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Comprehensive analysis of information dissemination in disasters

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HIGHLIGHTS

- Seven defects on pre-warning in disaster of current research are listed.
- Information dissemination and personal response in a disaster are analyzed.
- The optimized information dissemination model can reduce risk in disasters.
- Large governmental coverage ratio improves the efficiency in information spreading.
- Combining media with different characteristics can save a lot of time.

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ABSTRACT

China is a country that experiences a large number of disasters. The number of deaths caused by large-scale disasters and accidents in past 10 years is around 900,000. More than 92.8 percent of these deaths could be avoided if there were an effective pre-warning system deployed. Knowledge of the information dissemination characteristics of different information media taking into consideration governmental assistance (information published by a government) in disasters in urban areas, plays a critical role in increasing response time and reducing the number of deaths and economic losses. In this paper we have developed a comprehensive information dissemination model to optimize efficiency of pre-warning mechanics. This model also can be used for disseminating information for evacuees making real-time evacuation plans. We analyzed every single information dissemination models for pre-warning in disasters by considering 14 media: short message service (SMS), phone, television, radio, news portals, Wechat, microblogs, email, newspapers, loudspeaker vehicles, loudspeakers, oral communication, and passive information acquisition via visual and auditory senses. Since governmental assistance is very useful in a disaster, we calculated the sensitivity of governmental assistance ratio. The results provide useful references for information dissemination during disasters in urban areas.

1. Introduction

There have been numerous man-made and natural disasters in recent years, resulting in great loss of life as well as economic loss. For these reasons it is important to give public security greater attention. When Hurricane Andrew hit Miami on August 24, 1992, 1.4 million residents lost their power and more than 180,000 people were left homeless [1]. The terrorist attack in New York took about 3000 lives on September 11, 2001. On March 11, 2011, more than 20,000 residents died or disappeared in a 9.0-magnitude earthquake in Japan [2]. According to the data from the international disaster database of

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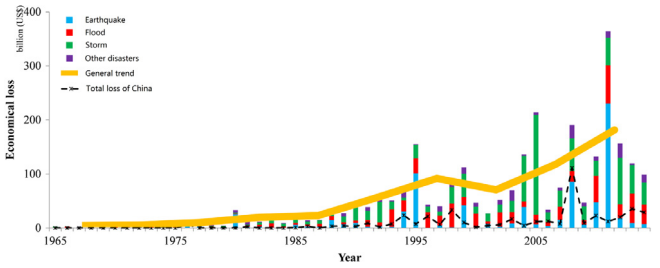

Fig. 1. Global and China's disaster cost trend for the past 50 years.

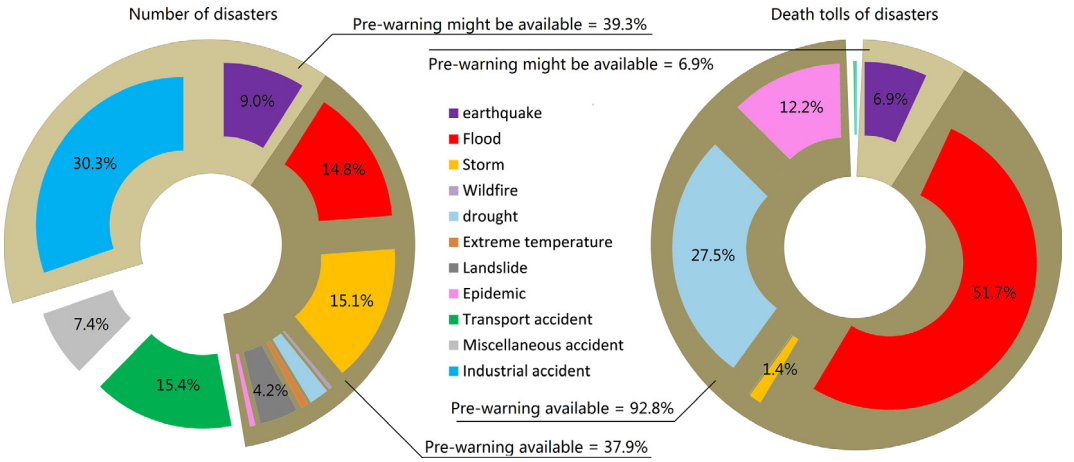

Fig. 2. Statistical data for deaths caused by natural disasters and technical accidents in China.

the Centre for Research on the Epidemiology of Disaster (CRED), large-scale natural disasters and technical accidents caused 896,150 deaths in the past 10 years (2005–2014). In addition, Fig. 1 shows that economic losses resulting from large-scale natural disasters and technical accidents have increased sharply since 1965, and that total economic loss for the 4 years from 2011 to 2014 was over 1 trillion dollars. China has unfortunately suffered inordinately from serious natural disasters, even given the frequent occurrences of different types of disaster and accidents globally. Since 1900, the death toll and economic loss caused by natural disasters and technical accidents in China were 16.4% and 39.2% of the global death and losses, respectively.

Fig. 2 shows the statistical data for the frequency and number of deaths caused by the 1686 serious natural disasters and technical accidents that have occurred in China since 1900. The first five disaster types resulting in high death tolls are floods (51.7%), droughts (27.5%), epidemics (12.2%), earthquakes (6.9%), and storms (1.4%). The percentage of deaths caused by other serious disasters including industrial accidents, landslides, wildfires, extreme temperatures, traffic accidents and miscellaneous accidents is less than 1%. In these emergencies, a great number of deaths can be attributed to the lack of, or an undeveloped disaster pre-warning system [3] and a non-existent or poor mechanism for information dissemination [4]. In disasters including floods, storms, wildfires, droughts, extreme temperatures, landslides, epidemics are easy to monitor. Some of earthquakes and industrial accidents can also be monitored, but early forecast is usually useless for the settler in epicenter. For these disasters, pre-warning information can be spread. Considering, in retrospect, the 1686 serious disasters in China since 1900, 39.3% of disasters and 92.8% of deaths resulting from natural disasters and technical accidents could have been prevented by improving the publication and dissemination of pre-warning information.

Early forecasting of the aftershock activity of the earthquake of M9.0 in japan, 2011 played a critical role in saving lives [5]. In India in 2004, facing the threat of a serious tsunami, thousands of lives could have been saved if there had been an effective pre-warning information dissemination [6]. Therefore, in a disaster, an effective information dissemination mechanism is very important. In 2005, an effective information dissemination mechanism saved a lot of lives and property from hurricane Rita.

At present, there is a great deal of research focusing on information dissemination before and during disasters. This information is usually spread via microblogs, short message service (SMS), phone, email, news portals and television [7–9]. However, there are still some omissions in current research.

(1) The spread of pre-warning information about disasters is closely related to dynamic population distribution [10]. Based on an analysis of emergency responses, urban planning and multi-agent, it has been shown that knowledge of the population is very helpful when preparing for information dissemination during disasters [11].