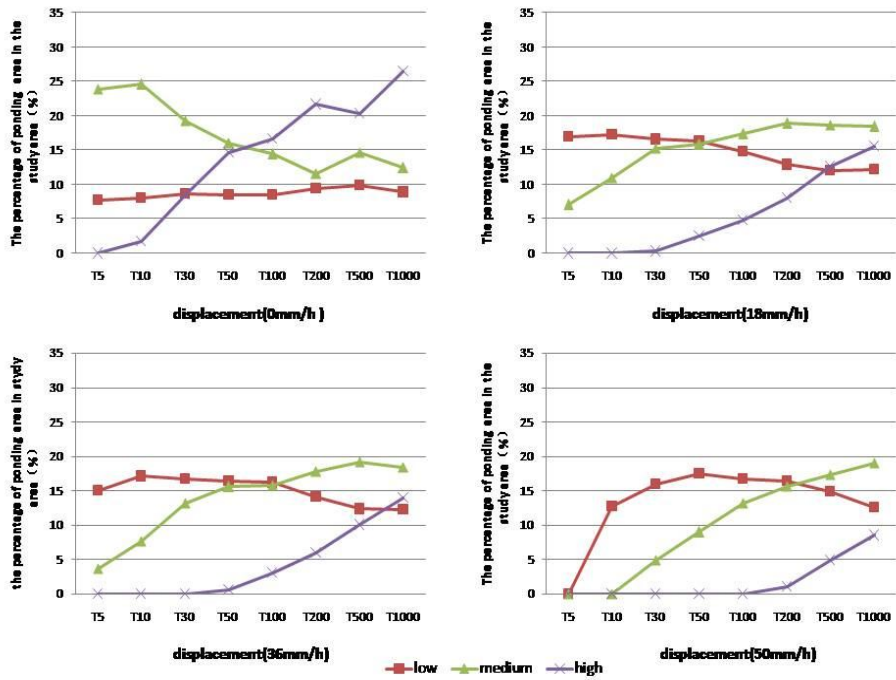

Fig.4 the different levels waterlogging hazard area ratio of different return period rainstorm under Four drainage scenarios
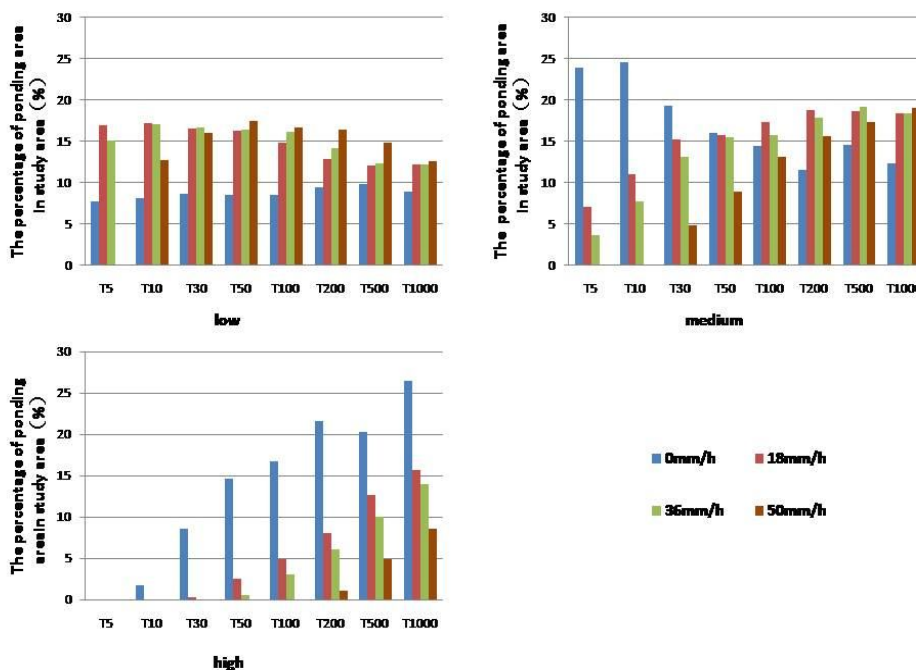
Figure 5 different levels hazard of waterlogging area ratio changes with displacement

(1) With the storm return period increases, the high-risk acreage shows increasing trend; the medium-risk acreage shows a continuously increasing trend but under 0mm / h drainage condition it is a continuously decreasing trend and the low-risk acreage shows a continuously decreasing trend under 18mm / h and 36mm / h conditions, a continuously increasing trend under 0mm/h condition and increasing first and then decreasing trends under 50mm / h condition. From Figure 4, under the scenario of the drainage of 0mm / h, with the storm return period increasing, the low-risk and high-risk acreage shows a continuously increasing trend, and the medium-risk acreage is reducing continuously. Under the scenario of the drainage of 18mm / h, with the storm return period increasing, the low-risk acreage shows a continuously decreasing trend, and the medium-risk and high-risk acreage are increasing continuously. Under the scenario of the drainage of 36mm / h, with the storm return period increasing, the low-risk acreage shows a continuously decreasing trend, and the medium-risk and high-risk acreage are increasing continuously. Under the scenario of the drainage of 50mm / h, with the storm return period increasing, the low-risk acreage shows the trend of increasing first and then decreasing and the medium-risk and high-risk acreage are a continuously increasing trend.

(2) As the drainage increases, the high-risk acreage in a variety of storm return periods all shows a continuously decreasing trend, and the rainstorm scenario with the return period of 200a is the turning point. The medium-risk acreage shows both continuously reducing trend and decreasing after increasing trend , the rainstorm scenario with the return period of 100a is the turning point. The low-risk acreage had no clear trend. From figure 5, with the drainage volume increasing, the low- risk acreage shows the trend of increasing first and then decreasing under the return periods of 5a, 10a and 30a, the continuously increasing trend under the return periods of 50a and 1000a, the "N"-type trend of increasing first, then decreasing and increasing again under the return periods of 100a,200a and 500a. The medium-risk acreage shows the continuously reducing trend under the return periods of 5a, 10a, 30a and 50a, the trend of increasing first and then decreasing under the return periods of 100a,200a and 500a and the continuously increasing trend under the return periods of 1000a. The high-risk acreage shows the continuously decreasing trend under all return periods, but under the return periods of 200a,500a and 1000a, the decreasing trend reduces.

3.3 The waterlogging risk matrix Construction and analysis

In order to further analyze the relationship between waterlogging risk and storm return periods and the displacement at the study area, according to the area distribution of different levels of waterlogging risk under different scenarios (Table 3), waterlogging hazard matrix at study area is built. That is, waterlogging risk is considered high if rainstorm have high-risk area distribution under any drainage conditions and any return periods, it is considered medium risk if there are only medium-and low-risk area distribution and it is considered low risk if only low-risk area distribution. The results are shown in Table 4 .

Table 4 rainstorm waterlogging disaster hazard matrix

Return Period / Rainfall volume	a	0a	0a	0a	00a	00a	00a	000a
0mm/h	orange	red	red	red	red	red	red	red
18mm/h	orange	orange	red	red	red	red	red	red
36mm/h	orange	orange	orange	red	red	red	red	red
50mm/h	pink	pink	orange	orange	orange	red	red	red

From Table 4 , we can get that among 32 waterlogging disaster scenarios, there are a total of 21 high-risk , accounting for 66% , a total of 9 medium-risk, accounting for 28% and 2 low risk , only 6%. Of Which , the waterlogging risk of rainstorm under the return period of 5a is medium risk except that it is low risk under the drainage condition of 50mm / h. The waterlogging risk under the return period of 10a is high risk under the drainage condition of 0mm / h, medium risk under the drainage conditions of 18mm / h and 36mm/h and low risk under the drainage condition of 50mm / h. The waterlogging risk under the return period of 30a is high risk under the drainage conditions of 0mm / h and 18mm / h, medium risk under the drainage conditions of 36mm / h and 50mm/h. The waterlogging risk under the return period of 50a and 100a is high risk but it is medium risk under the drainage condition of 50mm / h. The waterlogging risks under the return period of 200s, 500s and 1000s are all high risk under the four drainage conditions.

The analysis shows that : (1) under the drainage condition of 0mm / h at study area, rainstorm waterlogging disasters under return periods below 10a could be gotten through; Under the condition of 18mm / h, rainstorm waterlogging disasters under return periods below 30a could be gotten through. Under the condition of 36mm / h, rainstorm waterlogging disasters under return periods below 50a could be gotten through. Under the condition of 36mm / h, rainstorm waterlogging disasters under return periods below 200a could be gotten through. （2）rainstorm waterlogging disasters under the four displacement conditions are all high risk under return periods at and above 200a and is hard to deal with at study area, so it need to take systematic measures. The degree of rainstorm waterlogging disasters would be reduced effectively as long as drainage capacity could be increased under return periods at and below 100a.

3.4 The Waterlogging Risk Curve Construction and Analysis

Waterlogging risk curve is the expression of time series characteristics of waterlogging risk, namely the relationship between water depth and the annual exceedance probability. Among them, the annual exceedance probability (AEP, A_{AEP} in the following formula) is the inverse of the return period. The calculation formula is:

A_{AEP} = (1 / T) * 100%. According to the formula and maximum water depth corresponding to rainstorm at every return period, waterlogging risk curves and the corresponding expressions at different drainage conditions are built. The results are shown in Figure 6.
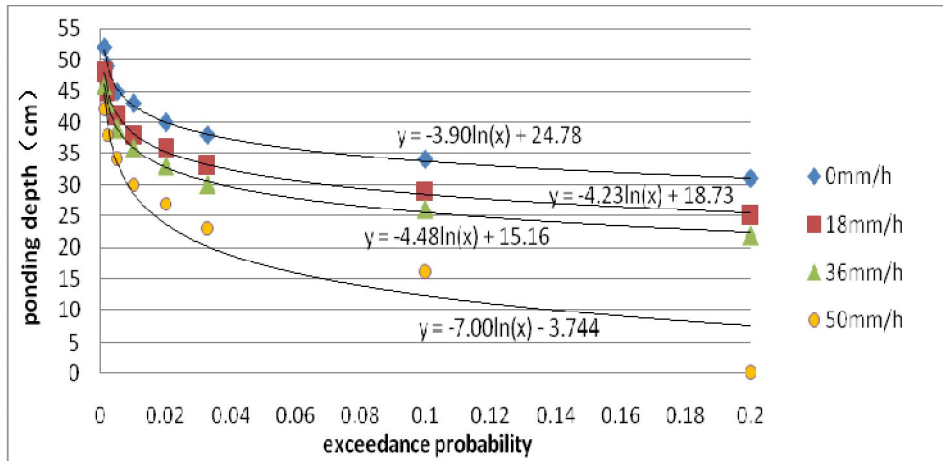

Fig.6 The rainstorm waterlogging hazard curve under Four drainage scenarios

In Figure 6, under the condition of 0mm／h , the probability of more than 30cm of water depth reaches 26 %, that of more than 15cm reaches 100%. Under the condition of 18mm／h , the probability of more than 30cm of water depth reaches 7%, that of more than 15cm reaches 100%. Under the condition of 36mm／h , the probability of more than 30cm of water depth reaches 3%, that of more than 15cm reaches 100%. Under the condition of 50mm／h , the probability of more than 30cm of water depth reaches 0.8%, that of more than 15cm reaches 6.8%.

This indicates that as drainage increases, the occurrence probability of medium risk (more than 15cm) of the rainstorm waterlogging decreases from 100% to 6.8%, that of waterlogging high-risk (over 30cm) decreases from 26% to 0.8%. Therefore, improving the design criteria of drainage system is the effective way to prevent urban waterlogging.

4. Conclusion and Discussion

In this paper, using the method of scenario analysis and taking Jinsha Community Putuo District as an example, it is analyzed and evaluated of waterlogging risk under four conditions of displacement (0mm／h, 18mm／h, 36mm／h, 50mm／h) and eight return periods(5a, 10a, 30a, 50a, 100a, 200a, 500a and 1000a) with the use of urban communities waterlogging model. The main conclusions are as follows:

(1) Rainstorm waterlogging risk under four drainage conditions and eight return periods is mainly concentrated Jinsha New Village and Jiefang Village in the middle of the study area, that is "Old City" buildings of brick-wood structure. The degree and range of risk decrease with the increasing of displacement and increase with the increasing of rainfall intensity .

(2) As the storm intensity increases, the high-risk acreage shows the increasing trend, medium-risk acreage shows continuously increasing trend in addition to a continuously decreasing trend under the condition of 0mm／h and low-risk acreage shows continuously decreasing trend under the conditions of 18 mm／h and 36mm／h, the continuously increasing trend under the condition of 0 mm／h and the increasing first and then decreasing trend under the condition of 50mm／h.

(3) As the drainage increases, the high-risk acreage under a variety of return periods shows a continuous decreasing trend, in which return period of 200a is the turning point; The medium-risk acreage shows both continuously reducing trend and increasing first and then decreasing trend, in which return period of 100a is the turning point, and low-risk acreage has no clear trend .

(4) According to waterlogging hazard matrix , of 32 waterlogging disaster scenarios at the study area, waterlogging disasters of high risk are 21, accounting for 66 %, those of medium risk are 9, accounting for 28 % and those of low risk are 2, accounting for 6%.

(5) According to waterlogging hazard curve , with the drainage increasing, the occurrence probability of the rainstorm waterlogging with medium risk (more than 15cm) decreases from 100% to 6.8%, that with high risk (over 30cm) decreases from 26% to 0.8%.

The reasons of urban waterlogging are 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 is an important but not the only cause. To prevent and govern waterlogging only by improving the design standards needs huge investment and has implementation difficulties and not obvious effect [17]. This article is only a preliminary study on waterlogging hazard in urban communities under different drainage scenarios. And there are some other factors which are 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 the urban community waterlogging disaster risk and variation.

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