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River Water Environmental Management System by Construction of Early Warning System - A Comparative Study on Korea and Japan.

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ABSTRACT

Typhoons Rusa (2002) and Maemi (2003) struck Kangwon and Gyeongnam provinces of Korea and caused the most extensive flood damages ever known since the foundation of Meteorological Agency in 1927. Many cities are inundated, crippling the critical facilities and resulting in high irreversible losses of human lives, and damages to infrastructures. These kinds of flood damages were among the worst natural disaster that Korean people experienced. In order to reduce flood damage, it is necessary to investigate how to use the information of water environment during the rainfall disaster. Therefore as per the result of this study, we have suggested few but effective countermeasures for controlling the flooding damages and also the advancements in the areas of disaster information dissemination and early warning system for water environmental management by using optical fiber system in Japan are discussed.

Keywords : Early warning system, river water environmental management

요 약

강원도 및 경상남도 지역은 2002년 태풍 루사 및 2003년 태풍 매미로 인하여 1927년 기상관측 이래 가장 큰 규모의 홍수 피해를 입었다. 호우로 인하여 많은 도시가 침수되었고 도시기능은 마비되었으며 또한 막대한 도시기반 시설의 파괴와 인명 피해가 발생하였다. 이러한 호우피해는 지금까지 경험한 것 중에서 최악의 자연재해였다. 홍수피해를 줄이기 위해서는 호우기간 중 하천 수 환경에 대한 정보를 어떻게 이용할 것인가에 대한 조사가 필요하다. 따라서 본 연구에서는 홍수피해를 줄이기 위한 효과적인 대응과 정보전달에 관한 방안이 논의되었으며 일본의 광 정보를 이용한 수 환경 관리 조기 경보시스템에 대하여 토의하였다.

주요어 : 조기 경보 시스템, 하천 수 환경 관리

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1. Introduction

The recent characteristics of flood damages from the storms such as Typhoon Rusa (20020 and Maemi (2003) shows increased risk and damages to the local downstream populations (Lee, et al., 2003). There are two major reasons for the increasing damages: the first is the rapid urbanization, and the second is the change of weather condition. The flood damages from large river are being controlled by continuous researches and practices on the river management system such as development and construction of better flood control facilities and multi-purpose dams.

But, the flood damage in the middle or small-sized mountainous river basins are gradually increasing due to the increasing urbanization and local torrential rainfall (Kang 2002, 2003). Furthermore, in these kinds of rivers, structural flood control measures such as improving levees are still emphasized than non-structural ones. In spite of the enforcement of flood control facilities, potential flood risk in small-sized mountainous river basins has always remained high (Ushiyama, et al., 2002). It means that both structural and non-structural measures should be considered together to reduce flood damages. Besides it, with growing concern in reducing human casualties, it's necessary to integrated flood disaster prevention programs including timely dissemination of flood information and emergency action plan for refuge activities during the heavy rainfalls (Asada, 2001, Oikawa et al., 2001). This paper describes current flood disaster control measures based on the data of Donghae City, Kangwon Province of Korea. Also, the early warning system to minimize flooding victims using optical fiber system in Japan is discussed.

2. Change of Flood Damage and Problems

With the rapid urbanization, a new trend of flood damage in the urban area such as urban inundation is on increase. Furthermore, with the frequent occurrences of abnormal climate conditions, flood damages have greatly increased resulting in huge human casualties and economic damage. Some aspects of structural and non-structural measures to reduce the flooding impact and to manage river water environment on the urban areas of Korea are discussed below:

2.1 Reservoirs

In many cases, reservoirs may be useful to reduce direct rainfall-runoff from the watershed. But, most of the reservoirs now serve the primary purpose of irrigation, hydro-electricity generation, fishery and water supply. More over, most of the reservoirs are medium-sized, so they are not so effective in controlling the storm flood. Even if some dams are especially planned for flood control, its construction will take 10 years or more, considering the permit from the local bodies.

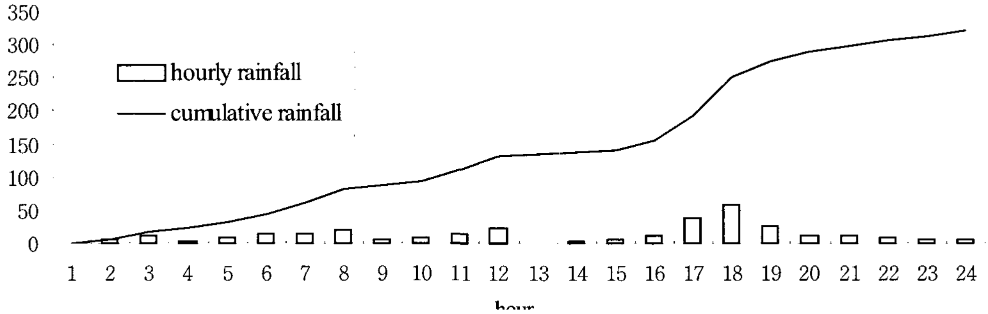
2.2 River levees

Most of river levees have been constructed from down stream to up stream, whenever flood disasters occurred. River channels were gradually improved and straightened thus their peak discharge from watershed increased and their arrival time shortened. Besides it, high levees may cause more severe damages when they busted or passed directly to the low lying down stream areas. Although the concerns of levee are increasing, it seems impossible to improve the discharge capacity of river. Even though flood control levees have greatly improved in the long term, but there still exist many problems resulting from rapid urbanization such as higher risks to the densely populated downstream areas, environmental and aesthetic impacts etc. Moreover if the flood damages done by Rusa and Maemi are considered, an insignificant amount of it has been spent on the flood prevention measures. Nonstructural measures such as: education and involvement, appropriate land use, flood insurance, flood-proofing, relocation and/or demolition of structures, inspection and maintenance, and emergency action programs should be also including along with the structural measures in flood prevention plan. Nonstructural measures are most effective when applied in a preventive mode to areas as they are being developed and usually cost less and can be implemented faster. The past failures in disaster mitigation were also due to the insufficient river management resources, plans, and standards necessary in consideration of the local conditions.

3. Flood control measures of Korea and Japan

3.1 The refuge activities in Korea

As shown in Figure 1, there was refuge warning announcement at 6:00 a.m. from Samcheok Munwha Broadcasting Company (MBC) due to flood in Samwhadong areas but it was ineffective because of interruption of electric power. When the Samhadong office gave typhoon warning at 8:00 p.m., most of the residents had already taken refuge in the uphill areas about 2~4 hours earlier. At around 1:00 p.m. landslide blocked a part of Shinhungchon and around 3:00 pm, part of Shinhungchon dike was destroyed. Thus, the residents of the town fled to the uphill areas by their own instincts cause they failed to get the early warning about the flood. As shown in Figure 2. the residents were isolated for one week from the outside world. The local peoples could not understand the intensity of flooding until their houses were flooded up to the floorboards. Luckily, there were just four human casualties but the material damages amounted to be billions of dollars. The results of a questionnaire survey, conducted in Samwhadong area after the



Warning of refuge from Samwhadong office	Isolation from outside during one week
Advice of refuge from Samcheok MBC	Four missing
Dike break of Shinhungchon	Inundation depth of 60cm in main road
Interception of Shinhungchon due to landslide	Finish of refuge activities
Power failure in Samwhadong areas	Start of refuge activities
Typhoon warning announcement	Inundation depth of 30cm in main road
Typhoon alert announcement	Start of inundation in main road
River situations and administrative actions	Damage and residents actions

Figure. 1 Countermove due to Flood with rainfall conditions

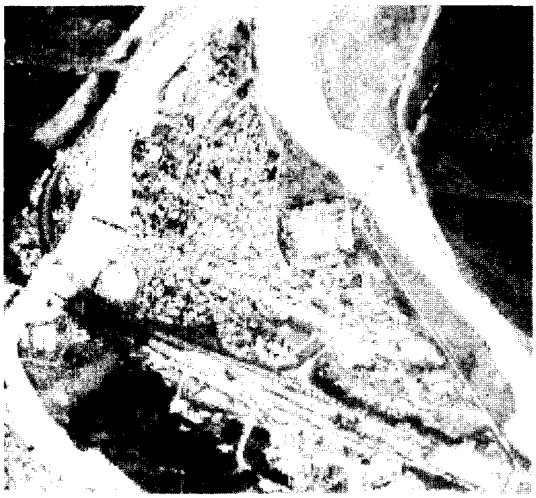


Figure. 2 Inundation due to Typhoon Rusa in Samwhadong area

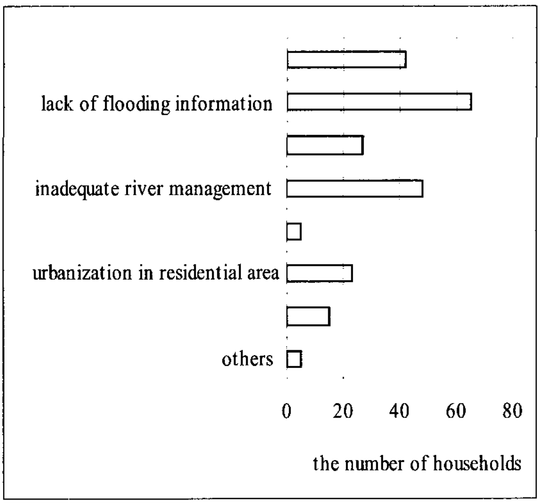


Figure. 3 Understanding of high flood damage due to Typhoon Rusa in Samwhadong area

disastrous event, shows that the main causes of high flood damage were: the lack of flooding information, inadequate river management, and unexpected rainfall, etc as shown in Figure 3. All these indicate lack of effective dissemination of disaster related information and also ineffective action plan to mitigate the disaster (Donghae city, 2002).

3.2 The comprehensive flood measures system in Japan

Japan is a mountainous country with the forested area covering over 70% of the total area. Compared with other countries in the world, its riverbed slope is very steep. In addition, owing to the influence of typhoons, heavy torrential rainfalls occur during a short period and thus the river discharge fluctuates highly in both the rainy seasons and normal ones. The population distribution is also highly concentrated in the down stream or floodplain area. With high speed urbanization and rapid economic growth after the Second World War, concentration of the people increased in the floodplain area. Vulnerability to hazards increased as the settlements were in fragile environments and disaster loss levels increased with the growing concentration of people, economic activity and assets and critical facilities. Under these backgrounds, comprehensive flood control management was built up in 1977 and mainly applied to highly urbanized area. In 1979, the nine rivers in Japan were adopted for this project. Similar plans have been implanted for 17 river basins in Japan. According to the 9th river restoration project, a new approach for flood control countermeasures is formulated as follows: integration of flood control measures, improvement of flood control facilities, and consideration of natural environment with focus on non-structural measures (Suzuki and Hayakawa2002).

4. Flood control and water environmental management using IT technology

4.1 Construct of optical fiber in Japan

To meet the local resident's growing need for information on river system, an optical fiber information system is in progress. Foundation of River and Basin Integrated Communications of Japan is conducting researches on the essential factors to be taken in consideration to reduce flood damage. It has proposed few of the items such as data of transmission of water movement with real time using graphic information, and water quality monitoring etc. As shown in Figure. 4 and 5, items like centralized supervision and operation of river facilities by remote observation, the provision of river basin information network, and improvement of internal network of Construction Ministry were discussed. In addition, it also pointed out the challenges of the monitoring system such as effective observation of the river condition, secure time

Figure. 4 Monitoring system for observing the water environmental condition

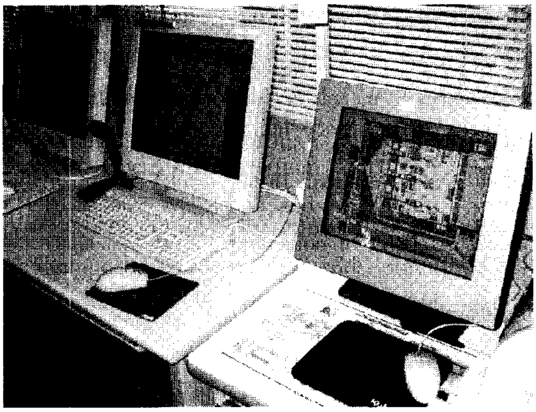


Figure. 5 Main flood control and water management system for early warning

shift of the worker, and setting up an automatic system.

4.2 Practical Use of WWW for Heavy Rainfall Disaster Information in Japan

The first use of the Internet for disaster information was around 1995, when the Hanshin-Awaji earthquake occurred in Japan. Initially, citizens and private sector groups used various Internet sites for the exchange of relief information. In 1996, private weather companies started to supply weather information, e.g., weather forecast, precipitation observation data, radar weather data, etc., through Internet (Japan Internet Association (Ed.), 2002).

The first full-fledged use of the Internet by the Japanese government sector was at the time of the Tochigi and Fukushima heavy rainfall disaster in August 1998 (Ushiyama, 1999). Local governments such as the Tochigi prefecture office, the Fukushima prefecture office and the Kouriyama city office, the areas that were heavily damaged, disseminated information on their homepages shortly after the disaster. By 2000, almost all central government, prefecture, city, town and village offices had their own homepages. Several governmental homepage played an active part in transformation of disaster information at the time of Tokai heavy rainfall disaster in September 2000 (Ushiyama, 2002).

On the other hand, it should be noted that several public offices did not use their homepages for dissemination of disaster information, as pointed out in a newspaper article on the disaster. Rather, the private individual homepages were more widely used to provide disaster information.

Until around 1999, most disaster information homepages were opened temporally after the disaster. These homepages mainly contained damage reports and relief information. Since 2000, the number of permanent homepages for disaster information has been increasing. In 2001, the types of disaster information homepages existing on the Internet consisted of: 1) The Weather forecast 2) Heavy rainfall warnings and advisories 3) Meteorological satellite image data 4) Weather radar rainfall data 5) AMeDAS observatories precipitation data 6) Precipitation and river water level, reported by the Ministry of Land Infrastructure and Transportation or the local prefecture 7) Short range forecasting precipitation 8) Disaster damage statistics and the actions being taken by the government sector 9) Relief information offered by voluntary groups and the like. 10) Hazard maps provided by government sectors (dangerous zones, evacuation zones, hazard simulation data, etc.) 11) Disaster research reports and basic knowledge about the disaster, provided by Japanese government sectors or by scientists. Figure 6 shows these weather warnings and advisories (Japan Weather Association, http://tenki.jp/).

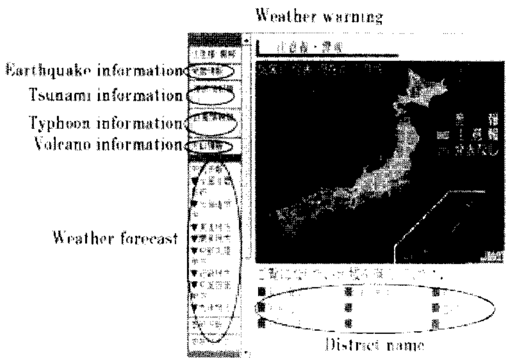


Figure. 6 Weather Warning and Advisory

Comparatively very few disaster warnings and advisories are set up by the Korean governmental authorities and consequently there is a big gap between the regional, national and local bodies in the dissemination of disaster related warnings and advisories.

4.3 Construct of river information in Korea

Rapid urbanization in the recent years is putting increased pressure on the urban infrastructure and concentration of population in the floodplains regions. Various structural measures such as the improvement of river channels and flood facilities have been implemented successfully to mitigate the flood damage and the safety degree from flooding of rivers has steadily increased. However, even in the major river systems an adequate degree of safety has not been achieved. For example, flood hazard map, which shows information on likely patterns of flooding and countermeasures, is an effective guide to reduce its damage has not been opened yet. The regional peoples should be provided with reliable information about flooding depth, refuge route, and refuge time, etc. but very few information is present for prevention of hazards becoming disasters.

5. Summary

Despite the various structural measures such as straightening, enlarging and lining channel, constructing levees and floodwalls being carried out by the governmental authorities; an optimum mix of nonstructural and structural measures is yet to be found. In order to reduce the flood damage, the flood forecasting and warning systems have been installed in the 5 main river basins and recently additional systems are under construction in middle-sized streams. Most of the rivers lack such flood forecasting and warning system despite high potential of flood risk and also the local residents didn't had the knowledge of recognizing the disaster risk and vulnerability information. When the Typhoon Rusa broke out, many people failed to understand the alarming rainfall information. An urgent intervention at the local level should be initiated to encourage cooperation and coordination of disaster preparedness activities and emergency action plans with clear roles and responsibilities that can be timely followed, throughout the region through the exchange and dissemination of knowledge and experience. Also, we should make effort to shift from the culture of relief to that of preparedness and mitigation, recognition that disaster risk and vulnerability reduction are essential to development planning, the development of self-reliance and self-help in communities and the forging of partnership to promote risk reduction and disaster management.

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