



Pre-rainy Season Rainstorms in South China—Risk Perception of the 11 April 2019 Rainstorm in Shenzhen City

Xuran Sun^{1,3} · Wei Zhou^{1,3} · Guoming Zhang^{1,2,3} · Lianyou Liu^{1,3} ·
Guangpeng Wang^{1,3} · Mingzhu Xiang^{1,3} · Yuting Xiao^{1,3} · Shufeng Qu^{1,3} ·
Shouwei Li^{1,4} · Jiaxue Li^{1,4}

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Abstract With the acceleration of urbanization in South China, rainstorms and floods are threatening the safety of people in urban areas. The 11 April 2019 (4·11 hereafter) rainstorm in Shenzhen City was a typical pre-rainy season rainstorm that caused great damage, yet such pre-rainy season events have not attracted sufficient attention in research. Risk perception of the public may indirectly affect their disaster preparedness, which is important for disaster management. In this study, we conducted a questionnaire survey that considered demographic factors and the level of risk perception, knowledge of risk, impact of the 4·11 rainstorm event on public risk perception, and degree of trust in the government. We used a two-factor model of risk perception to evaluate the factors that influenced public risk perception of the 4·11 rainstorm in Shenzhen. The main conclusions are: The 4·11 rainstorm improved public awareness of both risk and impact through the medium term, but the public's perceived low probability of disaster occurrence and lack of knowledge of the pre-rainy season rainstorm phenomenon led to serious losses during this event. Although the public has high trust in the Shenzhen government, the management

of rainstorm disasters in the pre-rainy season needs to be further improved.

Keywords Knowledge of risk · Pre-rainy season rainstorm · Risk perception · Shenzhen city · South China

1 Introduction

With the advancement of urbanization, human activities have exerted unprecedented influence on the natural environment, leading to an increasing number of natural hazards and disasters in urban areas (Peng et al. 2019; Xu et al. 2019). Pre-rainy season rainstorms are common in urban regions of South China, such as Shenzhen City (Li et al. 2021). They usually occur from April to June with short duration heavy rainfall, caused by the passage of cold fronts in the spring (Xue et al. 2021; Chen et al. 2022). Because of the difficulty in accurately predicting pre-rainy season rainstorm occurrence and its great harm to the public, April–June rain has always been a challenge for urban disaster management in Shenzhen City (Luo et al. 2017; Bang and Burton 2021; Gao et al. 2021).

In recent years, risk perception research has been frequently conducted for urban disaster management (Leon et al. 2021). Risk perception research examines people's ability to perceive the risks of one or more disasters by quantifying a series of controllable factors (Slovic 1987). Birkholz et al. (2014) believed that flood risk perception research generates a more comprehensive understanding of how risk perception affects the vulnerability, capacity, and resilience of individuals and communities in the face of floods. Rufat and Botzen (2022) found that older people, as well as those who have higher levels of income and education, are significantly more likely to express their flood risk

✉ Guoming Zhang
zgm@bnu.edu.cn

¹ Key Laboratory of Environmental Change and Natural Disasters, Ministry of Education, Beijing Normal University, Beijing 100875, China
² School of National Safety and Emergency Management, Beijing Normal University, Beijing 100875, China
³ Academy of Disaster Reduction and Emergency Management, Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China
⁴ School of Systems Science, Beijing Normal University, Beijing 100875, China

perceptions. Zinda et al. (2021) focused on the role of public trust in government authorities in flood risk perception, with particular attention to the response of the insurance industry. Muñoz-Duque et al. (2021) emphasized the important role of previous experience with coastal floods, risk habits, and emotional connection with local areas as determinants of risk perception. Most risk perception studies are based on a questionnaire survey of the target groups (Hudson et al. 2020; Kim and Madison 2020; Buchenrieder et al. 2021; Ng 2022).

At present, there are many difficulties in predicting short duration, heavy precipitation events such as the pre-rainy season rainstorms in South China (as reflected, for example, in the low accuracy and poor reliability of forecasting). These inadequacies result in the failure of relevant emergency management departments to issue timely early warning to evacuate people at risk (Yu et al. 2019). In such situations, the risk perception and response behavior of the public may play an important role in disaster risk reduction and loss prevention. Consequently, investigating the public risk perception of rainstorm disasters in the pre-rainy season in South China has an important significance for emergency management in the region.

2 Data and Methods

The following subsections present brief introductions to the study area, the design of the questionnaire for collecting data, and the test of the reliability and validity of the data.

2.1 The Study Area

Shenzhen City is located between 113°43′–114°38′E and 22°24′–22°52′N, with an elevation range of 0–944 m. It is seated in the southern coastal area of Guangdong Province, and the nine districts under its jurisdiction are highly developed economically. In 2020, Shenzhen's permanent population was 14.11 million, with an additional floating population of 12.44 million. The gross domestic product (GDP) of Shenzhen was RMB 2.6 trillion yuan, and the city is an international metropolis that is representative of China's rapid urbanization (Huang et al. 2021). The region has a subtropical monsoon climate with high temperature and plenty of rainfall in the summer. However, at the turn of spring and summer, the sudden change of temperature leads to more frequent activities of cold front and low-level jet streams. The resulting short duration heavy rainfall often causes serious meteorological disasters and brings huge losses to the city. This period of frequent short duration rainfall before the summer flood season, usually from April to June, is called the pre-rainy season.

In 1960–2020, precipitation in the pre-rainy season fluctuated between 206 mm (in 1963) and 1706 mm (in 2008), accounting for 22.56% to 62.95% of the annual precipitation total (Fig. 1b). The starting date of the pre-rainy season changed every year (Fig. 1c), and it even may not emerge in certain years. In 11 April 2019, the daily average precipitation of the city was 40.6 mm, of which the average rainfall in Luohu District was 65.0 mm, and the maximum rainfall in 10 min was 39.2 mm (Fig. 1a). Such a short duration heavy rainfall led to sudden floods in Luohu and Futian Districts, resulting in 11 deaths and heavy losses of roads, buildings, and other infrastructure.

2.2 Questionnaire Design and Test of Reliability and Validity

In this study, we used a two-factor model of risk perception—the possibility of encountering rainstorms/suffering losses and the degree of threat, that is, the perceived occurrence probability of rainstorm disasters and their threat level and consequences (Liu et al. 2006) to measure the level of public risk perception of rainstorm disasters in Shenzhen in the pre-rainy season. For data collection, we designed a questionnaire that considered knowledge, attitude, trust, and practice (Dai 2014; Ridha et al. 2022). Table 1 presents the four dimensions of our questionnaire survey: level of risk perception, knowledge of risk, impact of the 11 April 2019 (4-11 hereafter) rainstorm on public risk perception, and degree of trust in the government. For the four dimensions of our survey, we included a total of 16 questions (Table 1). The respondents were required to use scores to indicate their responses to these questions.

Before we formally distributed the questionnaire, a pilot survey was carried out in Shenzhen on the Questionnaire Star¹ platform. Participants were recruited through this platform's personal information management system. We selected 50 respondents and circulated the questionnaire to them. We adopted the Cronbach coefficient to test the reliability of the 16 questions (Zhou 2017; Ridha et al. 2022), and all the results obtained are higher than 0.7, indicating that the questionnaire has good reliability (Table 2). We also used KMO (Kaiser–Meyer–Olkin) & Bartlett value to test the validity of these questions (Chung et al. 2004). The total KMO value was 0.835, higher than 0.8, indicating the validity of the questionnaire (Table 2) and that the data can be used for factor analysis.

¹ <https://www.wjx.cn/?source>

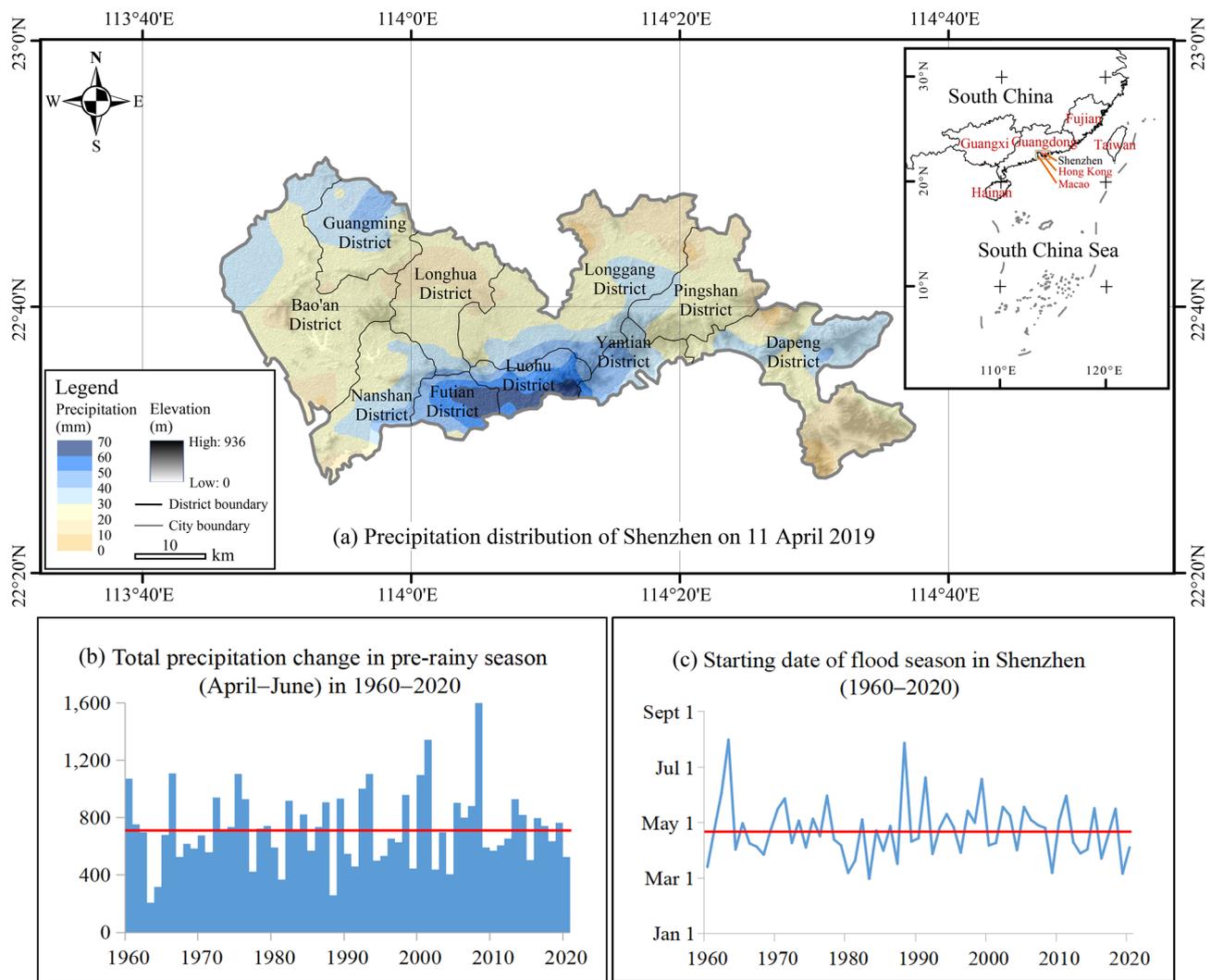


Fig. 1 Characteristics of the pre-rainy season in Shenzhen. **a** Precipitation distribution on 11 April 2019; **b** Change of total pre-rainy season precipitation from 1960 to 2020, where the red line is the average

value of 716.61 mm; **c** Change of the starting date of the flood season (including pre-rainy season) from 1960 to 2020, where the red line is the average time of 19 April

2.3 Analysis of the Questionnaire Survey Data

Through our online survey on Questionnaire Star in February 2021, a total of 429 valid participant samples were obtained. We acquired the basic information of the respondents with seven questions, which are regarded as demographic factors in this paper. The statistical results show that the gender distribution of the respondents in this survey is close to 1.28 male:1 female. The age of the respondents is mainly in the 18–60 years range and the educational background is largely university level. Income is concentrated at below RMB 200,000 yuan, while the occupations of the respondents cover many fields (Table 3).

More than half of the respondents claimed that they had experienced a rainstorm disaster in the pre-rainy season, which indicates that the pre-rainy season rainstorms and

their secondary disasters had a relatively wide impact on the public in Shenzhen. Nearly half of the respondents, however, said they had not heard of the concept of “pre-rainy season rainstorm,” which indicates that the public in Shenzhen did not have enough knowledge about and understanding of pre-rainy season rainstorms and flooding in the South China region.

We posed six questions about the level of risk perception according to the influence of pre-rainy season rainstorms on some important aspects of life. Among them, four statements are related to the degree of threat, and two statements are related to the possibility of encountering rainstorms or suffering losses. The respondents quantified the degree of threat and the possibility of encountering—the two factors of risk perception—with scores ranging from 1 (highly disagree) to 11 (highly agree) using an 11-point Likert scale.

Table 1 Questions used in the Shenzhen City pre-rainy season rainstorm survey

Dimension	Question
Level of risk perception	Q1: Do pre-rainy season rainstorms threaten urban public facilities? Q2: Do pre-rainy season rainstorms threaten your house or property? Q3: Do pre-rainy season rainstorms threaten your family's safety or life? Q4: Do pre-rainy season rainstorms threaten the daily work and life order? Q5: Are you likely to encounter rainstorms in the pre-rainy season? Q6: Are you likely to suffer losses from rainstorms in the pre-rainy season?
Knowledge of risk	Q7: How much do you know about the causes of rainstorms in the pre-rainy season? Q8: How much do you know about the secondary disasters caused by the pre-rainy season rainstorm? Q9: How much do you know about the disaster prevention for pre-rainy season rainstorms? Q10: How much do you know about the catastrophe insurance scheme in Shenzhen?
Impact of the 4-11 rainstorm on public risk perception	Q11: How much did the reports of the 4-11 rainstorm impact your understanding and evaluation of the risk of rainstorm? Q12: How much did the reports of the number of casualties caused by the 4-11 rainstorm impact your understanding and evaluation of the risk of rainstorm? Q13: How much did the reports of the emergency rescue and preventive measures taken by the government during the 4-11 rainstorm impact your understanding and evaluation of the risk of rainstorm?
Degree of trust in the government	Q14: What is your degree of trust in the rainstorm warning and forecast information issued by the meteorological department in the pre-rainy season? Q15: What is your degree of trust in the rainstorm information released by the mass media in the pre-rainy season? Q16: What is your degree of trust in the ability of rainstorm risk management by the government in the pre-rainy season?

Table 2 Dimensions of the questionnaire survey and reliability and validity test results

Dimension	Description	The number of questions	Cronbach α	KMO & Bartlett
Level of risk perception	Public perception of risks caused by pre-rainy season rainstorms in Shenzhen	6	0.899	0.851
Knowledge of risk	Respondents' knowledge of disaster risks	4	0.877	0.832
Impact of the 4-11 rainstorm on public risk perception	Influence of reports of this rainstorm event on the respondents	3	0.947	0.743
Degree of trust in the government	Respondents' trust in professional services, the media, and government departments	3	0.913	0.728
Total		16	0.733	0.835

KMO Kaiser–Meyer–Olkin value

This dimension in the survey is an intuitive evaluation of the public's risk perception. As for knowledge of risk, we included four questions whose scores range from 1 (low) to 5 (high). We evaluated the public's knowledge of the "pre-rainy season rainstorm" based on their self-assessed knowledge of the causes of pre-rainy season rainstorms, secondary disasters, and disaster prevention. For the particular impact of the 4-11 rainstorm on public risk perception, we included three questions and divided the degree of impact into four levels: 5 (very high), 4 (high), 3 (low), 2 (no impact), and 1 (did not pay attention). The results show the impact of the reports related to the 4-11 rainstorm disaster on public risk perception. The degree of trust in the government includes

three questions, with scores of 5 (very high), 4 (high), 3 (medium), 2 (low), and 1 (very low).

3 Results and Discussion

In this section, we examine the data collected through the survey, divide public risk perception into four levels by using Euclidean distance and the Ward's method (Bouguettaya et al. 2015), and compare the differences between classes. In addition, the relationship between demographic factors and the four dimensions of the survey are also discussed.

Table 3 Statistics of demographic factors and basic information of the Shenzhen City respondents to the pre-rainy season rainstorm survey

Factor	Value/Type	The number of respondents	Proportion (%)	
Gender	Male	241	56.18	
	Female	188	43.82	
Age	< 18	1	0.23	
	18–30	156	36.36	
	31–45	204	47.55	
	46–60	60	13.99	
	> 61	8	1.86	
Level of education	Lower than bachelor	80	18.65	
	Bachelor	305	71.1	
	Master's	37	8.62	
	Doctoral	7	1.63	
Occupation	Manager	31	7.23	
	Artisan	41	9.56	
	Clerk	68	15.85	
	Service personnel	82	19.11	
	Production personnel	1	0.23	
	Operator	6	1.4	
	Military (police)	32	7.46	
	Other	168	39.16	
	Income (annual, CNY)	< 100,000	221	51.52
		100,000–200,000	126	29.37
200,001–500,000		69	16.08	
> 500,000		13	3.03	
Have you heard about “pre-rainy season rainstorm”	Yes, I have heard about it.	220	51.28	
	No, I have never heard it.	209	48.72	
Have you suffered from a pre-rainy season rainstorm	Yes, I have suffered.	234	54.55	
	No, I don't know at all.	195	45.45	

3.1 Data Interpretation

The questionnaires were administered in April 2021, 2 years after the rainstorm on 11 April 2019, when the immediate impact of the event had gradually attenuated. Previous studies have shown that the public's awareness of risk remains very high within about 30 days after a disaster but over time, it will gradually return to the original level (Zhao et al. 2014). The reports on disaster relief can often bring a sense of security to the general population, so that they can evaluate and understand the potential risk and impact of disasters in a more objective way (Wang 2021). Even so, at the time of the survey, nearly half of the respondents (Fig. 2, Q11 and Q12) reported that they were greatly affected by the 4·11 rainstorm, indicating that major disaster events can significantly increase the public's awareness of the risk and potential impact through the medium term. Meanwhile, 80% or more of the respondents indicated high and very high trust in the government (Fig. 2, Q14–Q16). In contrast, despite the fact that the perceived threat level is high (Fig. 2, Q1–Q4), a normal distribution is observed

concerning the perceived probability of disaster occurrence/suffering losses and knowledge of risk (Fig. 2, Q5–Q10). This observation indicates that the public's perceived low probability of disaster occurrence and lack of knowledge of the pre-rainy season rainstorm have contributed to the serious losses during the 4·11 event and may have important implications for disaster prevention in the city.

Pan and Xu (2019) found that more than half of the residents of Shenzhen had experienced rainstorm disasters in the pre-rainy season. However, nearly half of the respondents in our study reported that they had not heard of the term “pre-rainy season rainstorm” in the area, indicating that the public in Shenzhen has insufficient awareness and understanding of this hazard, and suggesting that their understanding of the causes, secondary disasters, and prevention of pre-rainy season rainstorm disasters is limited, which is consistent with the findings of Yu et al. (2019). The 4·11 rainstorm had a great impact on the disaster risk perception of most of the respondents, and raised their perceived level of risk through the medium term. This is consistent with Ge et al. (2011) on public risk perception in the Yangtze River Delta region.

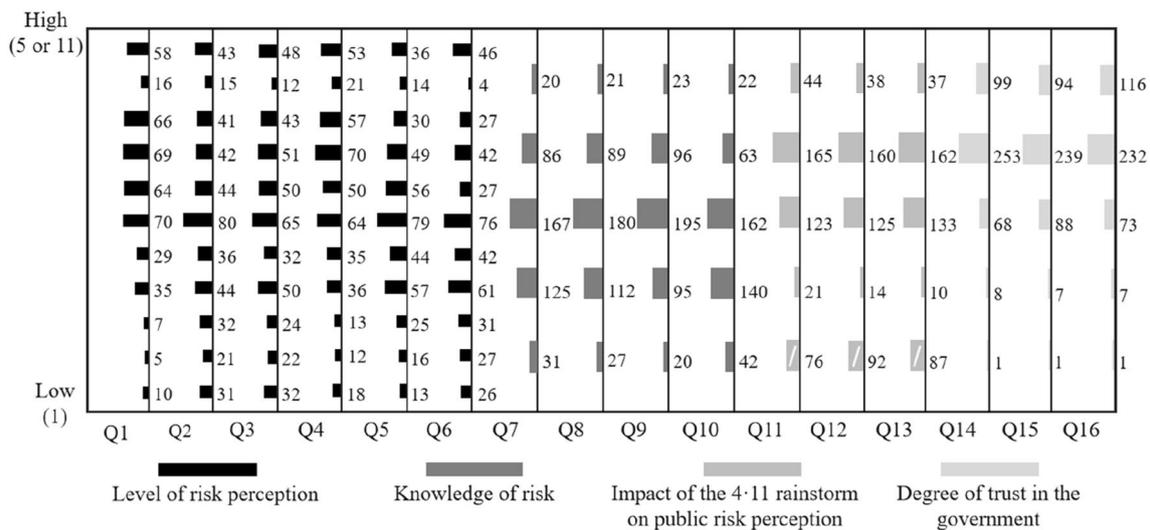


Fig. 2 Distribution of responses to the Shenzhen City pre-rainy season rainstorm survey questions. See Table 1 for the description of Q1–Q16

When disasters occur, the public expects the government, especially local governments, to be prepared for and respond to adverse events (Arceneaux and Stein 2006). Generally, in practice, the public tends to overestimate the government’s ability to cope with disasters (Russell et al. 1995). In recent years, Shenzhen City government and its meteorological and emergency management departments have made a lot of preparations for urban flood control and disaster relief, but the cooperation between departments is insufficient. Although the 4·11 rainstorm lasted only for 2 h, 11 people lost their lives in this highly developed modern city. The meteorological department issued the meteorological yellow warning in time, but this notice was unable to prevent accidents under an intensity of rainfall that was far greater than expected. This expectation gap also indicates the urgent need for city government departments to formulate more detailed generic plans that upgrade urban rainstorm disaster management.

3.2 Relationship Between the Level of Risk Perception and Knowledge of Risk, Impact of the 4·11 Event, and Degree of Trust

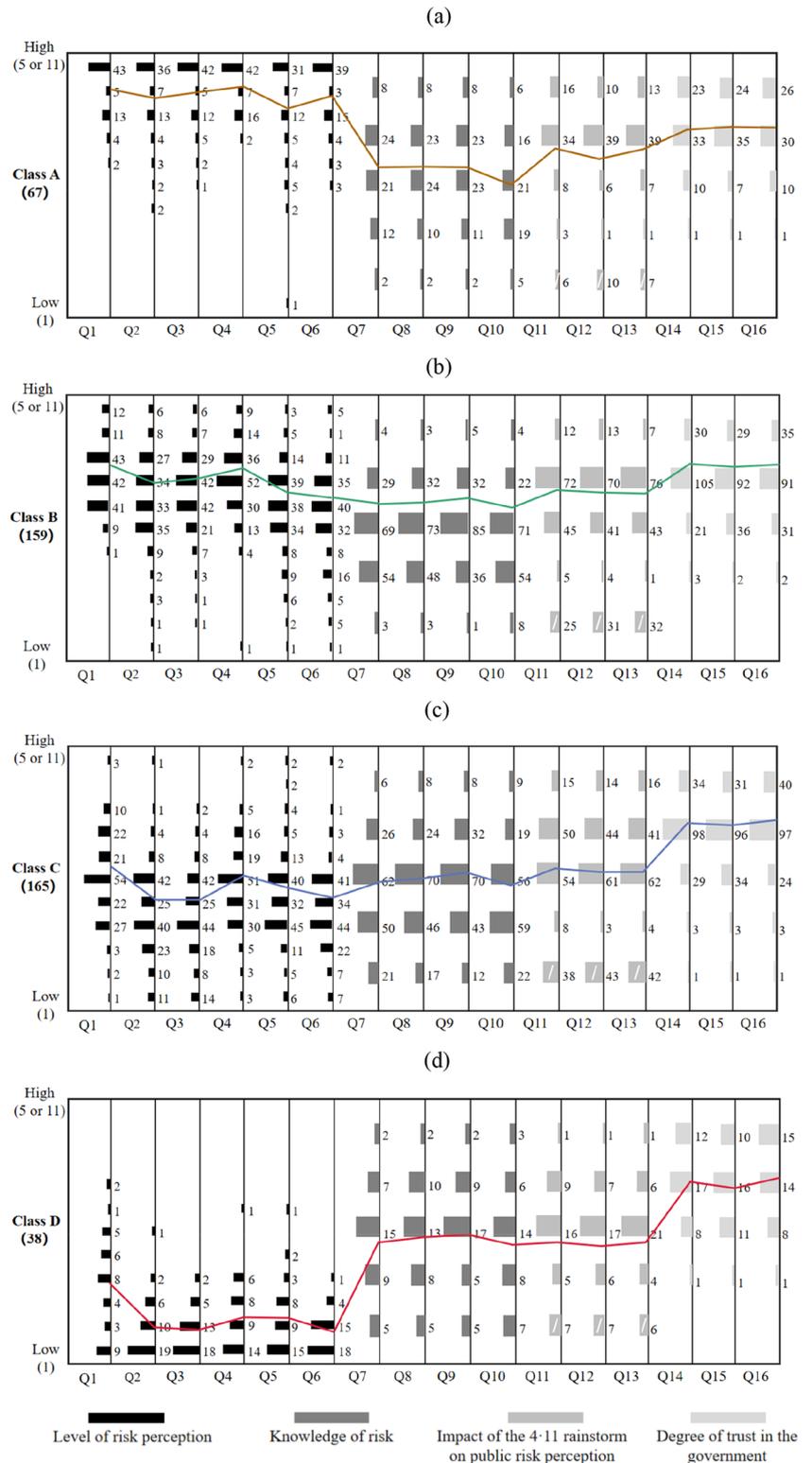
In order to explore the tendency of the risk perception level groups with regard to knowledge of risk, impact of the 4·11 rainstorm, and degree of trust in the government, we clustered the 429 respondents by maximizing the distances between classes and minimizing the distances within each class and divided the 429 samples into four classes.

Class A is the group with the highest risk perception level, with a total of 67 (15.62%) respondents. Their aggregated risk perception level scores range from 50 to 66 (out of $11 \times 6 = 66$), which indicate that they have a high sense

of risk and understand the threat imposed by the pre-rainy season rainstorms. Class B is the group with the second highest risk perception level, with a total of 159 (37.06%) respondents. Their aggregated risk perception level scores range from 32 to 52. The risk awareness of this group is at a good level, and the respondents also perceived the relatively high level of threat imposed by rainstorms. Class C is a group with a relatively low risk perception level, and a total of 165 (38.46%) respondents belong to this category. Their aggregated risk perception level scores range from 14 to 35, which means that their perception of risk is relatively poor. Class D is a group with a low risk perception level. A total of 38 (8.86%) respondents belong to this category, and the sum of their risk perception level scores range from 5 to 15. These respondents usually have difficulty in realizing the potential impact of rainstorms in the pre-rainy season on themselves, so they lack the ability to perceive such events as threats.

As can be seen from Fig. 3a, the Class A group gave high scores on various indicators of risk perception level. That is, they believe that the pre-rainy season rainstorm will pose a threat to urban infrastructure, real estate, people’s lives, and the order of daily life. Although many of the respondents claimed that they had rarely heard of the term “pre-rainy season rainstorm,” it did not affect their belief that some rainstorms would cause serious losses and damage for themselves. The Class A group also has a high level of knowledge about pre-rainy season rainstorm. Of these respondents, 60% to 70% gave a score of 3 or 4 in these questions, indicating that they know the causes and effects of the pre-rainy season rainstorms. About 10% of the respondents have a deep understanding of the formation process of pre-rainy season rainstorms, their secondary disasters, prevention, and

Fig. 3 Statistics of responses of Class A (a), Class B (b), Class C (c), and Class D (d) groups of participants in the Shenzhen City pre-rainy season rainstorm survey



rainstorm-related insurance. The impact of the reports of the 4-11 rainstorm on the Class A respondents' understanding and evaluation of pre-rainy season rainstorm risk was mostly scored at 4 and 5, and only a few respondents in this group

paid little attention to such reports. In addition, their trust in the government is also very high, and they believe that the protective measures taken by government departments against pre-rainy season rainstorm disaster will be effective.

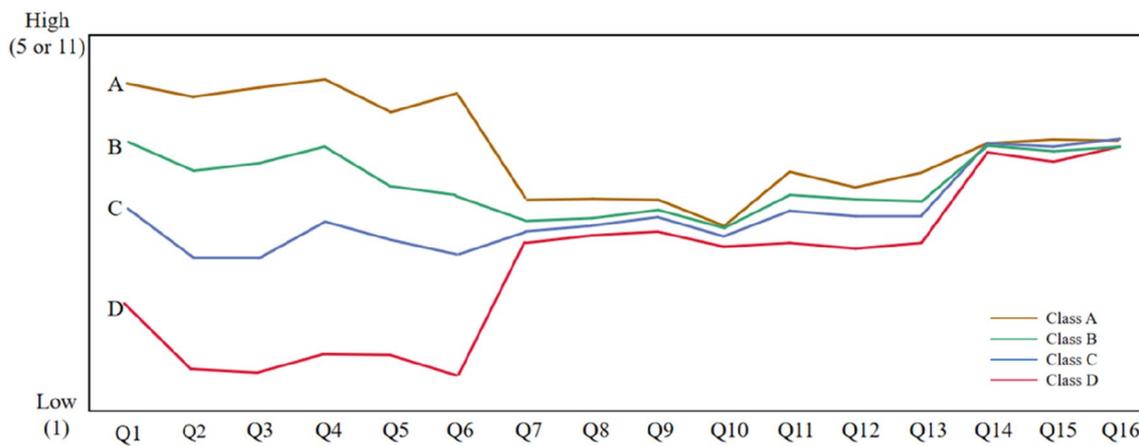


Fig. 4 Comparison of characteristic lines of the four population groups participating in the Shenzhen City pre-rainy season rainstorm study

Most respondents of the Class B group gave a score of 5–9 for each of the risk perception level indicators. This means that they have a clear but not firm understanding of the losses caused by pre-rainy season rainstorm. Their scores on various indicators of risk knowledge are mainly between 2 and 3, however, which indicates that their risk knowledge is insufficient. Only about 20% of the respondents have understood or paid special attention to relevant knowledge. Regarding the impact of the reports of the 4·11 rainstorm on their understanding and evaluation of risk, although most of the respondents still scored at 4, the proportion of those who gave lower scores has increased significantly compared with the Class A group. The Class B group also has lower trust in the government, the media, and flood control measures than the Class A group.

Most of the scores of the risk perception indicators given by the Class C group are between 3 and 5. It means that they are not so clear about the losses caused by pre-rainy season rainstorms. Compared with the Class B group, the proportion of the Class C group respondents giving low scores in the other three dimensions of the survey seems to have increased. They did not seem to be very sensitive to the reports that affect risk perception, and they gave the largest number of score 3 responses on the impact of the 4·11 rainstorm on risk perception.

The level of risk perception of the Class D group is very low. Compared with the Class C group, there are also more people in this group who gave low scores to the risk knowledge and rainstorm impact indicators. Yet their trust in the government, the media, and flood control measures is even higher than that of the Class B and C groups.

According to the average value of responses to each question, we extracted a characteristic line from each of the four groups (Fig. 4). It can be seen that the group with a high level of risk perception (A) is also higher than all other groups in the scores of other factors. The differences among

the four groups on Q10, that is, rainstorm insurance in the pre-rainy season, is very small, indicating that all groups do not pay special attention to the relevant insurance. As a representative megacity, the product of rapid urbanization, Shenzhen took the lead in implementing a catastrophe insurance system as early as 2014 (He and Tang 2018). However, our results show that only 19.81% of the respondents had a good understanding of the catastrophe insurance system in Shenzhen (Fig. 2, Q10). The government's campaign to promote catastrophe insurance is limited, and, on the other hand, the public may have a mentality of taking chances for low probability and high threat disasters. After all, although disaster events occurred in the city where the respondents live, only a few of them suffered serious losses under normal conditions, which may have also affected individual judgment about the risk of experiencing disasters (Weinstein 1982). In addition, there is no significant difference in the score of each group for the degree of trust variable. Compared with other main factors, degree of trust (Q14–Q16) has a smaller intergroup gap, and the average scores are the highest of all. It means that the government has good credibility in dealing with disaster events. Not only are citizens more willing to follow the government's advice on disaster prevention, but the government is also more likely to obtain public support (Wang 2016).

3.3 Regression Analysis Between Demographic Factors and Risk Perception, Knowledge of Risk, Impact of the 4·11 Event, and Degree of Trust

To explore whether demographic factors are related to the other factors in the four dimensions of our survey, a regression analysis was conducted. Table 4 shows that there is no significant correlation between demographic factors and the level of risk perception, impact of the 4·11 rainstorm event on public risk perception, and degree of trust. The public's

Table 4 Regression analysis between demographic characteristics of participants in the Shenzhen City pre-rainy season rainstorm study and other factors

Demographic factors	Level of risk perception	Knowledge of risk	Impact of the 4·11 event on public risk perception	Degree of trust
Gender	0.000	0.133*	0.083	− 0.024
Age	0.107	− 0.176*	− 0.153	− 0.010
Level of education	− 0.032	0.080	0.021	0.043
Occupation	0.032	0.054	− 0.023	0.055
Income	− 0.043	0.174***	0.087	− 0.049
Have you heard about “pre-rainy season rainstorm”	− 0.085	0.509***	0.288	0.130
Have you suffered from a pre-rainy season rainstorm	− 0.010	0.327***	0.225	0.073

The data in the table are standardized regression coefficients

* $p < 0.05$, *** $p < 0.001$

perceived threat of the rainstorm in the pre-rainy season, the influence of the relevant reports of the 4·11 rainstorm on the respondents, and their trust in the government are not obviously affected by their gender, age, level of education, occupation, or income, but are independent of these factors. These dimensions mainly indicate an individual's ability to process and evaluate the risk information, but this ability is often greatly affected by an individual's personality and general view of risks, which are not reflected by the demographic factors of the questionnaire survey. Despite this, some demographic factors, such as gender, age, income, and the two factors of basic information of risk perception have significant or very significant correlation with knowledge of risk.

The results indicate that there is a significant correlation between gender and knowledge of risk, and that women in Shenzhen have more risk knowledge than men. According to the research of Gustafson (1998), when men and women face the same risks, they will have the same concerns, but women constantly worry a bit more. It is worth noting, however, that in our study most women's risk knowledge is still at a medium level. There is also a negative correlation between age and knowledge of risk, indicating that the older respondents have less risk knowledge than the young people, possibly due to young people's greater exposure to and understanding of risk information on the Internet and in the media and social media. In addition, there is a very significant positive correlation between income and knowledge of risk. The higher the income, the higher the level of knowledge on pre-rainy season rainstorms in Shenzhen, but the causes of such association may be very complicated and context-specific, and warrant further examination in future research. Not surprisingly, pre-rainy season rainstorm experience is significantly correlated with knowledge of risk. People who had heard of the “pre-rainy season rainstorm”

and those who had experienced the pre-rainy season rainstorm often have more knowledge of risk.

In this study, due to the fact that the questionnaire was administered 2 years after the 4·11 rainstorm, the data collected only reflect the medium-term impact of the event, and cannot represent the public risk perception level in the immediate aftermath of the event. In future work, it is necessary to improve the data collection method, and examine the changes of public risk perception in different time scales after an event.

4 Conclusion

The 4·11 rainstorm has significantly improved the public's risk perception in the medium term and their understanding of the consequences of such events. However, the public's perception of the probability of disasters with high impact and their understanding of the pre-rainy season rainstorm were insufficient, which may have contributed to the serious losses caused by the event. Furthermore, the respondents with a high level of risk perception also scored high in knowledge of risk, impact of the 4·11 rainstorm on public risk perception, and degree of trust. Regardless of the level of risk perception, the respondents always have a high trust in the government, the meteorological department, and the media. In addition, gender, age, and income correlate well with the risk knowledge of individuals, which means that women, younger people, and high-income groups may have stronger risk perception ability.

Compared with typhoon disasters, the accuracy and reliability of rainstorm forecast in the pre-rainy season are low, and the response time for the public and meteorological department is relatively short. Therefore, considering the potential high magnitude of impact of pre-rainy season rainstorms, government departments should strengthen their

prevention and management efforts. Integrating government risk management and individual disaster prevention measures will lead to better outcomes in urban rainstorm disaster risk reduction.

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