A Study on Influences of Typhoon to Rokkaku River and Kase River Estuary, Saga Prefecture, Japan

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INTRODUCTION

In the past, there are 3 typhoons that gave big damages to Japan. First is typhoon Muroto (1934), second is typhoon Makurazaki (1945), lastly, typhoon Ise-wan (1959). The typhoon Ise-wan inundated about 8.34 x 10^5 ha area and gave 5,098 people dead. From 1952 to 2011 it has occurred 72 typhoon passing through Saga and within a radius of 150 km where the typhoon Ruth (1951), Wilda (1964), Songda (2004), Nabi (2005), Chaba (2005) and several other typhoons provided damages and casualties on the island of Kyushu. Characteristics of the typhoon is high wind speed with wind direction changing and the higher the wind speed is, the lower the air pressure is. The wind speed causes sea levels rise causing storm surges. Wind direction changes cause change of water flow. In Kyushu Island there is Ariake Sea. Most of the plains in Saga Prefecture are adjacent to the Ariake Sea and mainly lowland areas with a very small slope. Therefore when the sea water enters these areas it may create a large inundated area despite the fact that these areas are being used for agricultural, offices, residential, airport and etc. However, the Japanese government has built coastal dyke along the shorelines and rivers within this areas with the maximum height of 7.5m. In Saga plain there are two nearby rivers namely the Rokkaku and Kase River.

The aim of this study is to estimate to storm surge from the typhoon that ever crossed the region in Rokkaku, Kase River Estuary and lowland area surrounding them by using 3D hydrodynamic numerical model.

STUDY AREAS

Study areas are Rokkaku, Kase River estuary and the surrounding areas in Saga Prefecture.

Fig. 1 shows the studied areas and measured lines, that is line S, Line R, Line O, Line K and Line H.

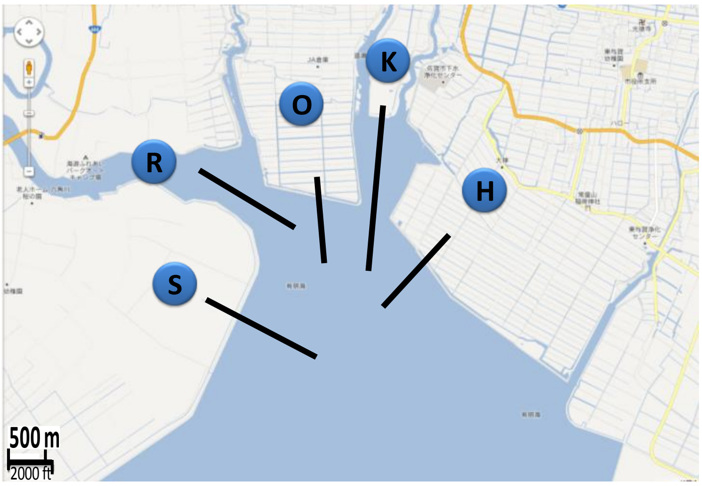

Fig. 1 Study Areas and Measured Lines

COMPUTATIONAL TOOLS AND METHODOLOGY

Computational Tools

The MIKE 3 Flow Model Flexible Mesh (MIKE 3 FM) developed by DHI (Denmark Hydraulic Institute) in the frame of MIKE ZERO packages version 2011 used in this study.

Data Needed

The following data are taken as input data; a) Bathymetric data are obtained from the Ariake project of Saga University. b) Topographic data are obtained from 50 m DEM of Japan supplied by Geospatial Information Authority of Japan. The elevation is taken up 20 m considering the number of points will determine the processing time on the computer and the assumption that the boundary conditions for groundwater is 10 m. c) Wind Data in the form of wind speed and wind direction from Chikugo River Office at Synthetics tower. d) The water level and tide in some stations. e) The simulation was taken from September 7, 2004 00:00:00 to September 8, 2004 01:00:00 when the Typhoon Songda (T200418) passed through the Ariake Sea area.

Scenarios

This simulation uses 3 scenarios. Scenario 1 is typhoon Songda (T200418), scenario 2 is typhoon Nabi (T200514) and scenario 3 is typhoon Wilda (T196420).

RESULT AND DISCUSSION

The simulation results obtained at 5 predetermined locations are in the following. Water levels are summarized in Table 1, where the highest water level generated by typhoon Songda in Line O is 2.562 m. As for the result of typhoon Nabi and Wilda, the highest water level are 2.461 m and 2.316 m respectively. The overall of typhoon Songda resulted in the highest water level in each location. Table 2 shows the results of the measurements of the current speed for each location, where the typhoon Wilda resulted in Kasegawa is the largest current speed, i.e., 0.715 m/s in the direction 23.065^{o} at 16.00 hours. For typhoon Nabi and typhoon Songda, the largest current speed are 0.457 m/s and 0.448 m/s respectively. From the simulation results it is seen that for all scenarios it is not found current speed exceeds 1 m/s.

Table 1. Simulation results on water Level

Location	Component	Songda	Nabi	Wilda
Shiroishi	level (m)	**2.185**	2.160	1.939
	time (hour)	24	12	24
Rokkakugawa	level (m)	**1.949**	1.628	1.530
	time (hour)	24	3	24
Ogi	level (m)	**2.562**	2.461	2.316
	time (hour)	24	12	24
Kasegawa	level (m)	**2.166**	1.922	1.643
	time (hour)	24	12	24
Higashiyoka	level (m)	**2.276**	2.125	1.982
	time (hour)	24	12	24

Table 2. Simulation results on current speed

Location	Component	Songda	Nabi	Wilda
Shiroishi	Speed (m/s)	0.285	0.225	0.424
	Direction (°)	175.796	4.892	188.018
	time (hour)	24	11	17
Rokkakugawa	Speed (m/s)	0.448	0.457	0.672
	Direction (°)	315.929	315.614	310.349
	time (hour)	11	11	13
Ogi	Speed (m/s)	0.342	0.346	0.642
	Direction (°)	16.128	14.214	199.823
	time (hour)	11	11	17
Kasegawa	Speed (m/s)	0.343	0.422	**0.715**
	Direction (°)	314.187	16.727	23.065
	time (hour)	22	11	16
Higashiyoka	Speed (m/s)	0.340	0.253	0.363
	Direction (°)	341.672	11.010	200.935
	time (hour)	21	11	17

In addition in the form of tables, MIKE 3 FM also provides output in graphical form either horizontally or vertically even in video form. Here is the output in the form of a cross section for the current speed along the Line K as in Fig. 2. The cross section is divided into 10 layers where vector of the current speed is described for each layer. Fig. 2 shows the vector of current speed and layer profile.

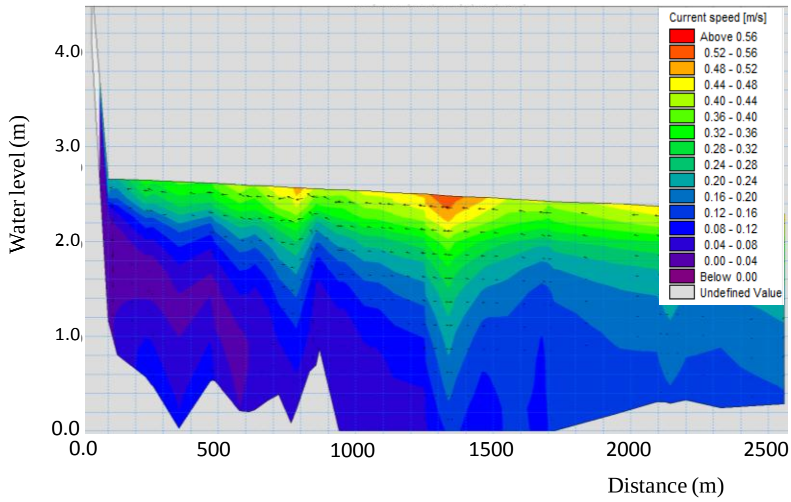

Fig. 2 Vertical profile of Current speed along Line K

CONCLUSIONS

Based on the hydrodynamic modelling it can be concluded as follows:

1. From the 3 simulated scenarios, there is no occurrence where the water levels exceed the height of coastal dyke, which means there will be no seawater inundates in Saga lowland area. There are needs to be simulated by using the largest tides to determine whether the water can pass through the existing coastal dyke.
2. Typhoon Songda (T200418), scenario 1, obtained the highest water level among the other scenarios yet.
3. Typhoon Wilda (T196420), scenario 3, recorded as the largest current speed compared to other scenarios but it has the lowest water level among the scenarios and in some locations, the water level is even lower than the water level on initial condition.
4. Current speeds generated by all the three scenarios are relatively small less than 1 m/s.

REFERENCES

(1) DHI, MIKE 21 & MIKE 3 FLOW MODEL FM, Hydrodynamic Module, Step-by-step training guide, 2009.

(2) Rohit Goyal, Prameet Rathod, Hydrodynamic Modelling for Salinity of Singapore Strait and Johor Strait using MIKE 3 FM, 2nd International Conference on Environmental Science and Development, IPCBEE vol 4, IACSIT Press, Singapore, 2011.