Typhoon Evacuation in Wenzhou, China: A Preliminary Analysis of Progress and the Remaining Challenges 1

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Field Report

Typhoon Evacuation in Wenzhou, China: A Preliminary Analysis of Progress and the Remaining Challenges[1]

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The need for a well-prepared response to hurricanes and typhoons[2] has become increasingly evident given the catastrophic impacts. While much research has focused on how American governmental and non-governmental organizations operate in response to hurricanes, the response in developing countries has received less attention. This article describes the progress and challenges evidenced in Chinese local government operations during typhoon evacuations, and is based on field research in Wenzhou City in September 2008, which includes historical official document analysis, on-site observation of the 2008 Typhoon Sinlaku response process and face-to-face interviews with one NGO director and 16 officials. Mass evacuation response in China has changed: there are basic shelters, emergency plans and legislation supports. But there are still problems that block effective and efficient response.

1. Introduction

Mass evacuation is considered one of the most important measures to prevent losses caused by hurricane disasters (Lindell & Perry, 1991). Most evacuation research focuses on the United States, such as studies on individual, family and organization behaviour during an evacuation, governmental decision making, engineering models (including traffic models, logistic models) and coordination and communication problems (Baker, 1991; Bolin, 1984; Dow & Cutter, 2002; Fischer III, Stine, Stoker, Trowbridge, & Drain, 1995; Kirschenbaum, 1992; Wilmot & Mei, 2004; Wolshon, 2001; Wolshon, Urbina, Wilmot, & Levitan, 2005). There is little empirical research exploring the progress and challenges of typhoon evacuation in China, and this article seeks to bridge that gap.

Southeast China, the most densely developed area of China's mainland, regularly suffers from severe typhoons. About nine typhoons target China every year (Wang, Li, Ren, & Wang, 2007). Some typhoons have caused many human deaths and economic loss. For example, the 1956 typhoon #12 was one of the deadliest tropical cyclones since 1949, killing $>$4,629 people after striking the county Xiangshan in Zhejiang province, 1969 typhoon #03 killed 1,554 people in Shandong city, 1994 typhoon #17 resulted in 1,126 deaths and about 12.4 billion Chinese yuan loss and typhoon Rananim caused at least 164 deaths and direct economic loss of 15.33 billion Chinese yuan in Zhejiang province in 2004 (Xu & Bi, 2005). The 2006 Typhoon Saomai was the most intense typhoon to strike China in the last 50 years; its landfall strength was stronger than that of hurricane Katrina, leaving at least 428 dead and causing $>$12.7 billion Chinese yuan economic loss in Zhejiang (China Meteorological Administration, 2006).

Among the coastal cities, Wenzhou city is one of the most frequently affected areas (see the geographical position of Wenzhou and typhoon-prone areas in China in Figure 1). Wenzhou is located on a small plane with hills in its western and northern regions. The population is 7.6 million (2007), of which the urban population

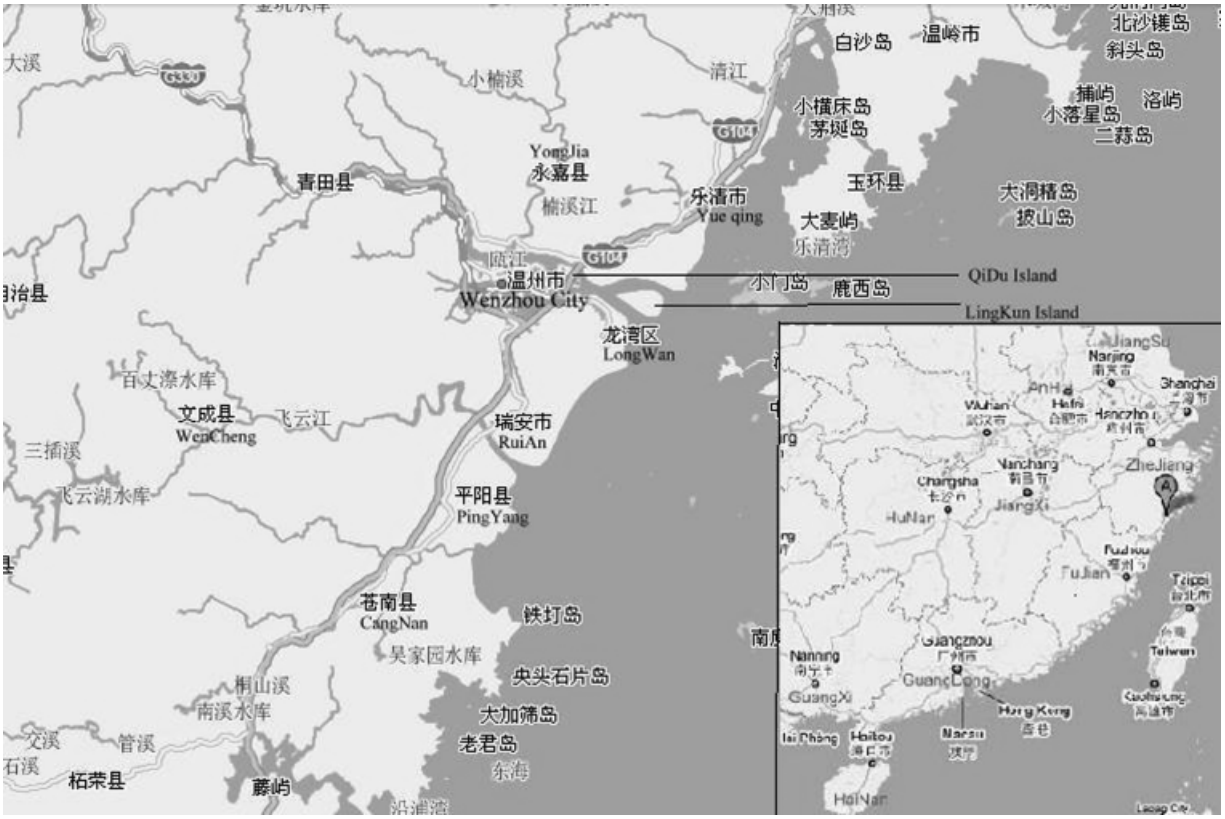


Figure 1. Typhoon-vulnerable provinces in China and the location of Wenzhou City.
Source: the website of State Flood Control and Drought Relief Headquarters.

is 1.4 million (not including peasant workers from other areas 2.5 million).[3,4] Sixteen typhoons landed in Wenzhou between 1949 and 2007. From 1990 to 2007, 219,000 houses were destroyed, 1,800 people were killed by typhoons or typhoon-triggered flooding and together they caused 55.2 billion Chinese Yuan direct economic losses.[5]

The total economic damage related to typhoons in Wenzhou has increased steadily, while the number of human deaths has decreased sharply.[6] Most of the increase is because of economic development in this vulnerable area. After opening-up policy and reform in the late 1970s, people have engaged in a new commodity economy, household industries and specialized markets (Wenzhou is called 'China's capital of Shoes'). The city created its own economic development model in China.[7] Like many other coastal cities in southeast China, the energetic economy attracts many investors and immigration peasant workers from other areas, which increase vulnerabilities in the face of typhoons.

In China, evacuation did not assume an important position on the political agenda until the recent two decades.[8] In the past, a strong emphasis on disaster prevention and community resilience[9] with an aim to prevent state property loss at any cost motivated typhoon responses, which led to several human catastrophes.

With the development of China's newly designed emergency management institution, in the wake of Typhoon #9417,[10] evacuation was introduced as a critical tool for typhoon response. Local governments set up typhoon emergency planning and identified shelters, appointing specific officials to be responsible for evacuation[11] (Deng, 1999). These advancements in typhoon response underscore China's recent effort to improve its emergency management system. There are still problems left in typhoon responses, which are described in the following sections.

But first, I will describe the decision structure for typhoon response in China. This will show how China's evacuation decisions have become institutionalized. Finally, I will discuss the long-term disaster prevention and preparation problems.

2. Data and methods

All the data presented in this paper were collected through field research in the Wenzhou City Bureau of Water Resource during September 2008, which includes: (1) One interview with an NGO director and 16 interviews with officials in the Bureau of Water Resource, eight of whom are from the city level, four are from the county level and the others are from the

town level; (2) personal observation during the response to typhoon Sinlaku in Wenzhou City Flood Control and Drought Relief Headquarters (FCDRH); (3) evaluation reports of the response; and (4) typhoon-response command documents.

Typhoon command documents are records of commands issued through facsimile with signatures from leaders in charge. During the typhoon-response process, a substantial amount of commands are transmitted to the lower level FCDRH.[12] The contents of these faxes which were sent from Wenzhou City level to county levels in its jurisdiction include (1) real-time information about rain and the typhoon, and commands about evacuation and response; (2) commands for real-time response information report (evacuation population statistical data); (3) coordination of the trans-county level response; (4) higher level instructions and governor's instructions; and (5) instructions with regard to the prevention of certain engineering projects that have the potential to cause danger to the community.

In the response phase, administrators at the local level are responsible for the typhoon response in their jurisdictions. If the lower levels face unresolved problems, such as releasing water from city-managed reservoirs in their counties jurisdiction in order to have enough space for the incoming flood, they need to ask for permissions or instructions from a higher level FCDRH.

The interviewees were selected using snowball sampling.[13] The criterion for selection was that the potential candidates must have at least 2 years working experience in typhoon response. I also interviewed some retired professional staff to verify some of the interview questions, because these retired staff could comment on these issues more frankly.

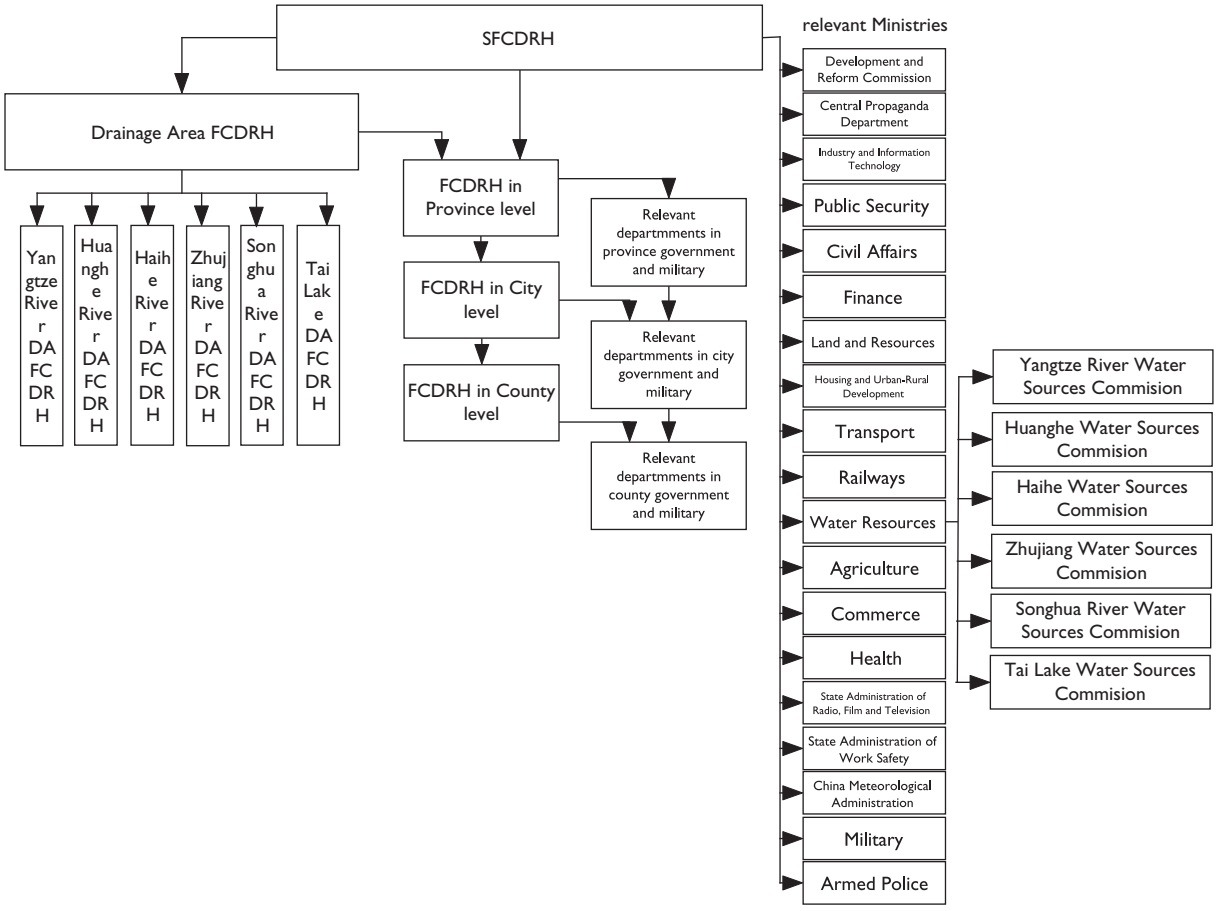
3. Decision-making structure for typhoon response in China

In China, typhoon disasters are classified as natural disasters, which is one of the four basic categories of emergencies.[14,15] State Floods Control and Drought Relief Headquarters (SFCDRH), which is led by the State Council, is responsible for all the tasks related to flood control and drought relief all over the country, including typhoon response.[16] Normally, a vice premier is the leader of SFCDRH and the members of this institution consist of the minister of water resources and a few other vice ministers who are relevant to flood control and drought relief response.[17] There is also a standing body that is placed under the Ministry of Water Resource, which works for the headquarter in daily crisis preparedness. The organization chart of typhoon response is shown in Figure 2. For the provinces that are run through by six main rivers, the governor also has to coordinate with the specific river basin FCDRH for disaster response[18] (Lu, 2007; Ma, Xi, & Wang, 2009). There are three other levels of FCDRH: province level, city level and county level. Each level is led by a direct superior and is responsible for all the tasks of typhoon response in its jurisdiction. Some local daily working offices are placed in the departments of urban construction.

When a typhoon threatens a city, FCDRH will hold a videoconference with relevant governmental organizations to analyse the situation and assess preparedness. In this conference, some technical governmental organizations present their real-time and forecasted technical data on rain, tide and typhoon activity.[19] Additionally, other tertiary governmental organizations present what they have prepared. Then the FCDRH leader makes the final decision on what category the response will be initialized and delivers a mobilization speech. If it is necessary, this videoconference will be held frequently, from state level, province level, to city level and county level.

Coordination problems do not emerge as frequently in China's decision structure as they do in the United States. All the interviewees agreed that once an evacuation decision is made, all governmental organizations involved tend to cooperate well in the response. There are two reasons for this level of cooperation:

(1) The variety of actors involved in typhoon response in China is not as broad as in the United States. Although ancestral halls or churches may serve as shelters during evacuation, the capacity of these shelters makes up only a fairly small part of all provided shelters. In China, non-governmental organizations have emerged in media reports recently, but they only participate in major catastrophes, such as the Sichuan earthquake, not in routine disasters, like typhoons.[20] In Wenzhou, only one volunteer organization, which was founded in 2007 and consists of taxi drivers participated in the typhoon evacuation.[21] This is also the first non-governmental organization related to typhoon-disaster relief in China. Business sections seldom build up their own disaster supply chain or typhoon-specific planning like Wal-Mart, Chevron or Weyerhaeuser do in the United States. Underdeveloped capacities for typhoon preparedness in non-public sectors reduce the chance of failure for cooperation with governments; the government plays an absolutely dominant role in Chinese typhoon response.
(2) The top–down bureaucratic structure in China is powerful during an emergency. China is a country with centralized state power (Lieberthal, 2004). Leaders can mobilize different levels of governmental organizations to rapidly participate in a



Source, the website of State Flood Control and Drought Relief Headquarters

Figure 2. Organization Structure Chart of Hurricane Response.

response. Most of the officials are nominated by their superiors (Zhong, 2007); hence, they tend to respond well to top–down orders.[22] Additionally, China also relies heavily on its military in disaster response, which promotes command and control models.

However, this model is not without problems. Centralization of state power in emergency management is partially offset by horizontal and vertical power structures at the local level.[23] Typhoons or other disasters are local problems that need support from different agencies at the national level. Sometimes, local governmental departments need to balance orders from local administrators and national agencies.

Higher level authorities cannot gain completely accurate information about a crisis situation; hence, their commands tend to be vague and can be considered as a kind of guiding ideology. These vague commands could protect the high-level decision makers from taking responsibility for faulty commands. Sometimes, the contents of the commands are just repeating emergency plans or handing out of the leaders' speech in the mobilization meetings, and therefore, they tend to be redundant. Local officials have to translate these commands into detailed marching orders.[24]

4. Evacuation or not: critical decisions under uncertainty

Deciding whether or not to evacuate is a critical task that must be undertaken under conditions of high uncertainty. Before landfall, predicting the area of a potential typhoon landing is only one kind of uncertainty that creates a dilemma for decision makers: deciding not to evacuate may cause life and economic losses if the typhoon strikes, while evacuation is costly in terms of capital and governmental credibility, particularly when the typhoon does not strike as expected. There are additional uncertainties that influence decision making, for example, a large number of vehicles are involved in evacuation, which significantly exceeds the capacity of local road networks (recall Houston's evacuation during hurricane Rita); many people rush to a few shelters while there is still adequate space for evacuees in other places because of a lack of shared information between

shelters. Some critical infrastructures (like highways, bridges) may be destroyed by floods or winds, which may further hamper the evacuation.

In practice, however, evacuation decisions are typically the outcome of an institutionalized process. This is because typhoons have become a kind of routine crisis in some areas, and governmental organizations learn from experience. Governmental decision makers institutionalize their decision making to reduce the dilemma caused by these decisions through a combination of: (1) emergency plans; (2) their accountability system; (3) the preference of the public and media; and (4) the dominant state ideology.

4.1. Emergency plans and amendments

Emergency plans serve as restrictive institutions that routinize common decisions based on historical experiences (Gao, 2008). Chinese governments have generated $>$1.3 million emergency plans after the SARS crisis (Gao, 2008). Every county level and town level formulated their own typhoon evacuation plans, invited experts to evaluate the plans and updated them regularly.[25]

As indicated before, decision makers may fear the false outcome of a decision to evacuate because of the uncertainty of typhoon trajectories. To reduce uncertainty in governmental decision making, typhoon plans clearly formulate which typhoon preparedness category should be issued. For example, if the city weather bureau releases an urgent typhoon warning, forecasts a severe cyclone or a typhoon will land in Wenzhou, or a Severe Typhoon or a super typhoon will hit between Ningde city, Fujian Province and Taizhou city, Zhejiang Province, which may influence Wenzhou seriously, a Category I typhoon warning is released.[26]

Article 30, Zhejiang regulations for flood control and typhoon prevention, clearly states that 'the government which is in charge of organizing evacuation and its relevant departments have the right to enforce mandatory evacuation for those who refuse to withdraw after being advised under the following emergent circumstances: flood, typhoon, landslide, rockslide, mud-rock flow or other geological disaster that directly threatens the lives of masses are likely to happen; The government has decided to carry out flood mitigation or flood discharge.[27]

4.2. Accountability system

All interviewees agreed that decision makers need not to think about the uncertainty caused by coordination between governmental organizations. If local leaders cannot perform as instructed, they will be punished. More and more local leaders, even province leaders, have lost their positions because of underperformance during crisis.[28] New regulations for the accountability of chief administrative officers have also been issued at the province and city levels. For example, Wenzhou Temporary Provision for Executive Accountability, which was issued in 2007, stipulates that executives will be held responsible if they cover up or not release timely emergency information, take no action in organizing emergency rescue, or cannot execute the function of public management, causing mass public conflicts.[29]

4.3. Preference of the public and media

The media and the public tend to forgive overreaction or false positive errors[30] (the 'boy who cried wolf' syndrome); they certainly prefer it over passivity, especially after the 2006 super typhoon Saomai (Atwood & Major, 1998; Breznitz, 1984; Dow & Cutter, 1998). Negative revisions or false negatives are measurable by human death or misery (e.g., the suffering victims of New Orleans in the super dome after the 2005 hurricane Katrina) and visible to the media and public; even small deficiencies will be amplified by the media in crisis.

The 2006 Typhoon Saomai changed attitudes of the public towards false positive errors in evacuation significantly. Because most of the permanent citizens in Wenzhou were born and raised there, flood and typhoon stories are part of their life. They formed their own normalized preparation procedures, such as consolidating their own houses, moving to higher place and detecting flood level [this is called 'disaster subculture' (Anderson, 1965; Hannigan & Kueneman, 1978; Kueneman, 1973)]. Before typhoon Saomai, some of them refused to evacuate relying on their own experience. Evacuation was often carried out only when the houses were flooded. Soldiers had to use kayaks to move people to higher place or rescue people from debris destroyed by typhoons. After typhoon Saomai, few cases were reported about refusing to evacuate[31] because the public realized how severe a super typhoon is.

In order to reduce economic costs caused by false positives, Wenzhou city FCDRH adopted a method called batchwise evacuation. Before typhoon landfall, citizens who live or work near the beach are required to evacuate first, then the potential vulnerable houses that may be destroyed by the winds, the community in the downstream of dams with potential safety problems, and then the people who live near potential geologic hazards (like debris flow) will be evacuated.

4.4. A change of ideology

In my field research, all interviewees suggested that the central government attached more importance to crisis management after the concepts of 'human-centered' and 'always put the demos first' were advanced by the

Communist Party of China.[32] All acknowledged that the accountability system stimulated them not to violate the dominant ideology in a crisis.

Mr. Jinping Xi, former Secretary of the Zhejiang Province Committee of the Communist Party of China, announced that they would rather evacuate without the typhoon striking, instead of being hit without evacuation. This ideology also became the principal guideline of evacuation management.[33] This ideology was advanced in the historical context that local government should not just protect economic property, but also the life of humans.

These four factors, emergency plans and amendments, accountability system, the change of the public and media preference and the change of the dominant ideology, have turned the typhoon evacuation process into an institutionalized process. In the following section, I will examine the effects of this institutionalized process; it makes for a conservative decision-making chain, which promotes false positive errors.

5. Conservative decision-making chain and evacuation politicalization

All the interviewees indicate that decision makers tend to err on the safe side of protecting the public in the face of cone uncertainty in typhoon evacuation (see for a similar observation in the United States Mileti & Sorenson, 1990). When a typhoon threatens a certain number of coastal cities, central and local weather agencies will release their forecast to what extent this area will be influenced by the typhoon. There is always a long list of threatened coastal cities. In general, this forecast tends to be more conservative when this information will be adopted by other departments or governors for decision making.[34] Once this forecast is adopted in decision making, weather service authorities are accountable for any failure caused by an inaccurate forecast. Therefore, weather service authorities try to exaggerate the potential threat and make the forecast vague.

After receiving information from the weather service, governmental decision makers have to determine if evacuation is required. Successful evacuation of the people in threatened areas will be considered as their duty; governmental officials will not acquire awards or social credibility.[35] It is not easy to measure to what extent successful evacuation is executed by the government. If they are unable to evacuate people in the threatened areas, they will be criticized by the public, mass media and other interest groups. The criticism from a wrong decision not to evacuate when a typhoon really strikes is far more serious than an evacuation that was proven unnecessary. Therefore, the best choice is to evacuate all the time even though the striking possibility is very low; this will cause economic loss and governmental credibility loss. However, this type of governmental credibility loss will not appear immediately, which means this may not cause trouble during the governor's term.

The commands that are issued from the higher to the lower level make up a conservative decision chain. Conservative decisions allow the potential evacuees' time to evacuate. The accumulation of conservative decisions down the decision chain shifts problems to operational officials. The operational level (town level) must modify these decisions to solve practical problems (Figure 3). For example, if there is still sunshine, it is not easy to persuade citizens to evacuate. This conservative evacuation was also witnessed before hurricane Gustav in the United States. The governor of Louisiana could not afford a failure like Hurricane Katrina, so he decided to evacuate massively and at an early stage. The evacuation was successful, but mostly unnecessary in hindsight.

Typhoons are considered normal disasters in Chinese coastal cities. What worried leaders in the past were that local officials would think every response to typhoons should be similar.[36] However, chief administrators sometimes show overreaction and politicize the crisis response.[37] According to Wenzhou city typhoon response emergency planning, the director of the FCDRH did not need to appear in the meeting of typhoon response when a Category III typhoon was declared; and neither the Mayor nor the Secretary of the Municipal (Wenzhou City) Committee of the Communist Party of China need to participate in a Category I or II typhoon response. In reality, even in Category III, the mayor and Secretary of the Party attended meetings for mobilization. This attendance demonstrates to the lower level officials that the leaders place great emphasis on this disaster response.[38] Repeated unnecessary evacuation, historical success in evacuation and long waiting time could exhaust responders and make them too confident with the procedures about evacuation response, which may result in losing any fears of problems (which is referred to as a 'failure of success' by Pearson & Clair, 1998).[39] This issue was referred to many times by leaders in videoconference and can be found frequently in command documents.

6. Other considerations about evacuation

6.1. Warning

Information dissemination changes significantly during a typhoon evacuation. Traditionally, door-to-door notification is the main channel for warning in China, especially in the rural villages. In the most recent

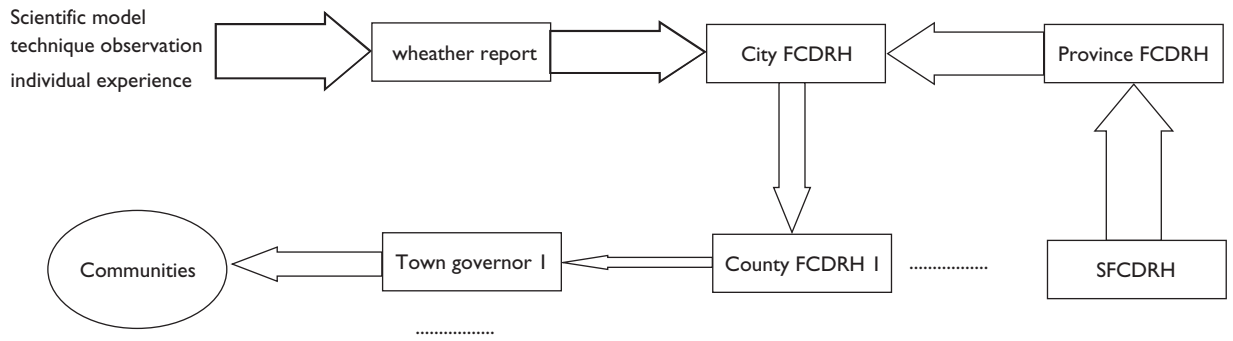


Figure 3. Conservative Decision Chain at the City level.

Table 1. Comparison of Hurricane Categories Between China and United States

	Speed	
	Low	High
China		
Tropical depression	10.8	17.1
Tropical cyclone	17.2	24.4
Severe tropical cyclone	24.5	32.6
Typhoon	32.7	41.4
Severe typhoon	41.5	50.9
Super typhoon	$\geqslant$51	
United States		
I	32.8	42.5
II	42.8	49.2
III	49.4	58.1
IV	58.3	69.2
V	$\geqslant$69.2	

typhoons, multiple channels were activated. Besides relying on top–down official communication, governmental departments also released real-time information on their websites. For example, all real-time hydrological information, satellite cloud pictures, tidal levels and typhoon forecasts are updated hourly on the official websites.[40] A float window appeared in the main official website in order to attract Internet users' attention. Live television announcements and cell phone instant messages were also used. Wenzhou government is proposing ADW,[41] which was used in anti-aircraft defence in cold war, to warn the city for an impending typhoon evacuation.

Additionally, China government adopted nationwide open government information regulations on 24 April 2007, which marks a turning point from a deeply ingrained culture of government secrecy towards making governmental information more transparent (Xinhua Reporter, 2007a, b). Following deficiencies of information dissemination in emergencies, especially during the 2003 SARS crisis, this regulation stipulates that emergency plans, warning information and response should be made public. This regulation also makes timely warning an obligation for emergency response departments.

6.2. Evacuation of people with special needs

Migrating peasant workers and citizens in vulnerable houses received much attention at the town level. Wenzhou and other coastal cities, which are affected by typhoons are economically developed areas and manufacture bases for export. These areas attract large numbers of migrating peasant workers from western rural areas. But these peasant workers find it difficult to make sense of what happens during typhoon seasons, because these situations completely exceed their previous experience (cf. Sellnow, Seeger, & Ulmer, 2002). Telephone numbers of their employers were listed in emergency plans of town levels, and these employers took the responsibility to evacuate their workers.[42] In batchwise evacuation, social security police and housing department officials are responsible for the final clearance of hazardous houses. Few specific plans, however, specified about the evacuation of special needs individuals (seniors, people in need of nursing care or people with disabilities).

7. Long-term typhoon disaster management

Successful evacuations entail more than moving people to shelters. Systematic preparedness is required. However, preparedness still plays a secondary role in China's emergency management system. In this section, several problems are presented related to long-term typhoon evacuation response, which are typically neglected by local governments.

7.1. Safety management of evacuation

Safety issues of evacuation have great impacts upon the well-being of citizens and governmental credibility (Moreno, 2005; O'Driscoll, Wolf, & Hampson, 2005).[43] Ill-prepared evacuations, which neglect potential safety problems, may result in unnecessary deaths. It seems that Chinese governments have not learnt much from foreign cases about safety issues of evacuation.

Little evidence related to evacuation safety was referred to by interviewees.

The area of official registered shelters in Wenzhou city is 486,847 m^2 in 2008, which can hold 162,574 people.[44] Some of the interviewees said that there are official evaluations for the shelters in their jurisdiction, whereas some others said there is no evaluation, but they got the official labels for shelters. Most of the interviewees agreed that large amounts of the shelters are vulnerable to super typhoons, especially shelters in the rural areas. For example, a private household shelter collapsed in Heweiyang village, Wenzhou in 2006 typhoon Saomai.[45]

7.2. Large public transportation system

Every city or village in Wenzhou has a hill or foothill nearby. Therefore, the citizens are not afraid of potential floods and other secondary disasters like debris flow or mud–rock flows caused by typhoons. The evacuations are relatively simple: just move to a safer and higher place nearby. However, many shelters cannot withstand super typhoons. Most families in China, especially in the rural areas, do not have the necessary vehicles to evacuate from coastal areas to far-away shelters. If a super typhoon makes landfall in China, this kind of nearby evacuation may fail.[46] Large-scale public transportation system for evacuation will cause bottlenecks. Successful small area public transportation may inspire further design of large-scale evacuation public transportation system.[47]

7.3. Coordination in daily preparedness and learning

Traditionally, governmental efforts concentrated on search and rescue after a typhoon made landfall or the flood reached public properties. China improved in prevention and preparedness, but there still are some shortcomings. China's mobilization ability demonstrates strength during typhoon emergencies, but in the daily preparation for disasters, FCDRH's agenda moves back to other issues and the office for FCDRH cannot coordinate other governmental organizations easily.[48] Crises are known as low-probability high-impact events that do not always compete successfully for resources in preparedness (Falkenrath, 2000). Most leaders do not have such foresight to invest in planning and preparedness. For example, reconstruction or maintenance of dangerous shelters could improve the response and reduce vulnerability, but it is not easy to get this on the agenda or get budgets for this.[49] There is hardly enough funding for compiling, evaluating or revising the emergency operational plans, especially at the town level.[50]

After major typhoons, governmental officials from various departments become active in typhoon preparation, mitigation and relief, driven either by their confounded performance or by the focus of news media. During this time, typhoon disasters function as 'focusing events', which trump other dominant issues on the policy agenda (Birkland, 1996). This interest in preparation for the next typhoon fades rather quickly, however.[51]

Most officials in FCDRH are trained as engineers in water resource-related areas. There are almost no officials with a background in social science, especially management, or public administration. These officials thus primarily rely on engineering measures and experience[52] (Le, 2000); they are less able to coordinate or plan. When I interviewed in Wenzhou, most interviewees talked much about engineering measures for typhoon response, for example, building more dams, flood control projects, storm gates, breakwaters and groins, detecting the potential debris flow site and assigning patrolmen for warning of big storms.[53] A Vehicle Synchronous Orbiting Satellite Mobile Communication System will be sent to potential islands whose communication system may be destroyed by typhoon. When I referred to non-engineering measures, most of them would refer to typhoon emergency plans. At the town level, response officials are volunteers without any formal disaster response training.

8. Conclusions

China has faced typhoons and other typhoon-caused secondary disasters in many provinces and requires high-level disaster response capacity. China is making rapid progress in local typhoon evacuation response. In two decades, China has changed its guiding ideology towards disaster response, formulated typhoon emergency plans and built basic dual shelters, introduced legislation to support evacuation, set up multiple warning channels and formulated specific policies for migrating peasant workers.

Some problems, however, still exist, which will challenge future typhoon response. A conservative decision chain was identified and evacuation is to some extent becoming politicized. Precautious evacuation is an effective way to reduce loss of life, but too cautious decisions may bring trustiness problems for the government in the long term. Long-term prevention, especially soft measures, does not receive enough attention. In 1990s, China governments invested much in engineering measures to prevent coastal communities and low land areas from being flooded by typhoon-induced tides and surges. After the 2003 SARS crisis, the central government initiated a national framework or institution for emergency management.

Still, more certificated shelters and public transportation system need to be designed and implemented. Like many other governments, governments in China are also prone to forget the pains caused by historical super typhoons and neglect implementing appropriate and continuous financial support for disaster preparation and mitigation.

Emergency managers are in great need of professional education programmes. In China, most emergency managers hold engineering degrees, and there are only a few professional education programmes (whether degree seeking or non-degree programme), which provide training for them. In building new education programmes or perfecting existing programmes, international experiences are of great value for both public institutes and private entities in China.

Chinese researchers in social science have become involved in crisis or disaster research since 2003, but there are still few researchers doing typhoon-specific research like scholars in other countries, especially in the United States, such as focusing on the evacuation warning process, individual and organizational responses to warnings, studying disable groups in evacuation. Knowledge and theories need to be imported from the Western world and adapted to China's reality.

Acknowledgements

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Notes

1. This paper was written during my stay at the Stephenson Disaster Management Institute of Louisiana State University in 2008–2009; and this paper has won the 2009 Annual Hazards and Disaster Student Paper Competition and been permitted to publish in this journal.
2. For the comparison of hurricane and typhoon categories used in China and the United States, please see Table 1.
3. Based on official estimate http://news.xinhuanet.com/employment/2005-04/29/content_2894703.htm
4. http://www.wzstats.gov.cn/
5. Based on the contents from *Wenzhou Municipal Manual for Flood Response*, edited by Xue Zhigang (2008).
6. Ibid.
7. For details, please see http://english.wenzhou.gov.cn/
8. Interview #4, 8, 15 and 16.
9. For example, if the dam burst under the weight of water, the party member led mobilized masses into the river to stop the water. Many lives were lost because of this kind of irresponsible leadership. This is reflected clearly in the disaster movie 'Super typhoon', directed by Feng Xiaoning, which is based on typhoon responses in China.
10. Interview #4, #10, #11 and #12.
11. Interview #1, #5, #6, #7 and #8. At the county level, 340 in 342 counties that were influenced by typhoons directly have finished typhoon emergency planning according to statistics at the end of 1998.
12. The amount depends on the situation of the hurricane; in total, it is from 10 to 40 per hurricane (not including upstream communication from lower level to higher level). Sometimes, these telephotographs are sent every 10 minutes.
13. Based on the recommendation of officials, experienced decision makers and retired officials at different levels were selected for interview.
14. Public emergencies are classified into natural disasters, industrial accidents, public health crisis and social security crises. For details, please visit http://www.gov.cn/yjgl/2006-01/08/content_21048.htm
15. State council is the leading agency of all types of disasters or emergencies in China. At least 21 headquarters, which are led by the vice premiers and composed of many vice ministers from other related departments are specially designed and responsible for each specific type of emergency. An implementation office is set up in the ministry, which is most relevant to this type of emergency, and is responsible for daily emergency prevention and preparation. In a declared national-scale emergency, the headquarter responses to the emergency directly.
16. For details, please see http://sfdh.chinawater.com.cn/jgsz/jgsz.htm
17. For which ministry is relevant to hurricane response, please see Figure 2.
18. This will be a more complex coordination issue, especially in Songhua River pollution crisis. For more, please see Lu (2007) and Ma et al. (2009).
19. Personal observation. In addition, all these forecast reports, real-time rain information and emergency planning are shared on the website for public viewing. But there is no integrating website for all the information.
20. Interview with the director of Cangnan emergency rescue volunteer centre.
21. For details, please see the website http://www.yjjy.org/
22. Although covering-up crisis information at the local level has been observed in other types of crisis, like public health incidents (SARS, Sanlu milk crisis), industrial incidents (Songhua River Pollution Crisis) and riots (Wengan riot), little evidence of that behaviour has been detected in recent typhoon response.
23. This issue was widely raised and recognized by Chinese scholars during discussion and keynote speeches in the International Conference On Risk, Crisis and Public Management in 26–28 September 2009, in Nanjing, China.

24. Interview #7 and #13; personal observation, officials in county level just forwarded the official command documents to the town-level command centre.
25. Based on interviewees #1-#14. In the field research, I also found that a retired official was recruited as a part-time employee to examine these town-level emergency plans at Wenzhou FCDRH.
26. http://www.wzsl.gov.cn/wzsl/html/fxfhya/
27. http://slt.zj.gov.cn/pages/document/47/document_537.htm
28. This kind of accountability system started with the resignation of Mr. Zhang Wenkang, the minister of Public Health, in the SARS crisis. Since then, a kind of 'accountability storm' has been blowing. In the Sanlu milk powder crisis, Director General of General Administration of Quality Supervision, Inspection and Qurantine, Governor of Hebei Province resigned, the mayor and co-mayor of Shijiazhuang city were fired. In Shanxi Miner crisis, Governor and vice governor of Shanxi province resigned. This also happened in the Wongan public conflict crisis, and the Jiaoji Railway accident crisis, etc.
29. http://www.wzsl.gov.cn/wzsl/html/gfxwj/2007-6/13/11_14_14_614.html
30. False-positive (also called 'type I error' or 'α error') and false-negative (also called 'type II error' or 'β error') are originally used to describe errors made in a statistical decision-making process by Jerzy Neyman and Egon Pearson in 1928. False positive means error of rejecting the null hypothesis given that it is actually true; false negative means the error of failing to reject the null hypothesis given that the alternative hypothesis is actually true.
31. Based on interview #3, 4, 5, 10 and #11.
32. After that, the government invested in evacuation and shelter management. In the past, FCDRH could obtain the budgets.
33. Interview #2 and #3.
34. Interview #2, #3 and #4. Forecast reports from local weather service authorities combine the forecast report from the central and province weather and their own experience. Normally the governor will follow the local weather service.
35. Interview #7.
36. Based on on-site notes of speech by the party leader in Wenzhou, Shao Zhanwei.
37. Interview #4, #5, #7 and #12.
37. Interview #2, #3, #4, #5 and #8.
39. 'Failure of success' means that they would think their organizations are no longer vulnerable to typhoon after repeating historical success.
40. http://www.wzsl.gov.cn/wzsl/html/fxfh/ http://www.zjwater.gov.cn/typhoneweb/
41. This is a kind of warning facility, which was designed during the cold war.
42. Based on interview and five town-level emergency plans.
43. For example, a bus carrying evacuees crashed and four people were killed, of which three from abroad were in Cuba during 2005 hurricane Wilma; a bus fire during 2005 hurricane Rita killed 24 elderly nursing home evacuees from Brighton Gardens in Bellaire, Texas; Houston's traffic jam during Rita evacuation compelled evacuees to run out of gas or experience breakdown in high temperature.
44. Based on Wenzhou Municipal Manual for Flood Response, edited by Xue Zhigang in 2008.
45. This is a shelter widely used by the people in this village, but not officially verified. There are still protests on the web to criticize governmental ill-preparedness.
46. Interview #2, #4, #6, #7 and #16.
47. Interview #5. They provide the case of Lingkun Island. The local government evacuated all the citizens on the island to the continent in using public transportation.
48. Interview #2, #3 and #4.
49. Interview #3 and #4.
50. Interview #2, #3, #11, #12 and #13.
51. Interview #3, and #5.
52. Having experienced huge economical and human life losses caused by the 1992 Typhoon Polly, 1994 Typhoon Fred and the 1997 Typhoon Winnie, Chinese local governments had invested much to build qualified sea walls and observation facilities for surge and communication networks.
53. Interview #2, #3, #4 and #5.1pc

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