INCREASING THE AWARENESS OF RIVER UPSTREAM PEOPLE ABOUT TSUNAMI DISASTER

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1. INTRODUCTION

As a result when tsunami invades into river, it may not only a threat of damages to the embankments but also cause the environmental problem such as inundation. Therefore, tsunami impacts to river upstream studies become more important. There have been several studies on tsunami impacts to the rivers such as Abe (1986), Tsuji et al. (1991), and Tinh N. X. and Tanaka H., (2010). Among them Abe (1986) has found that the tsunami wave can propagate up to 15km river upstream. Resonance occurred in river in about 80 minutes and causing a standing wave. Tinh N. X. and Tanaka H. (2010) have concluded that tsunami can propagate up to 33km in the Old Kitakami River during 2010 Chilean Tsunami. Small and narrow rivers can affect but in shorter distance compared to a big river.

Most researches on the impact of the tsunami have focused on evaluating its effects to the coastal areas that do not focus on the river upstream. Based on the measured data from more than 25 rivers in detail at the Tohoku District area after tsunami caused by Chilean Earthquakes in 2010, this study has shown that tsunamis can propagate up to several kilometers in the river axis. Depending on terrain conditions, the tsunami travel speed as well as propagation distances can be different in each river. The main purpose of this study was to raise awareness of people in preventing the damage caused by tsunami in the river upstream.

2. STUDY AREA AND DATA COLLECTION

2.1 Study area

Fig. 1 shows the location of studied rivers in the Tohoku District area in Japan. This area consists of 6 Prefectures, however, there are only 4 Prefectures, named Aomori, Iwate, Miyagi and Fukushima which faces the Pacific Ocean, was impacted by the 2010 Chilean Tsunami. An attempt is made to collect as many full data sets as possible from the local Prefectural Governments. In total, the data from 25 rivers were compiled and analyzed. Nevertheless, because of each river entrance has their own morphology so the influence of tsunami needs to be analyzed individually and compared among them.

2.2 Field measurement data

In Japan, water level was often measured at 1 hour of time interval in normal condition, however, due to some short-time extreme events such as typhoons or tsunami the measurement method can be switched to smaller time interval in order to catch more detail of the peaks of event. In this study, 10 minutes time interval water level measurement data were collected most of rivers and 1 hour data set for some rivers. The observed data inside of river were compared to the closest predicted tidal level data that is not affected by tsunami wave. The difference between water level in river and estimated tidal level can be used to detect the tsunami fluctuations in the river.

3. RESULTS AND DISCUSSIONS

3.1. Data analysis

Japanese rivers are classified into two different categories Class-A and Class-B according their dimensions and its importance. The Class-A rivers have relatively larger in terms of catchment and river morphology as compared to the Class-B rivers. The former are governed by the national government, while the latter by prefectural government.

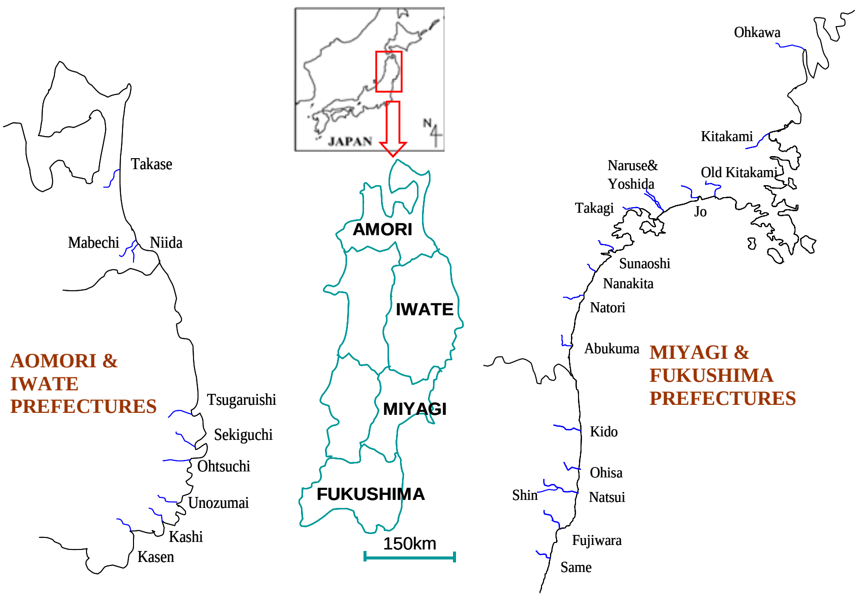

Fig.1: Location of the study area on Japan map

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The characteristics of each individual river are different in each prefecture. For example, there are many rivers in Iwate Prefecture flow into the steep rocky coast. Some rivers poured into the port or a hard structure located at entrance such as Mabechi River in Aomori Prefecture, Old Kitakami, Naruse, Sunaoshi, Natori Rivers in Miyagi Prefecture and Fujiwara River in Fukushima Prefectrue. The others rivers have sand spits at the entrance like Takase, Kitakami, Nanakita and Abukuma Rivers. Based on the characteristics of rivers in these prefectures, two types of river mouth morphologies are sub-divided to examine the tsunami runup influences to river upstream since tsunami energy dissipation before its invasion into river is highly dependant on the river mouth morphology. Hereafter, the analysis is based on these classifications.

Type 1: with non-constricted jetties or located inside a port.

Type 2: with sand spit or with constricted jetties

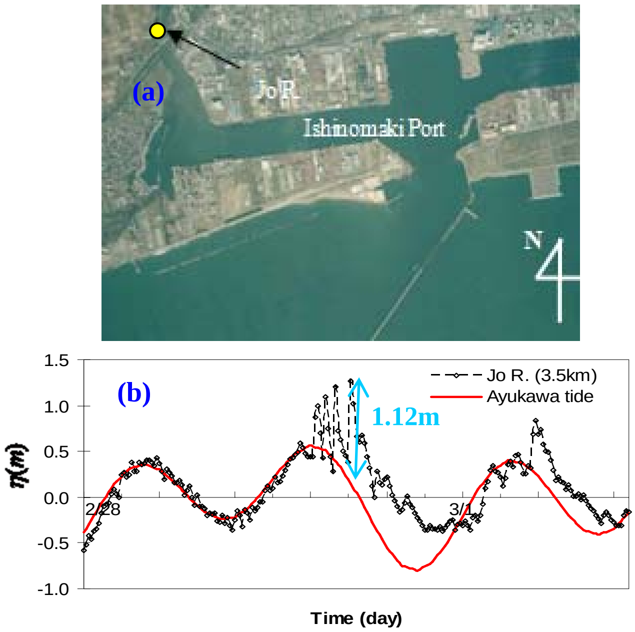

Fig.2: 2010 Chilean tsunami wave in Jo River

Jo River, as a typical example for Type 1, is located inside the Ishinomaki Port (**Fig. 2-a**). The width of river is gradually decreased to longitudinal direction. **Fig. 2-b** shows the comparison between measured water level at 3.5km from the mouth and estimated tidal level at Ayukawa station. The water level was almost no distinguishing difference compared to tidal level before tsunami occurrence. However, the maximum difference of 1.12m was observed after tsunami occurrence (**Fig. 2-b**). This tsunami wave height is the highest obtain value among these studied rivers.

Nanakita River is a representative for Type 2 river. The water depth and width at the entrance are shallow and narrow. Therefore, most of the tsunami wave energy was dissipated either at the coastline or close river mouth areas. A little tsunami height of 18cm was observed only during high tide level in the Nanakita River (**Fig. 3**). This tsunami behavior was found in the Same and Unozumai Rivers also.

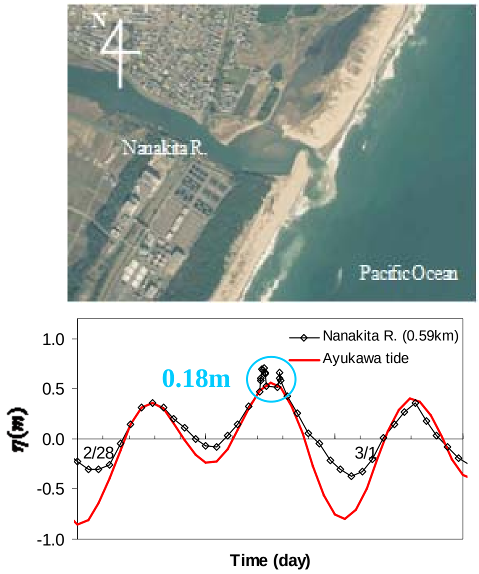

Fig.3: 2010 Chilean tsunami wave in Nanakita River

3.1. Discussions

The wave energy as passing through entrance is fully intruded into river in the Type 1 but it is divergent in the Type 2. Therefore, tsunami can propagate much further upstream distance in the Type 1 rivers and less in the Type 2 rivers. Tsunami can travel up to 32km as observed in the Old Kitakami River.

4. CONCLUSION

This study has found out that tsunami wave can propagate to very far upstream area in large river. Therefore, it is also important to warn the people living in upstream area of river in terms of tsunami disaster as well. This study is helpful for river authority, river management and engineers to find out the best solution in controlling the river environment and structure design in the river.

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REFERENCES

Abe K.: Tsunami propagation in rivers of the Japanese Islands, *Continential Shelf Research*, Vol. 5, No.6, pp. 655-677. 1986.

Tsuji Y., T. Yanuma, I. Murata, and C. Fujiwara: Tsunami ascending in rivers as an undular bore, *Natural Hazards*, Vol.4, pp.257-266. 1991.

Tinh N. X. and Tanaka H.: The influence of Chilean Tsunami wave in 2010 on rivers in the Tohoku District, Japan, *Proceedings of International Sessions of Coastal Engineering Conference*, JSCE, pp. 54-60, 2010.