IV. Hainan Flooding in China in 2010

September 2016

Preface

Whilst Asia is ranked as the most disaster-prone region in the world in terms of both natural and man-made disasters, research and training in the Asia-Pacific region is limited. Better understanding of the disaster epidemiological profile and human health impact will enhance response, preparedness and mitigation of the adverse human impacts of disaster. The concept of case-teaching method has been used extensively in research and teaching of disasters and humanitarian studies at schools of public health around the world, including Harvard School of Public Health, Johns Hopkins Bloomberg School of Public Health and London School of Hygiene and Tropical Medicine. Through the existing partners and networks of The Jockey Club School of Public Health and Primary Care, the Public Health Humanitarian Initiatives of The Chinese University of Hong Kong, and the Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response (CCOUC), this disaster and humanitarian relief monograph series composed of eight case study reports has been developed using a standardised analytical and reporting framework. Methods for case study including literature reviews, stakeholder interviews and retrospective data analyses have been employed.

The main objective of this China Hainan 2010 flood case study is to highlight the key lessons learnt in the region's medical and public health responses to disasters. The goal is to develop Asia-specific public health teaching materials for disaster response.

The "Guidelines for Reports on Health Crises and Critical Health Events" framework has been adopted as a reference for the literature search and the identification of key areas for analysis (1). We acknowledge that disaster management is a multidisciplinary area and involves much more than health issues, but we believe that the public health impact of all interventions should be appreciated across all disciplines.

This report is developed from a research conducted by Emily Ying Yang CHAN, Crystal Yingjia ZHU, Kevin Kei Ching HUNG and Polly Po Yi LEE in 2011 with the support of CCOUC fellows. Ms Zhu was then fellow and Dr Hung Research Manager of the Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response (CCOUC).

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Executive Summary

In an attempt to obtain a better understanding of the disaster, this case study introduces the background of the Hainan Island, how the disaster affected the island, the damage suffered and how the government responded to the event. Findings from a cross-sectional survey conducted three months after the disaster are also included.

The case study found that Hainan seemed to deal with the flooding efficiently although the consequences would have been less dire should the infrastructure be of better quality. Short-term relief responses are categorized and analyzed according to the Oxford Framework's five basic needs of living, namely water/sanitation, food, non-food items/shelter, health services and information. While the short-term measures seemed to fare well for the people, its effectiveness cannot be directly evaluated as there is no benchmark to do so. The survey gives an idea of what the situation was like at the local level. Results obtained were compared with other studies to evaluate the validity of the statistics and to measure the usefulness of the relief measures indirectly.

Poor social infrastructure poses the greatest risk, and has to be solved through long-term commitment. Aging reservoirs, deforestation and a poor drainage system are the main vulnerabilities which should be fixed.

1. Introduction/Material/Methodology

1.1 Introduction

This study examines the impacts of the Hainan flooding in October 2010, the lessons learnt and improvements needed for better preparedness against future flood disasters, with a focus on the public health and medical aspects of disaster relief.

Floods frequently devastate China, affecting millions every year, but literature on their impacts is

strikingly lacking, hindering research and response improvement. There is a pressing need to understand the intrinsic vulnerabilities of the Hainan Island, and what the current capacities are lacking to adequately protect the local population. Two reasons increase the urgency of research. The first one is Hainan's rapid economic growth that has made it a popular destination for tourists and a place of international concern. With the presence of an international community on the island, local disasters have become an international issue. The second reason is climate change. Trends predict that typhoons, which are climatological disasters, are going to occur more frequently in the future. Should disaster response measures not be improved promptly, the island would suffer significant setbacks on its recent developments.

1.2 Material

This case study integrates information from literature review as well as a cross-sectional and four-stage stratified clustered interview-based survey of a randomized sample of households. The survey was conducted in six villages (3 affected by the flooding, 3 not) in Hainan in Jan 2011. A total of 267 completed disaster-preparedness questionnaires were collected through face-to-face interviews. In each visited household, a face-to-face interview and an environmental assessment were conducted. The interviewer asked the respondent about the questions in the household survey while the other interviewer would fill in the environmental assessment through observation. Each interview lasted for around 30 minutes and a pair of couplets and a calendar were presented to each household as incentives.

PubMed, Medline, Global health and Embase were used to search for English language academic papers; and China Journal Net and Wanfang to search for Chinese language papers. The keywords used were "flooding", "torrential rain", "impact", "health impact", and "disaster" combined with the term "Hainan". Both national and provincial levels statistical yearbooks and civil affairs' statistical yearbooks were checked for related information. News articles from government websites, Xinhua,

Nanhai and Sohu were also used, accessed through the search engines Baidu and Google.

1.3 Methodology and a theoretical framework for a flooding case study

To achieve a systematic examination of the case, major public health principles of disaster response and the disaster cycle model will form the theoretical framework for this analysis.

I. *Public health principles of disaster response*

According to the *Oxford Handbook of Public Health Practice*, the three main principles of public health response to disasters include securing basic human needs required to maintain health, determining the current and the likely health threats to the affected community, and acquiring and providing the resources to address the two issues above (2). The discussion in this case study will focus on the five basic human health needs.

The five basic requirements for health include food, health services, information, water and sanitation, as well as shelter and clothing. Securing the access to the basic needs is considered the main goal of the emergency relief.

As a global effort in setting the standard for emergency relief, the international Sphere Project hosted by the International Council of Voluntary Agencies (ICVA) in Geneva is "a voluntary initiative that brings a wide range of humanitarian agencies together around a common aim - to improve the quality of humanitarian assistance and the accountability of humanitarian actors to their constituents, donors and affected populations." The Sphere Handbook, *Humanitarian Charter and Minimum Standards in Humanitarian Response*, provides a level of standard that has been agreed upon by a multitude of front line agencies (3). It contains the minimum standards for most aspects of the basic requirements for health, specifically water supply, sanitation and hygiene promotion; food security and nutrition;

shelter, settlement and non-food items; and health action. For each specific sector, it has distinct indicators to measure whether the minimum standards are being achieved.

II. *Definition of health*

Health is a state of complete physical, mental and social well-being instead of the mere absence of disease or infirmity (4). Specifically, public health is defined as "[t]he science and art of preventing disease, prolonging life and promoting health through the organised efforts of society", according to Sir Donald Acheson (5).

III. *The disaster cycle model*

Apart from the general public health principles, it is important to recognise the different actions required during the various phases of disasters. The disaster cycle model helps highlight the key stages in post-disaster emergency response. It can serve as a useful reference for different parties to take actions during disaster management.

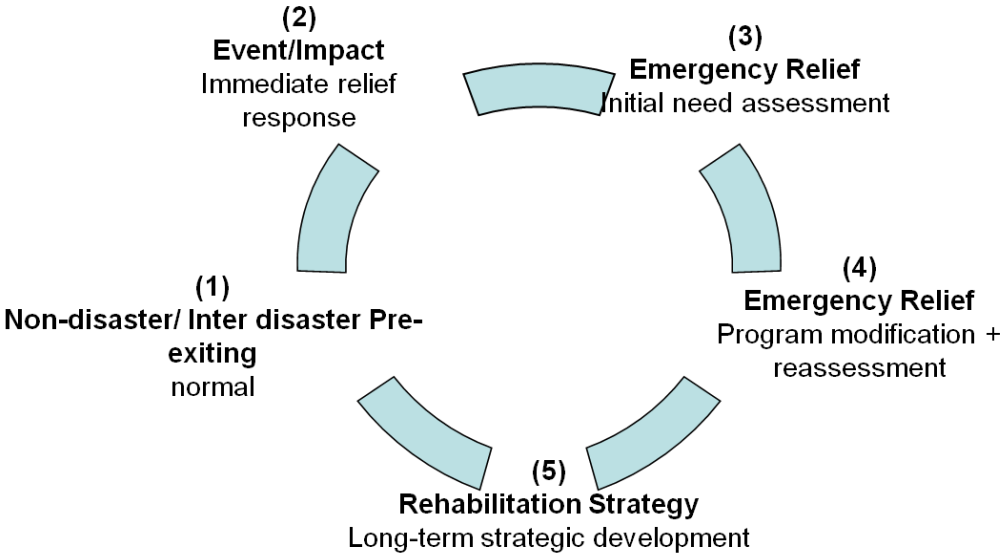


Figure 1 Disaster cycle

Source: Chan EYY, Sondorp E. Natural disaster medical intervention: missed opportunity to deal with chronic medical needs? An analytical framework. Asia Pacific Journal of Public Health. October 2007;19(Special Issue):45-51.

This case study report will examine the health impact of the 2010 China Hainan flood. It will focus on the emergency relief responses and assess the different aspects of the measures.

2. Pre-Event Status

2.1 Background

Hainan Province is located at the southernmost tip of China with Haikou as its provincial capital. It is home to around 8.64 million people (6). Being the second largest island of China (only smaller than Taiwan), Hainan has two prefecture level cities, four regions, six county-level cities, four counties, six autonomous counties, 183 towns and 21 villages. It has an area of 33,920 km^2 and is China's smallest province. About 82.6% of the population are Han Chinese while the rest are members of ethnic minority groups.

Among the various ethnic minorities, Li (黎族) is the largest and comprise about 15.8% of the population, followed by Miao (苗族) (0.8%), Zhuang (壯族) (0.4%), Hui (回族) (0.1%), and others(0.2%), as stated in Hainan Statistical Yearbook (7). According to the 2009 National Sample Survey, 50.87% of the people in Hainan were clarified as rural population, compared with the national average of 53.41%. The average temperature is 22-26℃, the coldest being 16-21℃. The warm climate makes Hainan an ideal place for planting plants and fruits. Besides the most popular crops and wheat, the main agricultural products include sugarcane, rubber, coconut, areca and pepper.

The life expectancy in Hainan is 70.66 years for male and 75.26 years for female, higher than the 2000 national average of 69.63 and 73.33 years respectively. As for the health system, figures in 2009

reported that there were 493 hospitals and health centers and 46,599 people employed in healthcare institutions in Hainan serving 8.64 million people. The lack of transparency of the relief responses and the lack of research literature in this flood-prone area have made it hard to evaluate the sufficiency and proficiency of the health system, as well as to identify any lessons learnt from the many past disasters.

2.2 Preparedness

2.2.1 Governmental Preparedness

On a national level, the Flood Control Regulations published in 2006 based on the Water Laws (8) give directions on aspects such as preparedness, surveillance, resilience, funds, and reconstruction, and list the responsible departments. There are also laws about Emergency Response and regulations on Public Health Emergency Response (9). Regulations on the army's participation in disaster relief were established in 2005, which stated how the army should be involved in disaster relief operations (10).

On a provincial level, Hainan has established plans for contingency responses, medical relief and public health responses to emergencies, and geological and natural disasters (11). The latest 2006 edition of the Hainan Preplan for Tropical Cyclone and Flooding was first published in 1999 (12). The preplan states the typhoon scale system, forecast methods, preparation for disaster relief and resettlement arrangements in face of typhoons and flooding. A warning system exists but lacks guidance as to what corresponding actions should be taken. Besides a brief mention of medicine use, the plan does not remark on the public health aspects of disaster relief, focusing instead on maintaining infrastructure. Public health, which is often the most immediate concern after a typhoon strikes, should receive more attention since a neglect of it could lead to disastrous consequences.

Hainan had also asked for a warehouse of disaster relief supplies in the end of 2008, which was

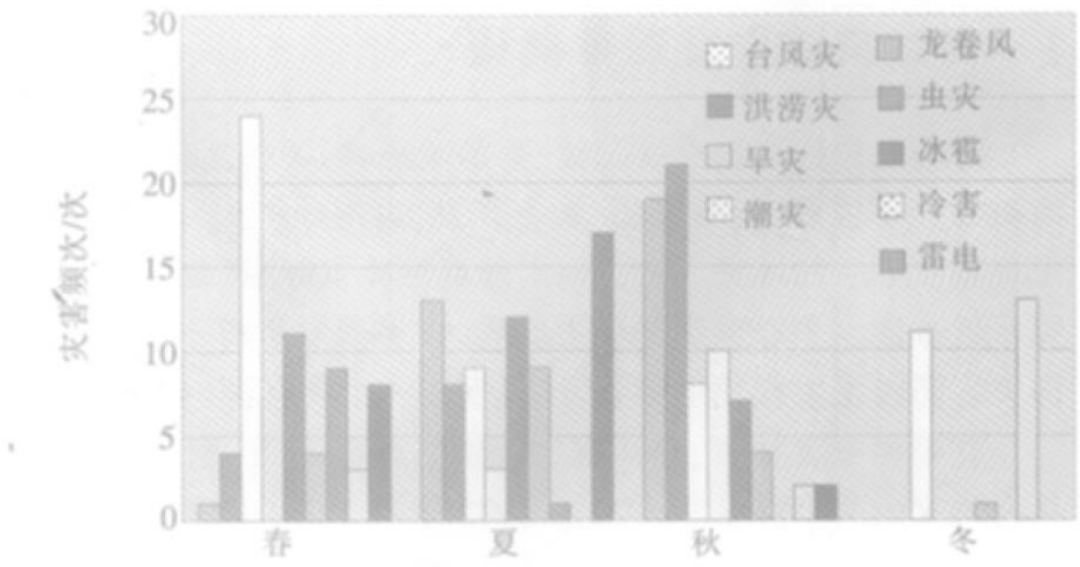
realised in September 2010.

2.2.2 Personal Preparedness

There is no existing benchmark to evaluate the level of preparedness of the local community. Examining people's perceptions of their exposure to risk would give an idea of their intentions and actions to prepare themselves for disasters, such as by stocking up on emergency supplies. A paper looking into people's risk perceptions after a torrential rain in Hainan in 2000 found no significant difference between the affected and non-affected population (13). The researchers believe that the population is already used to the many disasters that frequently plague the island. The paper's household survey found that factors such as the severity of the flood, ethnicity and age were not associated with the sample's perception of their exposure to disaster risk. However, agricultural workers were more likely to think that they lived in a high disaster risk area. Individuals living in severely affected areas were more likely to have considered or have actually prepared disaster-related emergency supplies at home, but they are less likely to have received a tetanus vaccination. It is important to note that many who had intended to prepare themselves for the disaster did not actually do so. The fact that people lived in more severely affected areas does not imply a greater possession of medicinal drugs or level of first aid training.

2.3 Hazard

Hainan Province is a tropical island with a monsoon climate, making it especially prone to disasters such as typhoons, tornados, cyclones, gales and floods. Records show that 234 natural disasters occurred in Hainan from 1949 to 1988, as can be seen in Graph 1 (14). Given the geographical features of Hainan, whose terrain is high in the center and low in the periphery, concentrated torrential rain also leads to water loss and soil erosion.



Graph 1 The disaster distribution of Hainan Island, 1949-1988

2.4 Risks

Prone to frequent disasters, Hainan has suffered devastating losses throughout the years; people in Hainan face high risk resulting from flooding and typhoon with reference to statistics of rainfall and economic loss of the disasters. The annual precipitation of Hainan is 1639 mm. Most of the rain falls from May to October, making up 70%-90% of the annual total. Flooding is extremely common in this period. Houses built are not going to last long due to water loss and soil erosion mentioned above. Previous statistics from 2000 to 2005 show that the annual direct economic loss from typhoons and floods is around RMB 3.86 billion, almost 5.66% of the local GDP (15). Around 70% of the loss came from the agriculture, forestry, stockbreeding, and fishing industries. In 2005, the 18th typhoon Davee destroyed 100% of the rubber, 80% of the banana and 60% of the rice crops. The fresh gale stayed in most parts of Hainan for over 20 hours, affecting 9 million people and 1.03 million hectares of crops. Davee eventually caused 21 deaths and the collapse of 30,000 houses, adding to a total loss of RMB 12.1 billion. In 2009, the total economic loss caused by natural disasters was RMB 534 billion, of which RMB 350.5 billion was caused by flooding and landslide. That year, 13 thunderstorms struck the island, causing 5 deaths and RMB 0.3 million of economic loss.

Although it is difficult to predict the loss caused by a future disaster, the number of lives lost is expected to decrease and the economic loss to increase. Fewer casualties are anticipated because of improved disaster responses, but greater economic loss because of the recent rise of more expensive buildings such as resorts due to booming tourism.

Table 1 The direct economic loss of typhoons and floods in Hainan in 2000-2005

Year	**Economic loss of typhoons and floods (RMB)**					**Hainan GDP (RMB)**	
	Total (billion)	Loss of agriculture, forestry, stockbreeding, and fishing industry		Loss of water conservancy project		Total (billion)	Economic Loss as a Proportion of GDP (%)
		Total (billion)	Proportion of Economic Loss Constituted (%)	Total (billion)	Proportion of Economic Loss Constituted (%)		
2000	5.82	4.04	69.47	0.51	8.70	51.8	11.22
2001	1.76	1.22	69.29	0.31	17.74	56.7	3.11
2002	1.03	0.61	59.71	0.15	15.03	62.5	1.64
2003	2.79	2.35	84.29	0.15	5.50	69.2	4.03
2004	0.05	0.03	56.28	0.01	21.23	79.0	0.06
2005	11.7	8.07	68.82	1.18	10.08	90.4	12.98
average	3.86	2.72	70.45	0.39	10.01	68.3	5.66

2.5 Vulnerabilities

2.5.1 Aging Reservoirs

Old reservoirs that lack modern safety measures or do not satisfy standards such as the flood load criteria pose significant risks of property damage and loss of life to downstream regions, especially highly populated areas. Most of the reservoirs in Hainan were built between the 1950s and the 1970s, and are approaching or have exceeded their designed lifespan (16).

There are about 1127 reservoirs in Hainan. Two thirds of the 72 medium-sized reservoirs and all the 1047 small-sized reservoirs are without water gates and spillways (17). Most of the dams are built with pure soil, and many lack rollers that mitigate erosion and have critical leakage problems. In April 2010, six expert teams from Hainan examined 1085 reservoirs. They classified 69.7% of them as high-risk reservoirs that lacked management and were operating with various problems. Many of them were small-sized reservoirs scattered on the mountains and other hilly areas. During the flood season, these reservoirs have a high risk of collapsing. When this happens, downstream regions would be buried under uncontrolled amounts of water, causing colossal damage.

2.5.2 Deforestation

The destruction of natural forests and vegetation is a cause of more frequent disasters, according to Mr. Liu, the previous Forest Fire Director of Hainan. Natural forests conserve water and bind the soil together. After raining, they absorb the surface water and break up water flow, thus reducing the risk of landslides. Previous studies have found that villages without shelter forests were the most affected by typhoons.

Deforestation is rampant in Hainan. Although in 2009 the province planted 25.6 thousand hectares of trees, increasing the percentage of forest coverage to 59.2%, many trees along the coastal area were for aesthetic purposes, and were not effective in preventing disasters. Some shelter forest areas have even been turned to golf courses and resorts with sea views to attract tourists.

2.5.3 Weak Drainage System

Although Hainan has seen fast economic growth, its infrastructure is lagging behind. As more expensive and sophisticated buildings are springing up, the local government has paid little attention to developing the drainage system. In some cases, the buildings may even be blocking the original drain lines. This is catastrophic for a flood-prone place such as Hainan, as an effective drainage system can divert water from heavy rainfall and prevent flooding.

Hainan has an area of 33,920 km^2, but only has 2,286 km of sewage pipes. Table 2 compares the areas of some other Chinese cities with their respective lengths of sewage pipes. The rate shows the length of pipe (km) per unit of area (km^2). Though the rate itself is not sufficient to reflect the strength of a city's drainage system (as other factors such as pipe distribution and quality need to be considered as well), it still reveals that Hainan obviously lags behind in the density of sewage pipes. Other coastal areas such as Zhejiang, which also face high risk of flooding, has a rate of 0.240, while that of Hainan's is only 0.067. Zhejiang has 258.2% more sewage pipe density than Hainan.

Table 2 A comparison of the area and length of sewage pipes in some Chinese cities (2009)

	Area (km^2)	Length of City Sewage Pipes (km)	Rate (length/area)
Beijing	16,410	9,344	0.569
Shanxi	156,579	4,864	0.031
Liaoning	146,900	13,350	0.091
Shanghai	6,341	10,213	1.611
Jiangsu	102,600	42,826	0.417
Zhejiang	101,800	24,456	0.240
Anhui	139,600	11,333	0.081
Fujian	124,000	8,565	0.069
Shandong	157,800	38,656	0.245
Guangdong	179,800	38,346	0.213
Guangxi	236,700	5,650	0.024
Hainan	33,920	2,286	0.067
Sichuan	485,000	12,883	0.027

2.6 Resilience

Hainan has recently taken proactive measures to prepare itself for the frequent flooding it suffers. In 2008, Hainan carried out a 3-year project that revamped 189 reservoirs that are in poor condition, although a vast number of reservoirs remained to be improved. Prevention preplans of tropical cyclone and flooding for the reservoirs have also been adjusted.

The Hainan Drug Administration was established in 2000, and it started to develop regulations on the

storage and distribution of drugs in order to cope with a large number of injuries and diseases resulting from disasters. These regulations were revised after the SARS outbreak in 2003. Hainan also established a warehouse of disaster relief supplies in 2010.

3. Health Crisis and Critical Health Events

On the evening of 30 September 2010, a torrential rainfall struck Hainan that lasted nine days, the longest recorded since 1961 with (18). The average precipitation per day during that period was around 648.3mm, almost 7 times the normal amount for this time of the year, which is 93.1 mm (19). Torrential rain first began to fall in the southeastern regions of Hainan, in cities such as Wanning, Baoting, Lingshui and Sanya. Then it spread to the whole island, especially the eastern region. In the early hours of 5 October, the Hainan Meteorological Administration called for the Class II torrential rain emergency response, and increased it to Class I by 5pm, the highest possible warning. The daily precipitation of Qionghai, Wanning and Wenchang went beyond historical records, reaching 701.9mm, 392.2mm and 297.2mm respectively. These numbers continued to rise, reaching 1465.6mm, 1187.2mm and 1408.2mm on 7 October. The torrential rain continued until the early morning of 10 October, when it stopped for three days before striking the island again with another round of torrential rain from 14 to 18 October (20).

Figure 1 The map of Hainan

In sum, average precipitation in Hainan during this period was 1040.6mm, 5.7 times the figure of the same period of the previous year, which was 181.4mm (21). From 1 to 9 October, precipitation in most of the cities was between 300mm and 1000mm. Total water volume in reservoirs increased by 2.2 billion m^3 to 5.9 billion m^3 as a result of the rain. 70% of the reservoirs were dangerously full.

Graph 2 The precipitation of Hainan, 1-18 October 2010

4. Damage & Consequences of Damage

4.1 Damage and Disturbances (Human)

I. *Human toll:* The two rounds of torrential rain brought devastating damage to the island. Most of the counties, especially those on the eastern side, were severely affected. Nearly 4 million residents on the island were affected by the floods (see *Table 3* for details).

Four people died and floodwater inundated 1,160 villages. 90% of Hainan was flooded. According to the Department of Housing and Urban Development in Hainan, 111,800 houses of about 10.286 million km^2 were flooded, 3,068 houses had collapsed and 42,400 were dilapidated. Many roads, sanitation facilities and national resorts were also damaged (22). More than 700,000 people were evacuated and the disaster damaged over 20,000 houses and caused more than RMB 10 billion of economic loss, of which RMB 6.28 billion was in the agriculture, forestry, stockbreeding, and fishing industries (23). This led to the rocketing of food prices.

Table 3 The extent of people, resources and economy affected by the floods in the period from 30 September to 9 October and from 14 October to 18 October 2010

	Population affected (person)	Population with emergency resettlement (person)	Affected crops (ton)	Collapsed Houses	Impaired Houses	Direct economic loss (billion RMB)
Total amount from the two periods of flooding:	3,999,830	731,459	249,518.8	8,810	13,592	10.6

II. *Sickness:* The top five sicknesses in the flooded areas were dermatitis, upper respiratory tract

infection, conjunctions, gastrointestinal infection, and hypertension. No outbreaks of infectious diseases were found (24). From 6-9 October, the numbers of new patients diagnosed with diarrhea each day were 39, 101, 183 and 279 respectively in all levels of medical institutions across the province. The self-reported post-disaster impacts of the studied population are shown in *Table 4*. In general, the morbidity rate is 23% and the major kinds of illnesses identified include upper respiratory tract infection, infectious diarrhea, and skin disease. Respondents from severely affected districts and the Han ethnic group were more likely to have fallen sick compared with respondents from mildly affected districts and the Li ethnic group respectively.

Table 4 Self-reported post-disaster impacts of the studied population

	Whole Study Sample (n=267)	**Different severity (geographic location)**		**Different Ethnicity**	
		Mildly affected (west side) (n=98/99)	**Severely affected (east side) (n=128)**	**Han (n=132)**	**Li (n=94)**
Morbidity	22.8%	14.3%*	36.7%*	32.6*	19.1%*
Main types of sickness (among those who got sick)					
Upper Respiratory Tract Infection	50.8%	42.9%	53.2%	48.8%	55.6%
Infectious Diarrhea	16.4%	21.4%	14.9%	18.6%	11.1%
Skin Disease	4.9%	0%	6.4%	7%	0%
Getting injured	7.1%	3%	12.5%	8.3%	8.4%
Main types of injury (among those who were injured)					
Sprains or Strains	36.8%	33.3%	37.5%	36.4%	37.5%
Open wound	36.8%	33.3%	37.5%	45.5%	25%

Contusions or crush	26.3%	33.3%	25%	18.2%	37.5%

**statistically significant difference found between groups*

III. *Injuries:* 7% of the sample reported being injured during the flood, the most common types of injury being sprains, open wounds, and contusions. Regarding the help-seeking pattern of the injured individuals, 52.6% self-managed their injuries while the remaining 47.4% sought external help through doctors in clinics, hospitals or medical units. 8.6% of the population had at least one family member injured in the flood but no disappearances were reported.

IV. *Evacuation:* More than one-third (36%) of the respondents had to be evacuated because of home loss.

V. *Mental health:* Respondents' state of mental health was measured by their general distress level (K6). The results of the t-test illustrated that individuals in severely affected areas experienced higher distress levels. While there were no significant difference in distress levels between those in the "below 50" and "above 50" age groups, the Li ethnic group was found to be more distressed than the Han Chinese. The majority of the studied population reported to be worried about their own safety and that of their family (77.6% and 82.8% respectively). Particularly, individuals from areas more severely impacted were 2.2 times more likely to worry about their own safety and 3.34 times more likely to worry about their family's safety. Respondents from the Li ethnic group were also more likely to worry about their own safety.

4.2 Damage and disturbances (environment)

I. *Damage to reservoirs and watertight barriers:* The two rounds of torrential rain destroyed 43 small reservoirs and 601 watertight barriers. 183 dams eventually collapsed under the immense weight of water. The collapse of the dam in Chizhi Reservoir forced more than 6,000 villagers to resettle.

Details are listed in Table 5.

Table 5 Problems caused by reservoirs during the Hainan flood in October 2010.

Time	**Reservoir in danger**	**Problem and effected population**
2010.10.4	Gongsun Reservoir in Baoting County	Water leakage; 700 villagers downstream were affected
2010.10.6	Shilong and Hongxing Reservoir in Anding County	Dam about to collapse
	Dapian and Daxiutan Reservoir in Wanning City	Dam about to collapse
2010.10.7	Nanyang Reservoir in Haikou City	High water level; 1,700 villagers, 17,000 hectare farmland and 30 aqua farms of 15 villages were affected
2010.10.8	Chizhi Reservoir in Wenchang City	100 meters of dam collapsed, 6.70 million cubic meters of water inside flushed out; 6000 villagers in 9 villages were trapped
2010.10.9	Tangjiao Reservoir in Wenchang City	landslide of 36 meters the dam
2010.10.17	Wanzhouling Reservoir in Lingshui County	50 centimeters piping 9,227 villagers in 14 villages were affected
	Zhuli Reservoir in Lingshui County	In danger of landslide
	Hejuelang Reservoir in Chengmai County	In danger of landslide
2010.10.18	Zhenghong Reservoir in Tunchang County	Dam collapsed

II. *Electricity loss:* According to the Hainan Power Grid, the torrential rain reduced the city's electric load by 316,700 kilowatts and caused an electricity loss of 886,400 kilowatt-hours. The loss was especially serious in Qionghai, where water spilt from the Niululing Reservoir, inundating 35 voltage transformers and forced a circuit breaker of 25 10-kilovolt wires to trip off, leaving 40% of the city without power.

III. *Road blockage:* Torrential rain not only inundated roads but also caused landslide and mud flow. More than 80 sections of the main highway lines were affected or blocked along the east and west coasts, especially in Wanning and Sanyang. On 3 October, the offshore wind increased to level 7 in Qiongzhou Strait, and all highway lines had to stop service. It wasn't until three days later that the lines started operating again. During the 80-hour suspension, more than 6,000 tourists and 1,400 cars were stranded in Xiuying Port.

IV. *Property loss:* A RMB 12.2 million loss was incurred through the destruction of medical equipment and RMB 5.57 million through the loss of medicine (25). In addition, many villagers also reported that they lost almost all of their wooden furniture and livestock. Moreover, the mass destruction of agriculture caused food prices to surge.

V. *Damage to infrastructure:* The first round of torrential rain had caused 112 health institutions to collapse and impaired 1,198 edifices.

5. Responses

5.1 Relief responses

The Hainan Government issued a preliminary plan aiming at ensuring the safety of reservoirs, people's lives and key infrastructures. The Provincial Military Command, the Armed Police Force of Hainan, the Farm Bureau and other related departments worked together to execute the plan.

The Military Command issued the contingency plans for disaster relief right after the torrential rain and organized 24 teams to the 10 most severely affected areas. By 8 October, over 2,000 serving soldiers, 7,800 militias on reserve service, together with 280 vehicles and 120 assault boats had been sent to the disaster-struck areas. They managed to resettle 13,800 trapped people and transported 1,540 tons of relief supplies. The Armed Police of Hainan deployed 1,500 police, 45 assault boats and 52 vehicles and managed to resettle 3,800 trapped people in four counties of Qionghai. The policemen in Hainan also worked to transfer 109,219 people (26).

According to the Department of Finance, Hainan had raised RMB 1.96 billion of relief funds by 20 October, of which 9.95% was from the central government, 37.14% from the provincial level and 37.70% from the county level.

Details of relief responses have been categorized into the five basic needs of living, namely water and sanitation, food, non-food items and shelter, health services and information.

5.1.1 Water and Sanitation

Hainan's Department of Health had five main focuses on maintaining sanitation. These were the surveillance of water to ensure its safety for drinking; the inspection and disinfection of rubbish and septic tanks; strengthening the monitoring of insect-borne diseases; carrying out Hepatitis A and Encephalitis B vaccination; and the surveillance of epidemic diseases such as diarrhea, cholera, and hemorrhagic fever.

The Department of Health reacted rapidly and called on 6 epidemic prevention teams to stand by on 5 October. 30,447 epidemic prevention personnel with 9,335 vehicles sterilized 46,604 wells in an area of 384.24 km^2.

5.1.2 Food

To counter the increase in food prices, the Hainan Government adopted a subsidy policy on 10 October to curb food prices by importing more vegetables from the mainland. Some places were so severely flooded that people's mobility was highly restricted. The Civil Affairs Bureau sent out teams to hand out food supplies such as instant noodles and bread to these areas.

5.1.3 Non-food items and shelter

On 7 October, the Ministry of Civil Affairs and National Disaster Reduction Authority issued the level four response of the national disaster emergency. The next day, the State Civil Affairs Bureau and the State Department of Finance allocated 30,000 quilts to Hainan province and RMB 50 million to help in resettlement and reconstruction (27). A further 20,000 quilts and 4,000 tents were dispatched to the disaster area by 19 October (28). The Office of State Flood Control and Drought Relief Headquarters also issued a RMB 40 million relief fund, 2.4 million woven bags, 60 assault boats and 20,000 life jackets. On 18 October, it further allotted 1.2 million woven bags and 50,000 life jackets to Hainan.

Considering that 4 million people were affected, with 700,000 evacuated and 20,000 houses damaged, non-food relief received by the people was far from adequate.

5.1.4 Health services

In case of communicable diseases, the Department of Health in Hainan had ordered for the "Zero Report" system, which meant doctors had to report the epidemic situation even if they didn't find any cases of disease (29).

On the morning of 7 October, 18 medical teams of around 100 health care workers began to arrive at resettlement sites. By 18 October, all levels of health departments had sent a total of 438 medical

teams of 36,362 professionals. Among them, 2,721 were doctors or nurses. They cured 26,557 people. 3,194 were health supervisors that observed 177 water supply units, 665 medical institutions and 139 temporary shelters. On 14 October, 9 experts and experienced nurses from the psychiatry and psychology department were also sent to the most effected villages in Wenchang to provide psychological assistance. They walked into temporary shelters, talked to villagers, and provided medical treatment where necessary.

5.1.5 Information

The media provided continual updates during the disaster. Hainan's Department of Health organized 3,324 field talks aimed at training 32,173 people on epidemic prevention. It is difficult to evaluate the effectiveness of these trainings, but no major epidemic broke out following the flood.

5.2 Recovery responses

5.2.1 Housing and Infrastructure

The priority of the recovery responses was to restore the normal life of residents. According to the Department of Housing and Urban Development in Hainan, 111,800 houses of about 10.286 million m^2 were flooded, 3,068 houses had collapsed and 42,400 were dilapidated (22). Many roads, sanitation facilities and national resorts were also damaged. An estimated RMB 3.12 billion in funds was needed for reconstruction. On 9 October, the department also sent out 18 professional teams to check and consolidate schools, hospitals and other residential houses in severely affected areas (30). The Hainan Government gave owners of the collapsed houses RMB 12,000 as subsidy for reconstruction, spending a total of RMB36.76 million in subsidy (31).

Eight six professionals also examined all the reservoirs in Hainan and found 564 reservoirs with serious risks.

5.2.2 Health System

On 20 October, the Hainan Department of Health announced that it needed RMB145.487 million to reconstruct the health system. Of this amount, RMB127.787 million would be used in the reconstruction of infrastructure. As mentioned, the first round of torrential rain had caused 112 health institutions to collapse and impaired 1,198 edifices. In addition, a RMB12.2 million loss was incurred through the destruction of medical equipment and RMB5.57 million through the loss of medicine (32).

5.2.3 Agriculture

The main tasks of the Department of Agriculture after the flooding were to rescue rubber, bananas, pepper and other flooded crops; to speed up harvesting the 0.5 million acres of rice which were already mature; and to reseed winter vegetables to fulfill the 2.6 million hectare quota that year. The Hainan Department of Agriculture reported soon after the disaster that the majority of the RMB0.23 billion fund from the Hainan Government would be used to subsidize the planting of winter vegetables to meet the set quota. It would also be used to prevent an epidemic outbreak by sterilizing slaughterhouses and animal sheds. On the morning of 15 October, a team of agricultural technology, machinery and animal epidemic prevention professionals was formed, operating as 200 smaller teams. The Department of Agriculture had sent 30,000 agriculture machines, 10 million animal vaccinations, 300 boxes of disinfectants and 5,000 agriculture systems maintenance equipment to disaster areas. The department randomly inspected 5,688 specimens of fruits and vegetables of which 99.17% were found qualified.

6. Development

As the reserve warehouse of disaster relief supplies was put into use one month before the disaster, Hainan was able to distribute emergency supplies in a timely manner. The province also sought help from Guangdong, a nearby province. An expert team from Guangdong arrived to assess the flood

status and gave suggestions to the Hainan Government. Hainan has also established co-operational relationships with some hospitals in Guangzhou. In case of emergencies, these hospitals would assist in the relief process.

After the disaster, Hainan continued to strengthen its management system for disaster prevention and mitigation. It started to compile prevention plans for natural disaster relief which aim to provide necessities to the affected population within 24 hours after the disaster. By October 2011, 22 cities, 224 towns, and 3,006 villages of Hainan had finished their revision and the new plan covers every corner of Hainan. Besides the reserve warehouse mentioned above, more warehouses are planned to be established in Sanyang, Wenchang, Danzhou and Qionghai. The Hainan Government also spared no effort in building emergency shelters. RMB4 million was put into Wenchang to build 9 flood protective buildings and RMB7 million in Qionghai to build 10 flood protective buildings (33). The capacities of disaster prevention and mitigation in both urban and rural communities have been enhanced. 13 national integrated demonstration communities for disaster mitigation with better disaster preparedness have also been built in Hainan.

One year after the flooding, Haikou, the capital city of Hainan, proposed to invest RMB3.23 billion to improve the drainage system in the twelfth Five-Year (2011--2015) Plan (34). During the five years, Haikou plans to complete a sewage pipe-laying project which will cover 95% of the city and build 15 drainage pump stations. Haikou would also invest RMB96.40 million to upgrade 83 reservoirs to modern standards. It will also pay RMB2.17 billion for a flood protection embankment project.

7. Discussion

7.1 Physical health

To better understand the epidemiology after the flood, the survey conducted focused on the physical and mental health impacts of the disaster, as well as the help sought for and received by the affected

populations.

The survey showed that the general morbidity rate of the sample was 22.8%. The prevalence of respiratory problem (50.8%) was consistent with the finding from a study of the 1998 Bangladesh floods (46.8%). Although the rates of diarrhea and skin problems were lower than those reported in the Bangladesh study, they remained the most common health issues encountered during floods.

The general injury rate was 7.1%, similar to the 6% reported in the Bangladesh report. The top three reported injuries were sprains or strains (36.8% in the current study; 34% in the Bangladesh study), open wound such as cuts and lacerations (36.8% in the current study; 24% in the Bangladesh study), and contusions or crushes (26.3% in the current study; 11% in the Bangladesh study). The findings were compatible with those in the Bangladesh study although the rates were slightly higher for the Hainan flood. Overall, the injury rate was not significantly different among the different age and ethnicity groups. Slightly more respondents chose to self-manage their injuries rather than seek external help from professionals.

As expected, individuals living in the severely affected area (Wanning County) showed more adverse health impacts. The morbidity rate reported there was slightly greater than one-third of the respondents, and they were 3 times more likely to have been sick, compared with the respondents from the mildly affectedly areas. These respondents also had higher levels of psychological distress and showed more concern for the safety of themselves and their family. This is consistent with previous findings where populations more affected by the flood experienced greater psychological problems.

7.2 Psychosocial health

Normal stress reactions were noted right after the disaster with occasional specific mental health

problems. Panic disorders and post-traumatic stress disorders were reported. Sleeping problems were common, especially during nights with torrential rain.

A good and supportive relationship was shown by the villagers, which proved to be instrumental in mitigating disaster impacts. They played an important role in providing physical and emotional support. They reported to have helped each other, especially the elderly and children, to flee as the disaster struck and take cover in a safe area. They also helped each other with farm work and household chores.

7.3 Sufficiency of Aid

The sample population was asked if they received adequate assistance during and after the flood. Only data from severely affected areas are included in the following analyses because those in mildly affected areas didn't require external assistance. Among this selected sample of 131 people, 81.7% reported to have received sufficient aid. It is interesting to note that individuals aged below 50 were less likely than the older group to think they have received enough assistance. There was no significant difference in this perception between Han and Li Chinese. Among the 24 respondents who thought they did not have adequate help, most said they lacked material aid (70.8%) including clothes and food, followed by financial support (62.5%), labor (41.7%) and medical service (37.5%).

7.4 Post-disaster needs

The major needs identified among the respondents were material and financial support, which are consistent with the findings of a recent report investigating the continual needs of typhoon-affected areas in southern Laos. Rice, clothes/shelter, and cash were the three most urgent needs be reported.

Hainan villagers reported that they lost almost all of their wooden furniture and livestock. On average, they stayed in temporary shelters for a week during the storm. They were given small amount of

monetary reimbursement and staple food from the government. The government promptly sent infection-control teams and doctors to the village after the torrential rain struck. The dissemination of health information and knowledge was primarily done through schools.

7.5 Evaluation and limitations

The study is based on available news and reports. Since literature and research are few, information not publicly available is excluded in this study. After the disaster, the media paid less attention to the area and hence few reports about recovery responses were found. This made it difficult to evaluate the effectiveness of the relief measures. Hence, results from this report can only reflect a part of the situation rather than offer a comprehensive conclusion. In addition, the impacts of the flood are different in urban and rural areas. Nevertheless the statistics found always reported the two as a whole, rendering it difficult to separate the figures of the two.

8. Lessons Identified and Actions Recommended

Aspect	**Strengths and Weaknesses**	**Lessons learnt and Recommendations**
Preparedness Plans	- The contingency plan mentions the responsibilities of the various departments involved, but fails to provide a clear idea of the concrete actions expected to be carried out. - Preparedness measures concerning public health were lacking. The plan mostly focused	- More specific directions for immediate post-flood action would assist in providing timely and appropriate aid to the affected local population. - More directions on monitoring and preventing infectious diseases should be included in the plan to prepare for an outbreak.

	on infrastructure. Only a small section mentioned the use of medicine.	
Availability of Literature	- Literature is rare, hindering effective research for better relief response. - A lack of transparency and media attention also renders it difficult to evaluate if the province is learning well from its past lessons.	- As a climatological disaster, typhoons are expected to be more frequent due to the trends of climate change. The impact of research will be far-reaching and critical in handling future disasters. - Increasing transparency would also increase collaboration. With the frequent occurrence of floods in Hainan, a valuable pool of information could be accumulated for effective research to achieve improvement.
Preparedness of Local Community	- Hainan itself is not sufficiently prepared for disasters. Most of the medical and immunization teams were sent from Haikou. If Haikou had also been affected, the consequences suffered would have been worse.	- The local community, who is at the frontline responding to the disaster, needs to be better taught how to respond. - They should have the awareness to prepare themselves for disasters, and take proactive measures in advance.

		- Hainan has started to establish medical centers in its eastern, western, southern, northern and central regions to establish its own relief system rather than rely on Haikou only.
Resource Availability and Avenues for Mobilization	- Resources were distributed in a timely manner, although the amount delivered was far from sufficient. - Patients and pregnant women about to give birth were still in the hospital when the typhoon struck (35). They were not transferred away in time.	- Raising global awareness of the disaster by more open media reports would help attract international support and donation of relief materials. - A clearer warning system may help pre-disaster response. Hospital patients should be transferred away when a certain warning is issued.
Infrastructure	- Poor social infrastructure, such as the inadequate drainage system and its numerous outdated reservoirs pose a great threat to the people and greatly increase the damage incurred from the disaster. During the period of torrential rain, 179 reservoirs which had been reinforced	- Hainan should invest more on future development rather than focusing on short-term profits. More money should be used in developing firmer infrastructure. Taller buildings should be built in higher areas to reduce the magnitude of future suffering. - Disaster-proof factors should be

	beforehand were all safe, but the rest reservoirs with risks were causing big troubles. Some main highways were also damaged. - For many villages in low-lying coastal areas, floods happen every year which cause them big losses both in infrastructural damage and reconstruction costs. - Electric failure is another serious problem, and can be fatal when it occurs in places such as hospitals.	considered when constructing highways and reservoirs. Existing infrastructure also needs to be upgraded to better standards. - Hainan also needs to develop an electricity backup plan, especially in hospitals.
Assessment Tools	- It is unclear how relief responses are being assessed. - There also lacks a benchmark for measuring the preparedness level of the local community.	- The research gap for evaluating preparedness should be filled by collaborative research.
Pace of Response Development	- With more tourists in Hainan, disasters have become an international issue. More	- Profits from tourism should be dedicated to developing more sophisticated means of disaster

	expensive buildings being built also mean a greater economic loss when disasters strike. - The pace of Hainan's response development is far from keeping up with its economic and tourism developments.	response.

9. Conclusions

This case study gives an overview of the flood through findings from a cross-sectional survey. Hainan has been growing fast economically, but its infrastructure is hardly keeping pace. A poor drainage system, old highways, mass of unsafe reservoirs and fancy new buildings only add to the costs suffered from the frequent hydrological disasters. Infrastructure should be upgraded to national standards to enable the province to better respond to floods. Overall speaking, Hainan did well in controlling infectious diseases with large-scale sterilization, despite the lack of emphasis on public health in its contingency plans. Still, there were considerable cases of dermatitis, upper respiratory tract infection, conjunctions, gastrointestinal infection as well as injuries. The health talks offered later on to villagers could focus more on ways to maintain hygiene, and although many people did intend to prepare themselves beforehand, they should be mobilized to actually take action to do so. More training would also be needed to better equip the local people, instead of relying on professionals in nearby areas. The reserve warehouse established a month before the flood played an important role to provide instant supplies to the affected population. More are currently being built. To conclude, the Central Government and Hainan reacted relatively quickly to ensure the safety of the people. But these are all short term measures. With the increasing trend of typhoons, the island needs

to invest more for better long-term resilience.

Three years after the 2010 Hainan flood, this is the first study about the disaster to be published. Literature on natural disasters in Asia is rare to find. This, together with a lack of transparency, makes research difficult and offers challenges to evaluate current measures. The local community would surely benefit from more research efforts.

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11. Appendices

Appendix I: Hainan Preplan for Tropical Cyclone and Flooding (海南省防风防洪工作预案)

(Hainan Provincial Water Supplies Department (1999), Available from http://swt.hainan.gov.cn/yjgl/762.htm) (Chinese only)

海南省地处南海，是台风、洪涝和风暴潮等自然灾害多发地区。为了切实做好我省防风防洪减灾工作，减少台风、洪水和风暴潮给我省社会和国民经济造成的损失，根据《中华人民共和国防洪法》的规定，特制定本预案。

一、组织机构及职责

海南省防风防洪·工作由省防汛防风防旱(以下简称“三防”)总指挥部统一指挥、协调。其主要职责是：执行上级防风防洪指令，制定各项防风防洪措施，统一指挥全省的防风防洪工作。在紧急防风防洪期间，指挥协调全省水库防洪调度；根据需要，在全省范围内调用物资、设备、交通运输工具和人力，决定采取取土占地、砍伐林木、清除阻水障碍物、实施陆地和水面交通管制以及其他必要的紧急措施。在风洪灾害发生后，组织有关部门和单位做好灾区人民的生活保障、卫生防疫、救灾物资供应、治安管理、学校复课、恢复生产和重建家园，以及各项水毁水利工程设施的修复等救灾工作。具体工作由省“三防”总指挥；郎办公室负责。

省直各有关部门按照各自的职责分工做好各项防风防洪工作。

各市、县“三防”指挥部统一指挥本市、县的防风防洪工作。其主要职责是：在省“三防”总指挥部和市、县政府领导下，贯彻执行国家防风防洪法规和指示，确定本市、县的防风防洪各项重大措施，落实各有关单位的防风防洪任务，落实防风防洪经费与物资，组织动员社会各界投入防风防洪斗争。

二、热带气旋和洪水等级标准与预报

(一)热带气旋和洪水等级标准

1．热带气旋等级标准

热带气旋按其中心附近的最大风力分为：热带低压(6～7级)、热带风暴(8～9级)、强热带风暴(10—11级)、台风(12级及以上)。

2。水库工程防洪标准

水库工程的防洪标准根据其工程规模和级别确定。我省的水库工程洪防标准执行国家防洪标准：

大(一)型（松涛、大广坝水库）：按1000年一遇(0.1%)设计，10000年一遇(0．01%)校核；

大(二)型(万宁、石碌、长茅、牛路岭水库)：按土00～500年一遇设计，2000年一遇校核；

中型：按1．00年一遇(1%)设计，1000年一遇(0．1%)校核；

小(一)型：按30～50年一遇设计，100～500年一遇校核；

小(二)型：按10～30年一遇设计，20～300年一遇校核。

3，堤防工程的防洪标准

堤防工程的防洪标准根据其防护对象的重要程度确定。我省堤防工程的防洪标准根据国家标准确定：海口市的堤防工程防洪标准为50—100年一遇，其他市、县城和重点堤防工程的防洪标准为20～50年一遇；一般江、海堤防工程防洪标准为5～10年一遇。

4．不设防的江河沿海的防洪标准不设防的江河沿海的防洪标准以警戒水位衡量。警戒水位是指江河洪水(或潮水)在某一河(岸)段达到一定的水位时将产生灾害损失而必须加以防范的水位。我省已制定南渡江、万泉河、昌化江、陵水河、宁远河等主要江河和沿海各港口及潮位站的警戒水位。(见附件4、附表5)

(二)热带气旋和洪水预报

1．热带气旋预报

热带气旋预报根据其距离和影响本省的时间分为：

(1-)热带气旋消息：表示热带气旋已经形成，正在不断发展，有进入南海的可能或就在南海形成，可能影响本省。

(2)热带气旋警报：表示按气象预报，热带气旋在48小时内，可能影响我省或在我省沿海地区登陆。

(3)热带气旋紧急警报：表示按气象预报，热带气旋在24小时内，可能严重影响我省或在我省某些沿海市、县登陆。

(4)热带气旋解除消息：表示按气象预报，热带气旋已经过境或基本停息，可恢复王常天气。热带气旋预报由气象部门负责发布。

2 ·江河洪水预报江河洪水预报是对热带气旋可能带来的暴雨或因异常天气情况引起的强降雨过程，可能引起发江河洪水的水位以及影响范围等的预报。

江河洪水预报由水文部门负责发布。

3 · 风暴潮预报

风暴潮预报是对热带气旋的风力引起的海水潮位异常壅高及其影响范围等的预报。

风暴潮预报由海洋部门负责发布。

三、风前汛前准备工作

(一)落实防风防洪责任制。按照分级管理的原则，把大小水利工程的防风防洪责任落实到各级行政领导身上，明确职责，责任到人。风前汛前，责任人要到责任联系点检查落实防风防洪工作，发观问题要及时解决，出了问题要负相应责任。

(二)组织防风防洪抢险队伍。各市、县要以当地驻军、武警部队、预备役部队和民兵为骨干力量，组织一支身强体壮、有一定防风防洪抢险技术的抢险队伍。

(三)做好病险工程除险加固和防洪物料储备。省、市、县和水库、堤防、涵闸等重点防洪工程管理单位及其主管部门要根据汛前水利工程安全大检查的情况，及时做好病险水库、涵闸和堤防险工险段的除险加固工作，并根据防洪需要，按照物资储备定额，认真做好防洪物料的储备工作。松涛水库的防洪物料由省负责储备，其他大中型水库由省帮助市、县储备，小型水库由市、县负责储备。

各级计划、财政部门要做好除险加固工程和防洪物料储备的项目立项审批以及所需资金的年度计划安排、拨付到位和监督使用工作。

(四)制定防洪风险图和防洪预案。各市、县和各主管部门要按规定制定水库、河流及城市的防洪风险图和防洪预案，为防洪指挥决策提供科学依据。防洪风险图和防洪预案要根据实际情况变化及时修正。

(五)做好河道清障工作。汛前，各市、县和各部门要依据《中华人民共和国防洪法》的有关规定，按照“分级管理”、“谁设障、谁清除”的原则，抓好河道清障工作，确保河道行洪畅通和防洪安全。

四、防风防洪救灾行动

防风防洪救灾行动由总指挥长(指挥长)统一调度指挥，省、市、党政—把手要亲临险要工程地段、重点灾区现场办公解决问题。各市、县和各部门要组织发动群众积极投入防风防洪救灾斗争。

(一)防风行动

1．热带气旋消息及相应行动

当热带气旋形成并可能对本省造成影响时，省气象台要及时向省“三防”办公室等单位报告热带气旋的编号、位置、风力、风速等有关信息，适时通过有关新闻媒介向社会发布热带气旋消息。各级气象台(站)要及时向当地政府、“三防”指挥部报告热带气旋消息、位置、移向及发展趋势。各级“三防”指挥部要加强值班，主动与气象台联系，密切注意热带气旋的动向。

2．热带气旋警报及相应行动

(1)各级气象台要及时对热带气旋做出预报意见，并将情况向有关领导机关和“三防”指挥部报告。

(2)各级“三防”指挥部应及时将热带气旋情况向当地政府汇报，指挥各有关部门做好防风防洪的各项准备工作。有关领导应切实掌握情况，亲自抓防风防洪工作。

(3)水产、交通部门和有关单位要及时通知出海船只回港或往就近港口避风，检查出海船只归港情况，并做好港内安全防护工作。

(4)各级政府、农业部门要组织群众做好农业生产的防风防洪准备工作。对已成熟的农作物，应迅速组织力量进行抢收。

(5)水利主管部门应及时了解热带气旋的动向，派出人员对水库，山塘、堤防涵闸、防洪排涝设施进行认真检查，发现问题及时抢修。对险库、险堤、险闸等危险工程要加强防守，及时抢修或采取特殊防护措施。各工程的防风防洪责任人要上岗到位，抢险‘队伍做好待命准备；各水库管理单位要根据预报情况，严格执行控制运用方案；施工中的工程要落实安全度汛措施；易涝地区的电力排灌站应注意预排。

(6)工业、农垦、侨务部门要做好下属单位的防风部署、防风措施落实工作，特别是要对所辖水库工程进行检查和维护，按，照省“三防”总指挥部批准的防洪调度方案进行调度运用。

(7)水文、海洋部门要根据热带气旋与暴雨预报，作出各主要江河、港口、海岸的洪水、风

暴潮预报，主动通报有关市、县；结合潮汐变化规律，及时向“三防”指挥部和重点防洪防潮。单位提出对洪水、风暴潮的分析意见，县以防潮准备。(8)各级“三防”指挥部要及时通知教育、建设等有关部门做好危险校舍、危房和危险高空悬挂物的加固以及危险区域的人畜安全转移工作。

(9)各部门和各市、县“三防”指挥部应向省“三防”总指挥部汇报防风防洪进展情况。

3．热带气旋紧急警报及相应行动

(1)各级领导要把防风防洪工作作为首要任务来抓，按照分工，立即亲临第一线，加强防风防洪工作的领导，动员和组织广大干部群众投入防风防洪工作。主要领导亲自参加值班，指挥部署防风防洪抗灾救灾工作。

(2)各级气象、水文；海洋部门应及时做好热带气旋、降雨、洪水和风暴潮订正预报，并报告“三防”指挥部；海南电视台、‘海南人民广播电台要增加热带气旋、暴雨、风暴潮消息的报道次数，并根据省“三防”总指挥部的意见，及时向公众发布防风、防洪信息。

(3)防风防洪抢险队伍要各就各位，服从统一指挥，执行各种抢险任务。

(4)可能受热带气旋正面袭击的中心区域，有关单位应开始进行重要物资和人畜的安全转移。货主应积极主动地配合港口及时提取货物，做好疏运工作。

(5)有关单位应注意防御热带气旋登陆时寸能出现的海啸、大海潮的袭击，做好水上和陆上的防护救护工作。

(6)邮电、工业部门要组织好突击抢险队伍，及时检修和排除电讯、供电线路故障，努力保证线路畅通，通信、供电正常；同时，邮电部门要在重灾区正常通信受到破坏时，短时间内建立起指挥调度通信保障系统，确保汛情灾情和指挥信息的传递。

(7)建设部门要加强对城市防洪排涝等市政设施的检查维护，做好城市排涝工作。

(8)各级政府要组织防风防洪抢险队伍，对港口、码头、江海堤围、涵闸、水库加强巡逻防守，排除险情。对险情较严重的地方，要组织群众安全转移；对内陆山区宴做好预防暴雨、山洪、泥石流的工作；对低洼易涝地区、洪、泛区，要根据洪水预报，进行水库洪水预泄，做好防洪排涝和人畜安全转移工作；如发生江河洪水、风暴潮，要按既定的防洪预案和应急措施，紧急急员和组织群众撤离，并安置好受灾群众生活；驻军、武警部队、各役部队要做好准备。

随时投入抗潮抢险工作　(9)各部门和各市、县“三防”指挥部要及时向省“三防”总指挥部汇报防灾救灾情况。

4．热带气旋解除消息及相应行动

热带气旋过境或基本停息后，气象部门要及时通过新闻媒介向社会发布热带气旋解除消息。

(二)防洪行动

1．水库工程的防洪

水利水电管理部门和水库工程管理单位要根据气象和水文部门提供的天气预报和雨情、水情预报情况，认真落实防风防洪责任制，按防洪预案组织行动；严格按照汛期限制水位进行控制运用，必要时采取措施进行预泄洪；加强巡逻观测，发现问题及时处理和上报；当水库出现险情时，抢险队伍要积极抢险，同时通知下游做好安全转移工作。

2．江河洪水的防御

江河流域发生洪水时，要按既定的江河防洪预案和应急措施进行防御。当洪水超过警戒水位时，有关市、县和有关单位要紧急动员和组织沿江沿河无防洪工程的低洼地区群众撤离，同时做好沿江沿河地区城市的防洪排涝工作；对重点江河堤款，防风防洪责任人和抢险队伍要各就各位，加强领、及时对堤防工程进行抢修加固，同时做好群众的安全转移二作。

3．沿海地区风暴潮的防御

根据海洋部门的风暴潮预报，当潮水位可能超过警戒水位时，各有关市、县和单位要积极进行防御。防风防洪责任人和抢险队伍要上岗就位，做好沿海、低洼地区、码头和港口的防潮排涝及群众、重要物资安全转移工作，并做好可能出现的海啸、大海潮的防御救护准备。

(三)救灾行动

1．风洪灾害发生后，各级政府、各部门要及时调查灾情，并向上级有关部门报告灾情和抗灾救灾情况；要全面部署，全力以赴开展救灾工作。

2．各有关部门要及时组织工作组赶赴灾区开展救灾工作，帮助灾区恢复生产。计划、商贸、交通等部门要优先安排抢险救灾物资的供应和运输；民政部门要安排好灾民的生活，优抚死难者家属；卫生部门要组织医疗队并调运药品到灾区抢救伤病员，加强检役工作，预防疫病流

行；教育部门要想方设法修复校舍，迅速复课；农业部门要加强灾后农业技术指导，发动群众采取措施排渍除碱，洗苗追肥，加强田间管理，恢复生产；水利、工业、建设、邮电、交通、农垦、侨务、水产等部门要抓紧所辖水毁工程和设施的修复，做好灾区正常供电、供水、通讯、通路等工作；计划、财政部门要及时做好水毁工程修复计划和防灾救灾资金的安排及拨付；公安部门要做好灾区治安保卫工作；民政、文体部门要组织抗灾救灾文艺宣传和赈灾义演等活动；宣传、新闻部门要及时报道抗灾救灾情况和抗灾救灾中涌现出来的先进人物及其事迹。

3．各级政府要组织和发动各行各业、社会各界开展捐助活动，支持灾区恢复生产、重建家园。

五、总结表彰

风洪灾害过后，各级党委和政府要认真对防灾抗灾救灾情况进行总结、表彰。

附件：

1．水库工程防洪标准

2．堤防工程的级别

3．堤防工程的防洪标准

4．海南省主要江河警戒水位和大型水库防限水位

5、海南省沿海警戒水位

6、海南省人大、中型水库防洪限制水位

12. Keywords

Crisis event management; crisis management; critical health event; disaster; disaster cycle model; disaster public health; emergency; emergency medical service(s); flooding; Hainan flooding; health crisis

13. Abbreviations

ICVA	International Council of Voluntary Agencies