Information Systems for Disaster Management: The Impact of National Context

Full Paper

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Abstract

Disaster management systems including information systems, differ in each jurisdiction as they are dependent on cultural context, available resources and disaster typology characteristics. As a result, developing knowledge and lessons learned in disaster management, to improve systems and processes is very difficult. By better understanding why systems and processes differ from jurisdiction to jurisdiction development of a body of knowledge for disaster systems and process improvement would become more achievable. To graphically highlight and learn from jurisdictional factors, we take a closer look at flood management practices (systems and processes) in China where there is a high incidence of flood disasters and significant death and damage at a far larger scale that that experienced in Australia. In China, flood preparation is based primarily on information systems predictive models to support critical hydraulic engineering decisions while response is mainly reliant on government resource allocation where the military become a key player.

Keywords: information systems, flood management, systems, processes, China, disaster management

1 INTRODUCTION

Information systems (IS) and associated organisational processes for disaster management purposes differ across the globe. For instance, we see varying approaches to the way data and information is generated and used to make decisions in response to bushfires, hurricanes and terrorist attacks (Bunker et.al 2015; Ehnis and Bunker 2013; Stieglitz et al. 2018). Apart from the formal operational systems used by government agencies in preparation, response and recovery to a disaster, we are also seeing the use of social media platforms by individuals and self-organising community groups to fill information gaps about and to organise response to a disaster where the general public cannot, or will not wait for an official response to a disaster situation (Bunker et al. 2019; Bunker et al. 2018; Pervin et al. 2014; Leong et al. 2015).

The use of IS and the organisation of the accompanying processes are highly dependent on cultural context such as government and organisational structures and economic systems (Greenburg et al. 2007; McCann 1983) available resources (Bunker et al. 2015; Sakurai and Kokuryo 2014) and disaster typology characteristics and frequency (Bunker et al. 2015). At the same time, we know that developing knowledge and lessons learned in disaster management, to improve disaster systems and processes is very difficult if not impossible, because of the vast differences in contextual factors, available resources and disaster typology characteristics from country to country and region to region. If we are better able to understand why IS and processes differ from jurisdiction to jurisdiction, through an analysis of cultural and economic responses to various disaster typologies, then development of a body of knowledge and lessons learned for disaster systems and process improvement is likely to become more achievable (Pearson and Clair 1998).

Our paper takes a first step in developing this body of knowledge with a focus on China and we firstly explain how data was collected for this study (Section 2). We then look at the current flood disaster situation in China (Section 3) and also more closely at flood disaster management practices in that country (Section 4). This study specifically investigates Chinese flood disaster management systems in terms of government leadership, government frameworks, and how the military and volunteers are involved in flood management. In addition, we have analysed flood preparation, prevention and flood response based on the current flood season (Section 5). The flood recovery effort is not discussed in this paper as these floods are still ongoing at the time of this paper submission. Our paper then highlights and discusses a specific case of the Chongzou flood (Section 6) as an example for study and analysis. The paper concludes with our observations regarding the lessons learned from this analysis of Chinese flood control and disaster management systems.

2 RESEARCH METHODOLOGY

The research data for this study was gathered from academic and publicly available literature, Chinese government reports, government websites, and newspaper reports. In China, all newspapers are owned by the Chinese government who publish critical information in them as well as through their government websites, therefore, websites and newspapers (in this case of our analysis) are considered as a reliable official information source.

Once data was gathered and translated from these sources by one of our Chinese speaking research team, it was then categorised and structured through general discussion and interpretation, by all research team members. Some members of our team are also experts in disaster management, having direct experience in the field. In analysing the data from the study, the research team focussed on flood management systems and practices in general, and then more specifically on the recent Chongzuo flood disaster case. Topics such as flood response deployment, Level III/Level IV response and flood management practices, dating back as far as 1983 up until current day were documented by this analysis, while the recent Chongzou flood data specifically focussed on the period of the flood in 2019.

For data collection on the Chongzuo Flood a keyword search was conducted using Google, Baidu (a Chinese search engine), the China Knowledge Resource Integrated Database, Google Scholar and Baidu Scholar. The keywords used for the search were: *Chongzuo flood, Chongzuo rescue, Guangxi flood, Tiandeng rescue, Chongzuo military, Chongzuo Armed Police* and *Chongzuo warning*.

Descriptive quantitative (flood management statistics) and qualitative analyses (case outlines of practices and management structures) were conducted in order to outline general Chinese flood disaster practices and processes as well as those specifically occurring in the Chongzuo flood.

3 CURRENT FLOODS IN CHINA

Floods commonly occur in China almost every year and this year (2019) is no different. China has suffered from large scale rainstorms since March 2019 which have led directly to flood and geological disasters impacting a huge proportion of the population and more than half of Chinese territory. From March to July 2019, it has been reported that 19.91 million people have been affected directly by flood or flood relevant geological disasters, wherein 222 people died, 21 people disappeared, 1.298 million people had to be evacuated urgently, and 34,000 properties collapsed (Ministry of Emergency Management of the People's Republic of China 2019). There were 22 provinces suffering floods because of serious rainstorms, and serious floods occurred in Guangxi, Jiangxi, Fujian, Guangdong provinces (Hu, 2019), which required information sharing and cooperation among governments in different provinces.

Flood response activities and actions were initiated from the national government to local government levels. From 7th January, 2019, different levels of Chinese governments and government departments/commissions started their flood preparation based on predictions for possible 2019 flooding using historical data. For instance, on the 7th January 2019, the Changjiang Water Resources Commission of the Ministry of Water Resources organized a flood management meeting involving different government agencies and academic institutions to analyse and prepare for the 2019 flood season (Ministry of Water Resources 2019). Chinese governments at all levels warned residents before any flooding commenced by issuing different levels of alert via the National Meteorological Center of the Chinese Meteorological Administration as well as through different provincial meteorological centres. When flood events occur, Chinese governments also inform residents via different channels such as TV, websites, social media, as well as physically visiting areas and posting notices etc.

The Chinese national government and the various levels of governments i.e. county, municipal, provincial have individual levels of activation for disaster response arrangements (discussed in Section 4 in detail). By way of example in this paper, for this flood period in 2019, the national government activated a level IV flood response for Guiling city and Chongzuo city in Guangxi in May (Ministry of Emergency Management 2019b). It must also be noted that other provinces activated their own flood response action level depending on the scale and severity of flood in their area. In addition, in these floods, the Chinese government, especially the China Fire and Rescue and the Chinese military (the Armed Police Force), are the main response force with the help of few volunteers. From 26th May to 16th June, around 9400 members from the China Fire and Rescue joined in disaster management processes rescuing 5,060 people and evacuating 14,542 residents (Ministry of Emergency Management 2019c).

4 CHINESE FOOD MANAGEMENT SYSTEMS

4.1 Leadership

In China, higher-level governments lead and give orders to their local governments in times of crisis. The lower level governments directly report their flood management situation to the higher level of government, for example a county government directly reports to a municipal government, and municipal governments directly report to provincial governments. When a local government cannot cope with a severe flood or higher-level governments (including the central government) feel they need to be involved in flood management practices, they can intervene without lower level government permission. China's central government, therefore, plays a leadership role, and different levels of governments and departments are responsible for the implementation of disaster response plans following central government decisions (Gao 2008). In terms of flood management, decision making is fully controlled by the central government but the central government grants rights to local governments (from province to county levels) to implement the central government's decision and policies (Moore 2018).

4.2 Government Framework

In China, flood management includes physical (statutory) organizations and virtual organizations. Statutory organizations, at the national level, include the:

- Ministry of Emergency Management (MEM) which is responsible for management of all emergency events and disaster management (established in March 2018);
- National Disaster Reduction Commission (NDRC); and

- National Flood Control and Drought Relief Headquarters (NFCDRH) which is a professional agency for flood management with 25 different ministries and military department members, each level of government Flood Control and Drought Relief Headquarter (FCDRH) as branches (these were established in early 2018), and 7 different river basin FCDRHs.

The responsibilities of the different ministries of emergency management have all been merged into the MEM and they include the NFCDRH, State Administration of Work Safety as well as another 11 different departments. The MEM is responsible for making national level emergency plans, as well as leading and management of all emergency events and disasters including flood management (Wang 2018) It is also responsible for establishing a disaster reporting system, disaster response, management, and recovery. For the purposes of simplification, this complex organisational structure is shown in Figure 1.

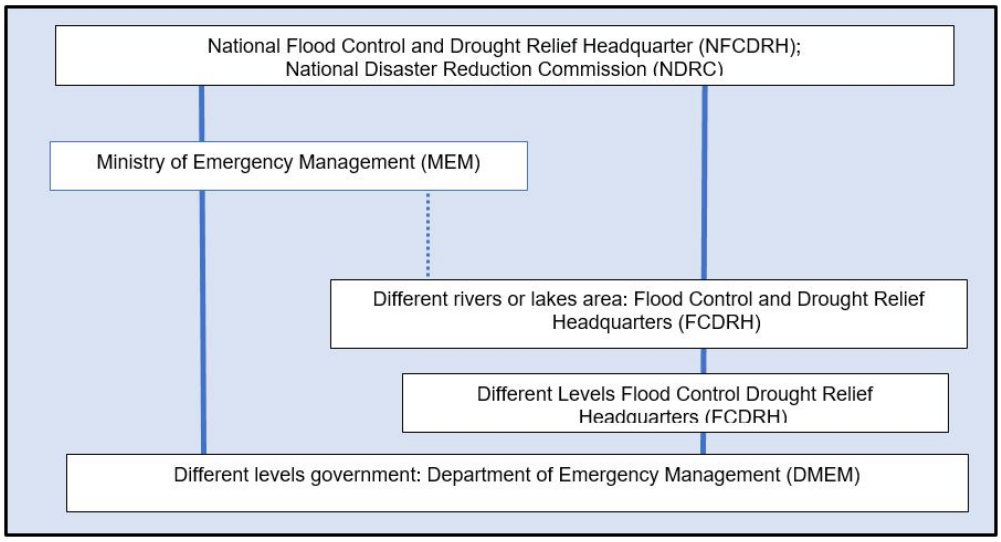

Figure 1 – Chinese Government Flood Management Framework

The NFCDRH main responsibilities are formulation of national level flood control policy, design of flood mitigation for main rivers and "across the province" flood control plans, and organizing and management of flood early warning, response, rescue and recovery (The State Council 2019). The NDRC is a coordination, liaison and non-titled department which is responsible for national disaster reduction policing and liaison with different disaster management agencies. The Ministry of Water Resources is one member of the NFCDRH, which is responsible for implementing and organizing flood management engineering solutions in terms of flood management. At local level, there are different FCDRH for different levels of government which have almost the same function as the NFCDRH in a local area. When crossing different provinces and areas flood control, there are flood control headquarters on rivers or lakes such as the Yangtze River Flood Control and Drought Relief Headquarters, which is located between the national and local government level (The State Council 2019). As we can see, flood control and disaster/emergency management is a complex human enterprise in China.

Temporary Emergency Organisations: These are created when a flood occurs, and different levels of governments (from provincial level to county level) form part of a temporary committee which includes different government departments and a military representative. In China, flood control responsibility is given to the Chief of local government and many government departments and agencies are given the responsibility to implement flood control (The National Peoples's Congress of the People's Republic of China 2016). The chief of the local government or local communist party directly leads this temporary committee. This means that the committee becomes the lead organization and main force within a local area during a flood as it has the most control over resources. After a flood, this committee is dissolved. In addition, the senior officer who comes from a high level of government, department of emergency management or FCDRH, will directly join and lead this temporary committee, without local government or local temporary committee permission.

4.3 Military Involvement in Flood Control and Emergency Management

The Chinese military includes the People's Liberation Army (PLA), Chinese Armed Police Force, the People's Liberation Army Reserve Force, and the China Militia. As outlined in the Flood Control Law of the People's Republic of China (The National People's Congress of the People's Republic of China 2000) the Chinese military is a main force in flood control. The Committee of the Communist Party at each

level of jurisdiction are responsible for leading the same level of government and there is also a military representative at each level. At each level of FCDRH (see Section 4.2 for a detailed description) there is also a military representative, so the military can become very easily involved in flood response. As discussed in the Regulation on the Military Participation in Disaster Rescue (The State Council and the Central Military Commission 2005), when the military is involved in a disaster rescue, they should be directed by the same level of government. In other words, the rescue military personnel will be led by the chief of the communist party or chief of government, but the rescue tasks would then be managed by the military. During the disaster period, local government can directly request the local military station for assistance, and the military should immediately provide this and report to a high-level officer at the same time. The government prefect must invite the military directly to be involved in flood control, and they can invite them without too much "red tape" so the military can provide fast and effective response. The most common military organisation involved in flood control or other disaster responses are the China Fire Service as well as the Armed Police Force including the Armed Police Forest Force and the Reserve. If the Armed Police and the Reserve cannot deal with the disaster, then the PLA become involved. From 2018, the China Fire Service was renamed China Fire and Rescue, belonging to the MEM, which is not considered to be a Chinese military organisation.

4.4 Volunteers in Flood Management

In China, many volunteers join in flood management, but they are not considered as a main or important force. Volunteers are normally responsible for very basic and general tasks in disaster management including flood management and are led by flood area governments. Normally, the volunteers come from companies/organizations and could be individual citizens but are temporary, untrained, and do not have specialized rescue skills (Lin and Wu 2018).

5 FOOD MANAGEMENT IN THE CURRENT FLOOD SEASON

5.1 Prepare and Prevent

The main methodologies for preparing and preventing floods are engineering solutions, prediction, "relief stuff"[1] preparation, and flood management training.

In terms of ***engineering solutions for flood preparation and prevention***, China has many engineering facilities such as reservoirs, dams, gate dams, pump stations, and dikes. The National Flood Control and Drought Relief Headquarters (2019), has highlighted that there are 1372 large and middle reservoirs which play a very important role for flood prevention. The popular engineering solution for flood management is to flood multiple reservoirs to balance flood levels. For example, in the same river system, one reservoir is full of water and it can dispatch flood water to other reservoir to reduce flood water temporarily, even though these reservoirs are located in different provinces (The State Council 2019). The Ministry of Water Resources of China and its subordinate agencies are the main management agencies in the flood management structure. In 2019, the earliest report stated that the Changjiang Water Resources Commissions of the Ministry of Water Resources hosted a flood preparation meeting (7th January), which summarized the status of flood management in 2018, and analysed and predicted floods in regional levels in 2019 (Ministry of Water Resources 2019). The central government including the Ministry of Water Resources and regional water resources agencies can organize across provinces or river systems' flood engineering facilities for flood preparation and prevention. On the 29th January, at the national level, the Ministry of Water Resources issued a formal notice to all provincial water resource agencies to request them to prepare for floods (Ministry of Water Resources of the People's Republic of China 2019).

Chinese governments also play a basic role in ***the prediction of early floods***. The prediction comes from combining historical data, technical analysis, and computer simulations of floods. From January to February 2019, the Chinese central government and regional commission provincial governments had organized different agencies to attend a meeting for analysing and planning for floods in 2019. For instance, the Jiangxi vice-governor who is also the chief of the Jiangxi Flood Control and Drought Relief Headquarters, hosted a flood control analysis meeting on 9th January 2019. This meeting can be considered the most important flood preparation and prevention meeting in Jiangxi province, because the main flood management departments attended this meeting, such as the Department of Emergency Management, the Bureau of Meteorology and the Department of Water Resources etc. The Jiangxi Meteorology Bureau and the Jianngxi Hydrological Bureau predicted that there would be a high

[1] Emergency equipment: tents, boats, tools etc. Suppliers: food, water, medicines etc.

possibility of flood occurring earlier than previous years based on technical analysis and historical data. The Jiangxi province vice governor requested that different departments prepare for flood such as issuing early warnings and monitoring floods and reservoirs (Department of Emergency Management of Jiangxi Province 2019).

Flood preparation in China can also include the development and delivery of a central and local government ***"relief stuff"*** reserve (Bao 2019). In addition, drones were to be used to deliver "relief stuff" in China and a drone relief stuff delivery test was completed in 2017 (Weng and Li 2018). These resources are usually delivered to residents the day following a disaster. Using drones in "relief stuff" delivery can significantly improve flood response efficiency. ***Flood control drills and training*** are also an important component in flood preparation. The Ministry of Water Resources sent notices to flood areas in 2019 which required river basin management agencies to apply flood control drills based on and across multiple rivers and then report results of these drills to the Ministry of Water Resources at the end of May (Ministry of Water Resources of the People's Republic of China 2019).

5.2 Response

There are five different aspects (warning, reporting, monitoring, level of activation and rescue) in the Chinese flood response to the current flood season. The military also play an active role.

Warning: China has a variety of warning methodologies that are applied during floods. The traditional media such as TV, radio and text message and outdoor audio speakers are the most popular ways to notify residents during a flood. In addition, social media such as WeChat and Webo (Chinese Twitter) are also used. Apart from these warning channels, physically visiting residents and ordering them to evacuate during a flood is also popular in the countryside and in some cities. In Jiangxi province, the provincial government issued a formal notice to local governments and required them to physically notify each resident during the flood (Disaster Relief and Material Support Division 2019).

Reporting: In terms of reporting, China has a very strict reporting system. The local governments need to report to higher levels of governments (or the local FCDRH), and the provincial government (e.g. Jiangxi FCDRH) may need to report to the national government and NFCDRH depending on the scale of floods. For flood status reporting, when the flood level III or higher has been activated, most of the provinces need to report flood information within 2 hours (Hubei Provincial People's Government 2010; Guizhou Provincial People's Government 2015).

Level of Activation*:* In China, each level of government has their own emergency plan for flood control and drought relief, which includes warning and prevention, emergency response, emergency support and recovery. The emergency response includes a level of activation for flood response arrangements. From province level to local level, their emergency plan for flood control and drought are based on a central government plan which is modified to meet local needs. In China, the levels of activation for flood response arrangement are normally from Level IV to Level I. Level I is the worst situation which means a large area will suffer flood, and where the national government and military have already been involved in flood response. Level IV is a small-scale flood that does not lead to serious issues. However, the same level of activation is different at different levels, for example the central government involvement in a level IV activation response would be similar to a provincial level of government being active at Level III. On 29th May (15:30), the Guangxi government activated a Level III emergency response (Department of Emergency Management of Guangxi 2019a) and at 16:30, the national government activated Level IV response for the same areas (Ministry of Emergency Management, 2019b). In the Chinese political system, local governments are the primary responder for floods, but they need to report the flood status to the central government within a short timeframe. Local or lower level governments have very good communication channels with higher level governments including the central government, so that the higher-level government can be fully informed and can make an efficient and organised response. In China, the higher level of governments including the central government are involved in local flood management without a local government's permission. The central government or higher level of government can be involved in local flood response via dispatching working teams, delivery of "relief stuff", calling up military rescue teams etc. Normally, the senior level officer involved in disaster rescue will be directly in charge of that area's rescue. In a special case like Jiangxi province, the vice governor who is also chief of the FCDRH of Jiangxi, was directly leading the local government and was responsible for rescuing 4 residents by issuing instructions via a phone/video connection in the FCDRH's duty room on 7th June 2019 (Department of Emergency Management of Jiangxi 2019).

Rescue: The main flood rescue forces are government, the military and some temporary volunteers. When a flood occurs, local governments or higher level of governments will initiate the level of activation

of response arrangements and start to organize resources for flood response especially evacuating and rescuing residents. In Chongzuo in 2019 the flood commenced from the 27th May, and the local government and Guagnxi provincial government deployed around 20,000 people to the flood rescue including the Fire and Rescue, military and volunteer residents (Department of Emergency Management of Guangxi 2019a). In this flood, local government evacuated 12,674 residents, wherein 273 residents were relocated to government provided shelters, and 12,401 residents were relocated to different places such as friends' houses (Department of Emergency Management of Jiangxi 2019). In addition, the government delivered the essential Emergency Equipment and Suppliers (EES) and provided medical services to flood residents. The military is the fastest and the most efficient force in flood rescue in China. Different levels of governments prefer to use the military for flood response and especially for dangerous rescue tasks. In the regional areas in Chongzou, the Chinese government directly deployed the China Armed Police Force (military) to rescue people. The China News Service (2019a) reported that around 400 residents were isolated by floods as electricity, water, flood and all communication with the outside were cut off in the Chongzuo regional area. At the same time, the residents ran out of food. In this condition, the first of 15 soldiers arrived and started rescue in around 25 hours, and the second group brought 2 days of water and food supplies for each family to consume (China News Service 2019b). This averted probable deaths and development of higher impact disaster management.

Military Involvement: Based on the definition of a Chinese military organization, more than half of the province's military personnel were invited into the flood rescue process in the current flood season (Xinhua News Agency 2019; China News Service 2019a). In many cases Chinese local residents will self-rescue before governments or the military arrive in flood areas especially regional areas. Local committees such as village committees, resident committees, and the local Chinese Communist Party (CCP) organizations play an important role in flood rescue. Before official forces arrive in flood areas, local committees and CCP organizations will temporarily take over local government roles. They will organize residents (especially the local communists) as temporary volunteers for flood rescue. In the Chongzuo flood, the local committees and communists organized young residents to relocate elders and patients to hospitals and check each property to make sure all residents were evacuated (Li and Li 2019). Even though temporary volunteers have not been considered as an important role and are not organized by local government, they can still make a great contribution when official forces cannot cover all flood areas. For example, Li and Li (2019) described that the Shagang Group helped residents to evacuate via forklifts as the whole Tiandeng county was isolated by floods in the Chongzuo flood.

6 CHONGZUO FLOOD CASE STUDY

Chongzuo is one of the cities which has suffered the most serious flooding in China from May to June in 2019. In the Chongzuo flood, the national government and local governments were involved in flood response including the military. As part of this study we analysed the different levels of government and military action during the flood (see Figure 2). The central, provincial level and local weather bureaux provided rain and flood warnings during the Chongzou flood. On 17th May, the central government (Ministry of Water Resources) had an early warning for Guangnxi and other provinces about possible floods and they sent a formal notice to request that they prepare. From 19th to 23rd May, different levels of government warned residents about the heavy rain and to prepare for floods (Ministry of Water Resources, 2019). On 26th may, the military had been notified to prepare for flood rescue and waited for local government requests (Xie and Zhang 2019). On 27th May, Chongzou local governments and local Chinese Communist Committees organized resources to relocate and evacuate residents (Li and Li 2019).

At the same time, local residents and volunteer organizations started to self-rescue (Li and Li 2019). On the same day, Chongzuo activated a county Level II flood response (Tang 2019). The Chongzuo City government involved local (Tiandeng county) flood response, and the Chongzuo city government was put directly in charge of the local government flood response. On 28th May, the Chongzuo city government activated Level IV flood response (Tang 2019). In addition, the Armed Police Force were involved in flood rescue in Xiaoshan village. On 29th May, the Guangxi government activated a Level III emergency response (Department of Emergency Management of Guangxi 2019a) and the Ministry of Emergency Management activated a national Level IV emergency response when the Ministry of Emergency Department's work task delivered a response to Chongzuo within one hour (Ministry of Emergency Management, 2019b). From 30th May to 2nd June, the National government and Guangxi government (province level) were directly involved in local flood response via work teams. On the 3rd June, the Guangxi government notified that the Level III rescue response was completed (Department of Emergency Management 2019).

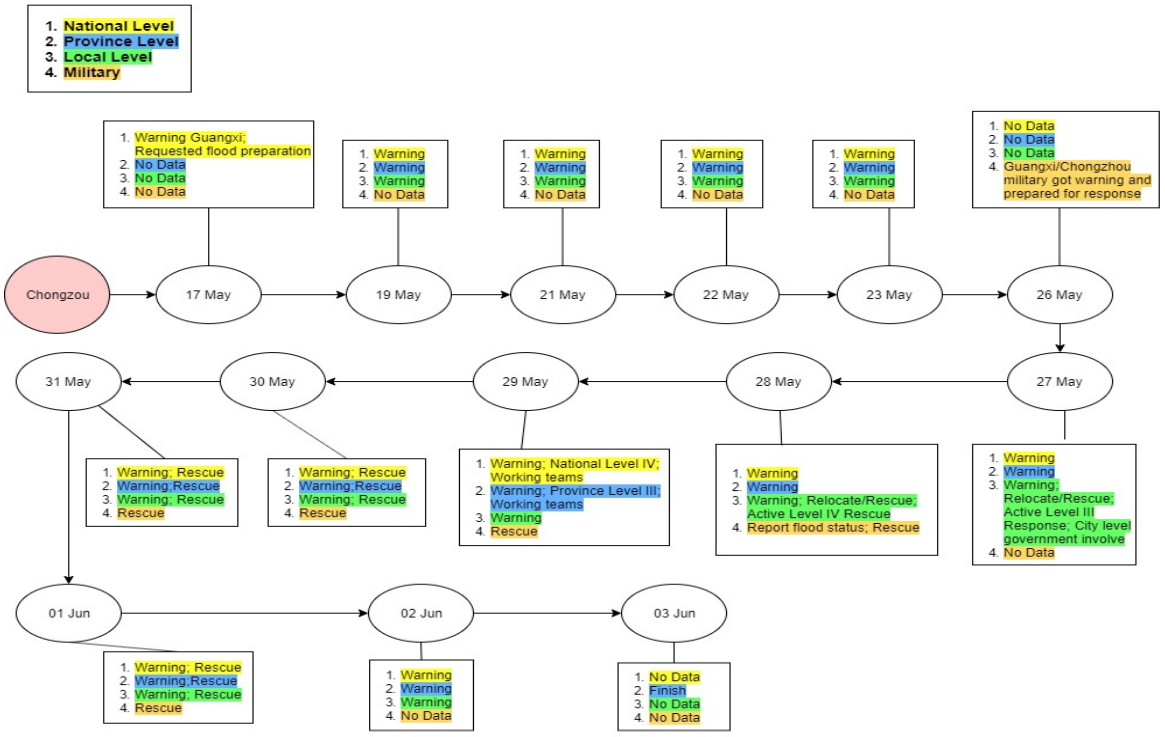

Figure 2: Government Actions During the Chongzuo Flood

In the Chongzuo flood case, the higher-level of governments such as the central and provincial governments, were directly involved in flood warning, preparation and response without lower-level government activation. Up to June, there were no reports regarding temporary emergency organizations in the Chongzuo flood, and only statutory organizations were involved in Chongzuo flood management. Different levels of governments provided flood warning information via the web, TV etc. Across all levels of government, requests were made for lower-level governments to report flood information to higher-level governments including the central government. In the same period, the central and provincial government organised working teams in Chongzou for flood response and the Guangxi military also deployed soldiers for rescuing residents in Chongzou regional areas.

7 SUMMARY AND CONCLUSION

This research has highlighted the cultural factors, resource availability and management and disaster characteristics as they apply to Chinese flood management systems and processes for flood prevention, preparation and response. China has an early flood preparation system based on information systems that use historical data to produce prediction models. Different Chinese agencies such as the Chinese Meteorological Administration and the Ministry of Water Resources, are responsible for weather and flood prediction, and provide data and predictions for governments to make informed decisions. Governments are able to put early flood preparation processes into action by using these predictions as a basis.

In terms of ***cultural factors***, China takes a highly centralised and proactive approach to managing and preventing floods. This is a vastly different approach from many other jurisdictions like Australia and the US where less federated flood prevention approaches are taken. An engineering solution for flood prevention is also a key focus for the Chinese government and China has integrated and powerful hydraulic engineering facilities, which can be used across areas to dispatch flood water and minimise flood damage in these areas. Many countries do not devote such a high level of resourcing to flood mitigation. Other engineering facilities like dikes are also used in flood management which is similar to the approach taken in the Netherlands. China also utilises a top down approach in flood response with regional and local governments led by higher levels of government or the central government. Government leadership and frameworks reflect a top down organisational structure in flood management. This is in stark contrast to the approach taken within Australia where state and local governments take the lead.

In China, most ***resources*** are centralized in the higher levels of government so that local government may not be capable of large-scale flood response. As a consequence, higher levels of government in China can be involved in local governments' flood management without their permission. China has centralised strength in organisational coordination, cooperation and communication because the central government is already involved with flood area organisations that are responsible for flood response. The military is also more frequently involved in flood responses in China, however, different countries define their military organisations in different ways and so direct comparison is problematic. For instance, in China the Armed Police Force is considered part of the Chinese military, while in other countries like Australia, the police are not considered to be a civilian keeper of "law and order".

If we look closely at the ***characteristics of these current floods***, the Chinese central government were prepared early based on a prediction of a large-scale event and production of a warnings to lower levels of government for flood preparation. These seasonal floods occur at a far larger scale and with a far greater impact than in many other countries and so and hydraulic engineering flood prevention approaches have been developed by the Chinese government in response. In the Chongzuo flood, the central government, provincial governments and the military were involved in local flood response in a fast and efficient manner, so that within 6 days they had relocated and rescued a large number of residents.

Every jurisdiction and country have developed their own flood control and disaster management strategies as a result of cultural context, available resources and disaster typology characteristics. This paper is a first step in documenting and learning specifically from flood control and disaster management systems in China so that we may compare and contrast systemic approaches and learn lessons across jurisdictions. The advantages of Chinese flood management practices may be learned by other countries so as to improve their flood management and the information systems that support them.

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