CASE STUDIES OF NATURAL DISASTERS

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Contents

Summary

Some case studies of natural hazards are given in this article, namely: Yangtze River floods (1998, China); the Kobe earthquake (1995, Japan); the Andrew hurricanes (1992, United States); the Volcanic eruption of Mount Pinatubo (1991, Philippines); Tsunamis (1998, Papua New Guinea; 1960, Chile); and landslides (1998, Papua New Guinea). Six natural hazards are introduced briefly through the case studies, including their mechanisms, characteristics, associated disasters, and the levels of possible incidence of their future migration. Emphasis is placed on the fact that we cannot stop volcanic eruptions, earthquakes, hurricanes, or floods, but by knowing how the Earth works we can warn populations of impending danger and reduce these threats by taking the

appropriate actions.

1. 1998 Yangtze River Floods in China

Floods in China cause 40% of the total economic loss from natural calamities and are one of the most important and serious natural disasters in China. In 1998, catastrophic floods occurred in the whole area of the Yangtze River basin. The peak of flood, volume of flow, and duration were all record-breaking.

The Yangtze River, with a length of 6300 km, is the longest river in China, and the third largest in the world, with a catchment area of 1.8 million km^2. The Yangtze River leaps over 32 longitude zones from west to east and 11 latitude distances from south to north. The Yangtze River basin accounts for 20% of the area of the whole country, 30% of the population, 35% of agricultural production, and 40% of the industrial output for the whole country. It is clear that the Yangtze River basin plays an important role in the social and economic development of China.

Most of the Yangtze River basin belongs to subtropical zones. Little of it belongs to the climate of the plateau. It is located in the subtropics of the monsoon region of East Asia, with an annual average precipitation of 1100 mm. However, climate conditions in each area differ greatly, ranging from moist, semi-moist, semi-arid, and arid zones, in which the distribution of rainfall is extremely uneven over time. Rainfall is concentrated in the summer, with 80% between August and September. Moreover, the profile of Chinese terrain is high in the West and low in the East, which creates a ladder-level distribution. In the areas of the middle and upper reaches, precipitation exceeds 1600 to 2000 mm. The terrain of the Yangtze River source is flat and slopes gently. The area of the upper reaches is full of mountains and gorges, with a precipitous landform. The loosely organized rocks and vulnerable environment there lead to many geological disasters and soil erosion. The ratio of drop in elevation between the river’s main tributaries is 1.44 to 4.85. The terrain of the lower reach area below Yichang city slopes gently and the river fall is only 0.028 m/km. Since the riverbed is silted up, and the drainage is not smooth, floods have always occurred in the past.

1.1 Characteristics of Yangtze River Flood, 1998

The Yangtze River flood in 1998, which lasted more than 80 days, caused an exceptionally serious disaster. This flood is one of the largest ever recorded. The flood was a basin-wide event. In addition to a number of floods taking place in the upper reaches, the rivers of the Panyang and Dongting lake basins flooded. With this coincided high-water levels that lasted for a long period. The water levels of most river segments in the middle and lower reaches remained at their highest level in history for a month, and remained over the danger levels for more than two months.

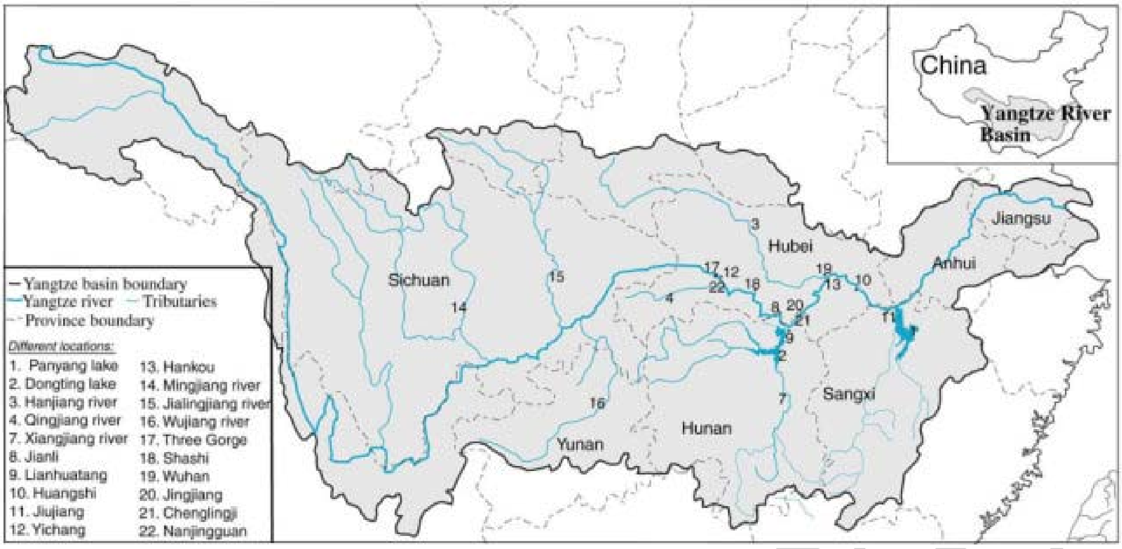

Figure1. The Yangtze River basin with the main River and the major tributaries (INCEDE Newsletter)

For example, the water level exceeded the historical record by 1.74 m in Jianli, and 1.85 m in Lianhuatang. The discharge in the 1998 flood was also high, only a little smaller than the catastrophic 1954 Yangtze River flood. The highest flow rate at Yichang hydrological station reached 63 600 m^3/s. In July, the flood volume reached 121.5 billion m^3 in Yichang—considerably greater than the 117.0 billion recorded in 1954 by 4.5 billion m^3. Finally, flood peaks repeated several times during the flood: eight separate flood peaks were observed following June 11, of which the fifth and sixth crests were the highest.

1.2 Analysis of Flood Causes

1.2.1 Excessive Rainfall and Water Flow Resulted from Abnormal Weather

The Yangtze flood of 1998 resulted from the basin-wide, long-lasting deluges caused by abnormal weather. From the beginning of June to the end of August, heavy rain occurred widely and continuously in the Yangtze basin. The rainfall was up to twice that in ordinary years. This is because that most of the Yangtze basin is located in monsoon zones under the influence of subtropical high-pressure systems. Affected by El Nino, the subtropical high pressure of 1998 returned back to 18°N latitude instead of continuing to move to north as usual; it was affected by the colder north air in its weakened state. The subtropical high-pressure wave stagnated around 25°N latitude, resulting in long-lasting rainfall, causing the Yangtze flood of 1998.

1.2.1.1 Low River Discharge Capacity and Low Criteria of Flood Control

As the Yangtze River rushes into plains emerging from the Nanjingguan Pass, the slopes become gradual, reducing the conveyance capacity of the rivers. The present levees can only contain floods corresponding to a ten-year return period. In addition, the river courses and reservoirs silt up very quickly. The water conservancy facilities along the Yangtze River are outdated, and the criteria of flood control are well below the standard required. The control criteria of the main rivers are to deal with floods that might occur every ten to twenty years, while in other countries, like Japan and the USA they may occur once in every 100 to 200 years.

When the discharge rates exceed the river capacity, floods search outlets and burst dykes, dams, or levees. In 1954, a total of 61 breaches along the main Yangtze River and Hanjiang downstream, as well as 13 other collapses of levee and many collapsed small embankments, occurred. Fortunately, when the levee broke on the main stream in Jiujiang in 1998, it could be blocked at once.

1.2.1.2 Reduced Storage

In ancient times, the many lakes connecting with the main stream spreading all over the middle and lower reaches of the Yangtze River, could delay the floods easily. However, the extensive reclaim of land from lakes has reduced the water area, and the colossal silt in waters weakened their store capacity and flood regulating ability in the Yangtze basin. The thickness of annual silt is 3.7 cm, and the annual loss of water surface is 54 km^2. The total area of lakes in middle and lower reaches of Yangtze River was 25 828 km^2 in 1949, but only 14 074 km^2 remained in 1977, decreasing by 45.5% and a loss in store capacity of 30 billion. In 1825, the area of Dongting Lake was about 6000 km^2 which became 4350 km^2 prior to 1949. In 1995, the lake area had declined to 2691 km^2. Roughly 1100 lakes have disappeared.

The province of Hubei, called the “Province with thousands of lakes,” had 1066 lakes in the 1950s, but now has less than 100. In the past, many lakes were connected with the main Yangtze River, but now many floodgates have been built which cut off the connection between lakes and the river so that their function of delaying floods is removed. With the decline of lake area, the volume of lakes reduces and the capacity for delaying flood flows becomes poorer, resulting in frequent flood disasters.

1.2.1.3 Dykes Overwhelmed in the Floods in Jianli, Hubei Province

The sediments of the Yangtze River have been increasing every year, but because of the conditions of the terrain and the reservoirs built in the upstream reaches, a large amount of sediments are stored in the river system. On average, the amount of sediment increases every year by about 0.53 billion tons. Since many meandering river courses have been straightened, some conservation projects have been carried out and some lakes have shrunk, parts of the Yangtze River have seriously silted up. For example, in the most important segment of the River, from Chenglingji to Hankou, flow capacity has declined by 5000 m^3, accounting for one-fifth of the total releasing volume, because the sediments have raised the riverbed.

In addition, the flood cross-sections of rivers have reduced because those flood lands have been occupied and reclaimed. Although the Anti-Flood Plan and Anti-Flood Laws have been instituted, many illegal developments and construction activities persist, reducing river flood capacities, and making it another major cause of flood risk.

1.3 Hazards

The impact on the rural population affected by the flood disaster was overwhelming. Five million people were made homeless in these three provinces (Hu Bei, Hu Nan and Jiang Xi). Some of them stayed with relatives or other families, some in public buildings. Of the homeless, 2.9 million were lodged in makeshift shelters on dykes in the flooded areas. Their overcrowded camps extended at times for several kilometers over narrow stretches of land. The dykes are unprotected with narrow banks, only a few meters wide, with water on both sides. Here, the people were totally exposed to the sun, wind, cold, and rain.

These victims were the most vulnerable. They lived in insufficient shelters made of plastic sheeting. The government also provided some tents. The summer heat wave with temperatures up to 39 degrees centigrade and over, as well as heavy rains, and winds, aggravated their situation. The temperature, especially at night, is currently much lower and during the winter between November and February, the temperature goes down to below zero centigrade.

During the rescue process, to reduce and avoid the loss of life and property, the Chinese people and army waged an extremely hard and bitter fight against the floods on an unprecedented scale. All parts and all circles of the country made a concerted effort towards flood-control and disaster relief. The main levee, important cities, and vital traffic lines were guaranteed, the life and safety of the people was protected through a life-and-death struggle enacted by rescuers and victims. A magnificent success in flood control was achieved. However, the economic loss caused by the floods was still tremendous.

Official figures indicate that the floods in the three provinces damaged a total of 2.22 million houses. Depending on the local severity and nature of the impact of the floods, housing has been damaged in a number of ways. In the worst circumstances where dams had burst or flash flooding had occurred, entire houses and their contents were washed away. In some cases, whole villages were swept away. In other areas, houses were submerged but some contents salvaged.

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Biographical Sketches

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