AN OUTLINE OF THE HISTORICAL STAGES OF FLOODS AND COUNTERMEASURES IN THE REPUBLIC OF KOREA

Sangho Lee
Pukyong National University, Busan, Republic of Korea

Floods returns by hydrologic circulation. People have to be prepared and to protect lives and properties from floods by structural and non-structural measures. The following briefly describes some flood status in Korea and countermeasures. The historical stages includes the Joseon Dynasty, twentieth century, and recent decades. The keyword of flood were searched 193 times through the Annals of the Joseon Dynasty recorded for about 500 years and the results of the search for the word 'Cheugugi' were 17 times (Kim, 2000). Cheugugi is the first rain gauge invented in 1441. Figure 1 shows a replica of Cheugugi, and Figure 2 shows annual precipitation from 1776 to 2003 including the record of Cheugugi up to the beginning of the 20th century. Cheugugi and water mark (Figure 3) were used during the Joseon Dynasty; they were related with agricultural production and flood disaster management.

Figure 1. *Cheugugi*

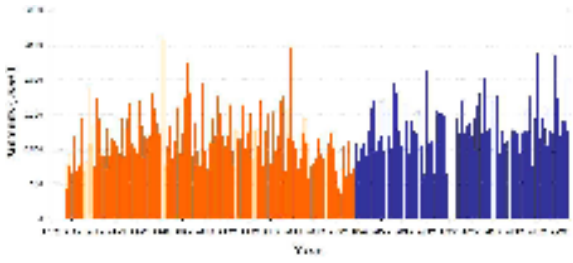

Figure 2. *The annual precipitation records in Seoul from 1776 to 2003. (Chun et al., unknown).*

Figure 3. *Water mark*

The highest stage at Hangang Bridge for the 20th century was recorded in 1925. Figure 4 shows the failure of Han River Railway Bridge in July 1925 and we can see the trajectory of the depression accompanied by the flood in Figure 5. The number of deaths from four floods in 1925 was 647. The monetary amount of flood damage corresponded to 58 % of the annual budget of the Japanese Government - General of Korean Peninsula.

Figure 4. *Failure of Han River Railway Bridge in July 1925. (Japanese Government - General of Korean Peninsula, 1926)*

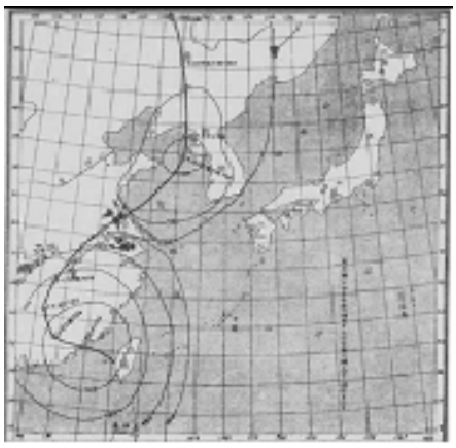

Figure 5. *The trajectory of the depression in the second ten days of July 1925. (Japanese Government - General of Korean Peninsula, 1926)*

The Han River basin reconnaissance, which began in 1966, was an important work for flood control in the river. Following the reconnaissance, Soyanggang and Chungju multipurpose dams (Figure 6) were constructed that have been major structural measures for flood damage reduction on the downstream region including the national capital region. The basin reconnaissance on the other three major rivers had been followed and multipurpose dams were constructed for the rivers. The establishment of the Han River Flood Control Office in 1974 and the flood prediction and warning system have been important non-structural measures to reduce the damage caused by floods. There are four reservoirs used for flood control (Figure 6, 7; Lee et al., 2015). The reservoirs had been operated, using independent flood forecasting and control models. The flood forecasting and control model importantly improved in 2006 by the development of reservoir system operation model. One can see the decreasing trend of annual highest stages at Hangang Bridge in Seoul (Figure 8; Lee et al., 2015): the highest stage was recorded in 1925; multipurpose dams of Soyanggang and Chungju greatly contributed to reduction of the annual highest stage; and the application of the reservoir system operation model has played a major role in the flood stage reduction since 2006.

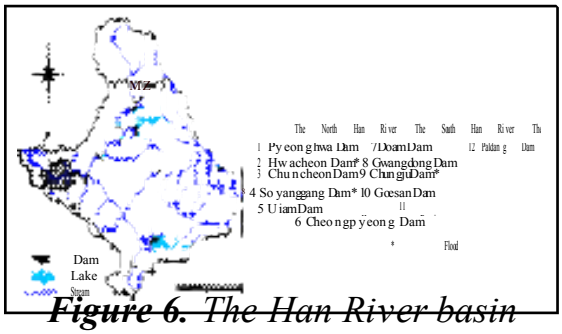

Figure 6. *The Han River basin and major dams*

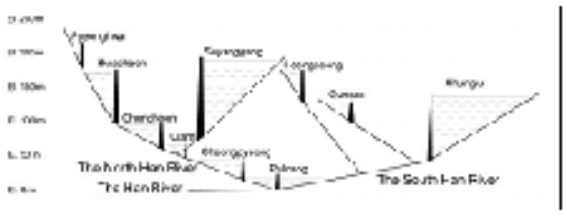

Figure 7. *Dams for flood control in the Han River system*

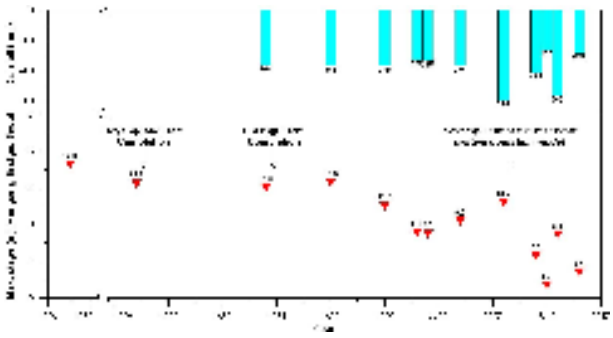

Figure 8. *Highest annual flood stages and rainfall amounts before and after the development of operational model for reservoir system simulation*

Floods occurred in relatively small streams managed by local governments have been primary concern of natural disaster in the past several decades. Some levee sections covering drainage structures through levees collapsed during floods, which induced damages on landside areas. Figure 9 shows the collapsed levee section around the drainage conduit of Gwangam levee. Hence, levee inspection have been strengthened for safety of levees and various analysis tools (Figure 10) have been used. Storm and flood insurance, which was implemented in 2006, is a policy insurance that subsidizes more than half of the insurance premium to compensate people for the damage by floods and storms.

Figure 9. *Failure of a levee around drainage conduit.*

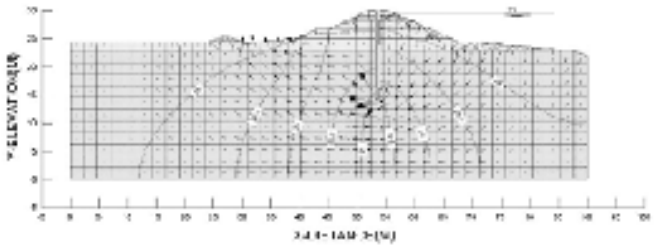

Figure 10. *Seepage analysis after cut off wall placement. (Korea Infrastructure Safety & Technology Corporation, 2012)*

Some urbanized areas are suffering from the recent floods (Figure 11). To enhance drainage capacity of urban areas, design standards for rainfall have recently been increased. Low impact development is a strategy to reduce flood volumes such as storm waterstorage, pervious pavement, and infiltration trench, etc. A simulation model of urban runoff and inundation may be used to analyze inundation on an urban area and to establish a countermeasure.

Figure 11. *An urban inundation in Busan*

Figure 12. *Inundation analysis for a region*

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