CONSTRUCTION AND OPERATION OF A WORK VESSEL LOCATION AND NAVIGATION INFORMATION SYSTEM FOR FISHING PORT CONSTRUCTION

by
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ABSTRACT

When Tsunami and typhoon attack ports, a large amount of drifts materials and debris appears and fills in basin of port and waterway. The first work to do is open the waterway buried with debris and drifts by work vessels. Work vessels are dredger and crane vessels. After then, cargo ships carry relief goods to the port. The work vessels carry out recovery work for the destroyed port facilities. In large-scale disaster ex. East Japan great earthquake disaster, the work vessels at the disaster area are destroyed, therefore work vessels must be dispatched from the other areas.

In order to promptly dispatch work vessels, the following three conditions are necessary. (1) to catch the location of work vessels, (2) to determine the necessary work vessels and (3) to rapid navigation to the damaged ports under the weather conditions. We construct a system that accumulates the location information sequentially and displays the current locations and navigation history information of each work vessels. In addition, the work vessels location and navigation information are accompanied with the weather condition information at the current location and the destination. In order to verify the effectiveness of this system with weather condition information, we installed GPS and transmitters in 35 work vessels in the Nagasaki prefecture waters area.

1. INTRODUCTION

In East Japan great earthquake disaster 3.11st.2011, the work vessels at the disaster area are destroyed, therefore work vessels must be dispatched from the other areas to open waterways of many destroyed ports. At first, it is necessary to get information what kind of work vessels are where. After deciding which vessels to send to which ports, It took nine days to dispatch work vessels to destroyed ports from another area. Even at fishing ports, It took 41 days to dispatch work vessels.

We should have dispatched these work vessels more quickly. Therefore, the location information of work vessels are acquired by GPS(Global Positioning System) and the location information are transmitted in real time via the Internet. We construct a system that accumulates the location information sequentially and displays the current locations and navigation history information of each work vessels. In addition, the work vessels location and navigation information are accompanied with the weather condition information on the wind direction, wind speed, wave height and wave direction at the current location and the destination. Therefore, it is a system that can ensure the safety of the action of the work vessels at the time of a disaster.

	After earthquake (2011/3/11) Arrival date of support work vessel		
Fishing port relation	Iwate	4/21	Torinokoshi port
Harbor port relation	Hachinohe port	3/18	General meeting material 2012 fiscal year Japan Dredging and Reclamation Engineering Association
	Miyako port	3/14	
	Kamaishi port	3/16	
	Ohunato port	3/19	
	Ishinomaki port	3/19	
	Sendai port	3/14	
	Shiogama port	3/17	

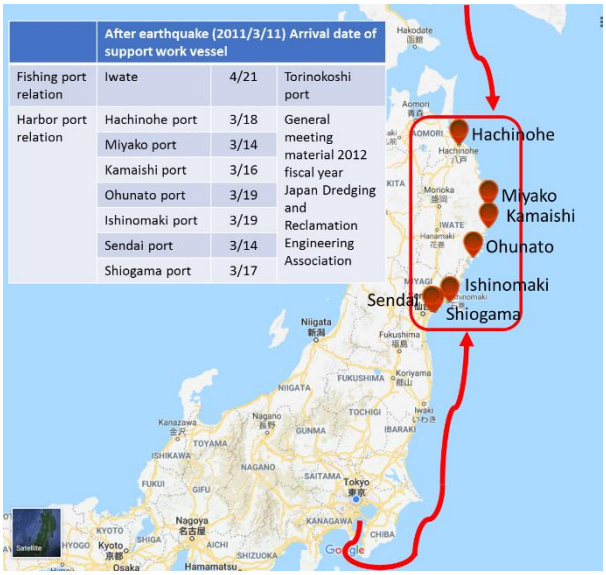

Figure 1: Work Vessels from Non Affected Area

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In order to verify the effectiveness of this system with weather condition information, we installed GPS and transmitters in 35 work vessels in the Nagasaki prefecture waters area. After that, the system has been put to practical use.

2. FLOW OF RESEARCH

This research is conducted as shown Fig.2.

The research consists of three parts. The first part is the construction of following each systems, location and navigation information system of the work vessels, weather condition information system, and a system for searching and browsing those synchronized two systems. The second part is to implement the equipment that transmits the location information of the work vessels. Then we obtain and input the weather information of the sea area and synchronize with the location information of the work vessel. The third part is the construction of a search and browsing system to grasp the movement of a specific work vessels.

In this pater, We implement GPS and transmitter at 35 work vessels in Nagasaki prefecture sea area and grasp the weather information. We operate this system and verified its usefulness.

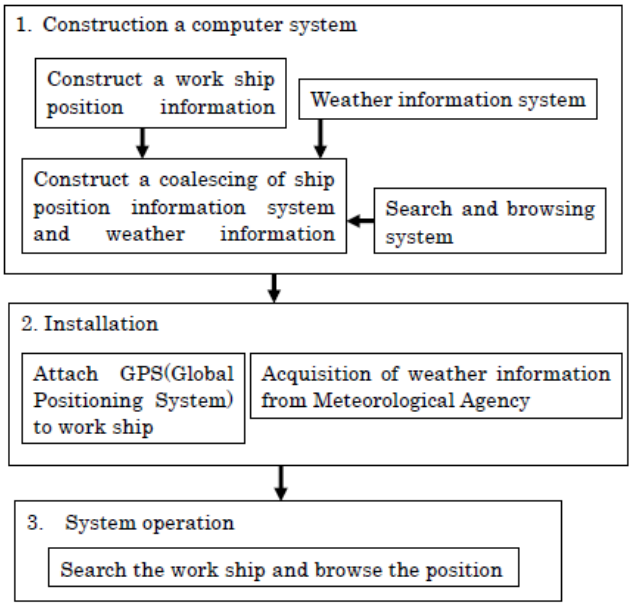

Figure 2: The Flow of The Research

3. CONSTRUCTION OF COMPUTER SYSTEM

(1) construction of work vessels location information system

At first, We construct the system to transmitter the work vessels location to cloud server. Second, the application of monitor screen is constructed in order to view the work vessels location. As the result, viewer ex. civil officer in charge of disaster restoration search and browse the work vessels location information.

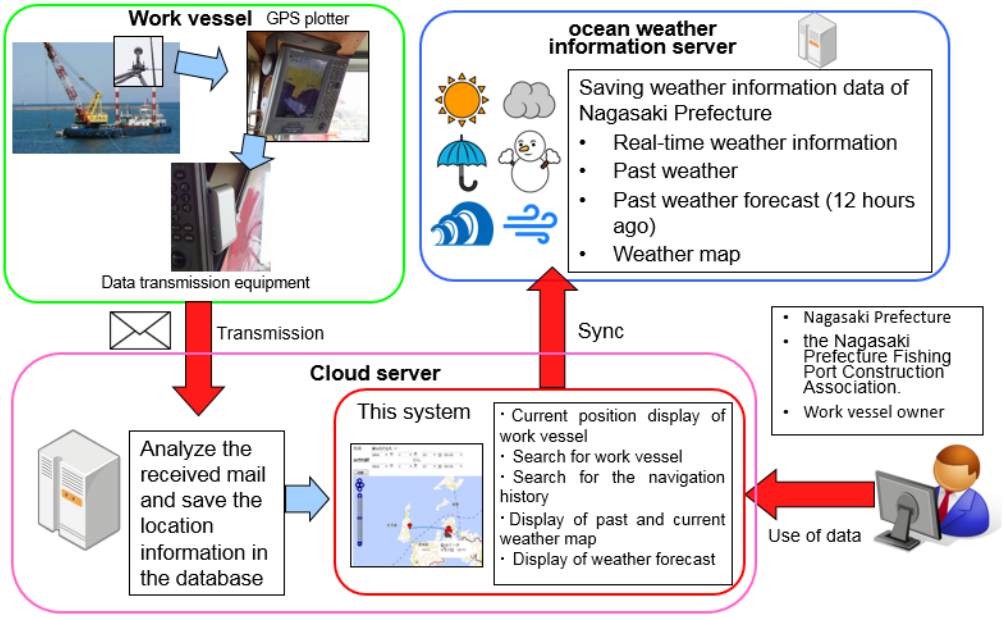

Figure 3: Work Vessels Location Information system

(2) construction of weather information system synchronizing location system of work vessels

The application is constructed to indicate weather information of Meteorological Agency synchronizing with location of work vessels. This application covers in range where work vessels navigate sea area, Nagasaki prefecture.

4. INSTALLATION OF GPS AND TRANSMITTER OF WORK VESSELS LOCATION INFORMATION

We installed GPS antennas and plotters and transmitters via the Internet on 35 work vessels in the Nagasaki prefecture waters area. The location information is acquired by the GPS antenna and the transmitter of the NMEA0183 standard is used. Work vessels　speed and location information are accumulated in the cloud server. The transmitter is a 3G communication module. It transmit location information of the work vessels to cloud server every 5 minutes on the Internet.

There is an AIS (Automatic Identification System) system that identifies the position of a vessels. But the GPS and 3G-transnsumission method is adopted for comparison of expenses and convenience for system program. The all coastal area of Japan (coastal area 22.2 km) is a communicable area of 3G-trannsmission.

	AIS	AIS (ClassB)	3G communication machine
Data transmission method	VHF radio wave		3G communication (same as mobile phone)
Accumulation of data	Not accumulated (It can not be confirmed whether the receiving station has received the radio waves.)		When 3G communication is out of range, data is accumulated and transmitted collectively when entering the area.
Open scope	All the world (anyone can set up reception stations)		Specific person
Vulnerability	Security hole report that can tamper with information on ship, etc. Reported		Same as mail service of used mobile carriers (docomo, au, SOFTBANK etc)
Size (mm) Horizontal * Width * High	420*250*85	1/2 - 1/4 of AIS	130*90*35
Price	$1,500	$1,000～$3,000 GPS antenna required If you want to monitor output on board, you need a GPS plotter separately (There is also a monitor function if it is an expensive item)	$1,500 GPS antenna required If you want to monitor output on board, you need a GPS plotter separately
Communication cost	Free		$120/Year
Remarks	GPS antenna　$200～$300		
	GPS plotter　$1,200～$3,500		

Table 1: The comparison 3G-transnsumission method with AIS

In this system, when outside the 3G communication range of the outside seas and the shelter of the mountains, data is accumulated in the transmitter, and within the communication range, the accumulated data is transmitted to the server. From the accumulated data, the navigation route history of the work vessel is displayed on the map (Fig.4).

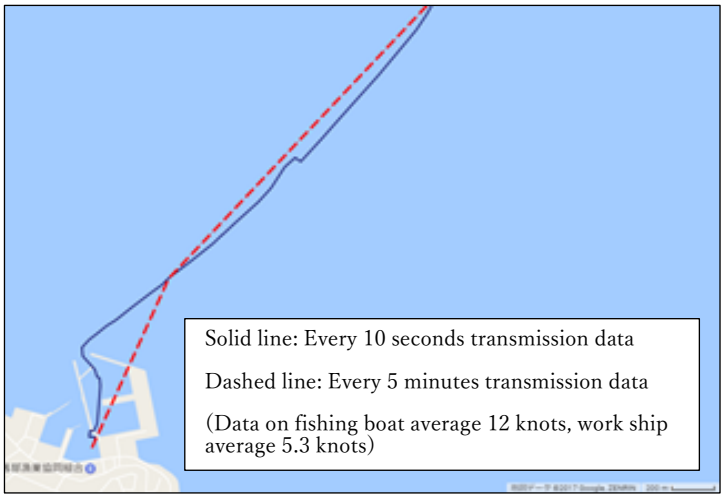

Figure 4: Navigation Route History of The Work Vessel

5. OPERATION OF SYSTEM

(1) work vessel location information system

Currently, the Nagasaki Harbor Fishing Port Construction Association manages the location navigation information system of 35 work vessels. Therefore, it is possible to dispatch some work vessels early when a disaster occurs. In order to carry out the restoration work of the harbor, they have established a system that can dispatch work ships efficiently.

The basic screen on the monitor of this system is shown in Fig.5.

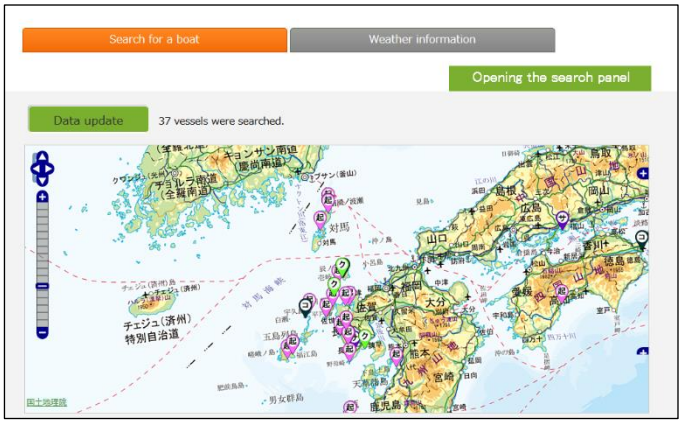

Figure 5: Location of Work Vessels

Figure 6: Details Information of Work Vessels

On this monitor, the position of the work vessel is indicated by the icon. Icons are displayed separately by the type of work vessels, hoist vessels and dredger vessels, etc.. As clicking the icon of the work vessel, the type and ability of the work vessel are displayed in detail (Fig.6). As clicking the character of root, the route history of the work vessel is displayed. When weather character is clicked, weather information on the position of the work vessel is displayed.

(2) weather information system

The basic screen of weather conditions necessary for the operation of the work vessels is displayed on the monitor as shown in Fig.7. In Nagasaki prefecture area, forecast of rainfall amount, wind data and wave data are displayed. Clicking on one point in the sea area, Forecast of the rainfall amount, the wind data and the wave data are displayed with numerical value and graph (Fig.8). Based on these information, it is possible to decide the navigation of the work vessels.

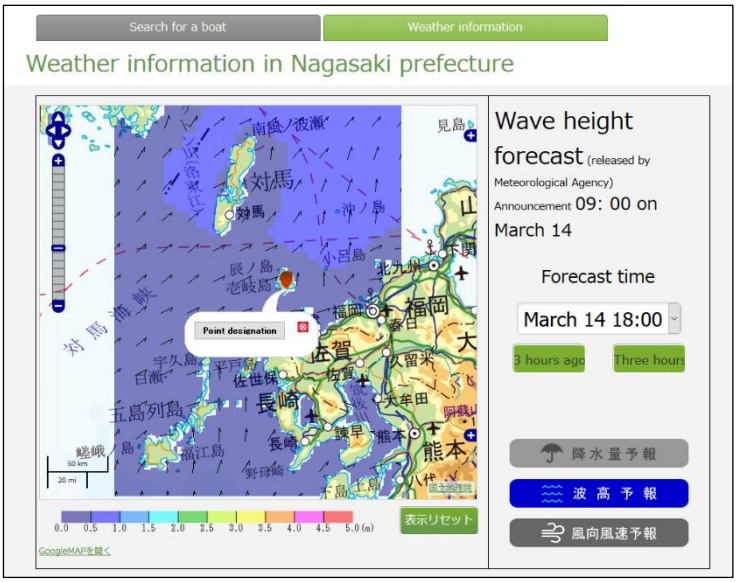

Figure 7: Weather Information Map

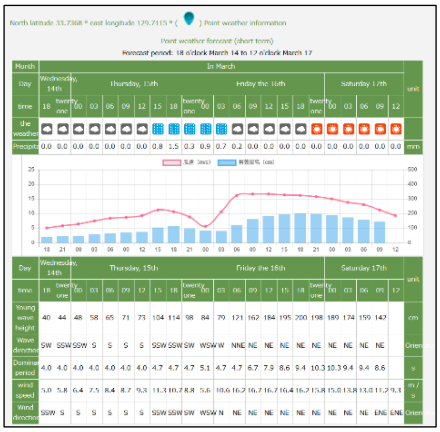

Figure 8: Numerical Weather Information

(3) coalescing of work vessels location and weather information system

Fig. 9 shows the monitor screen combining the navigation history of the work vessel and weather information. When the departure time and the arrival time of the work vessel are entered, the navigational trajectory during that time is displayed. And weather information of departure time and arrival time is displayed. This fig.9 is used as a document certifying that navigation was safe and appropriate. Current weather information and weather forecasts of the destination should be acquired, the current and predicted weather information can be obtained by clicking the destination as shown in Fig.7 & Fig.8

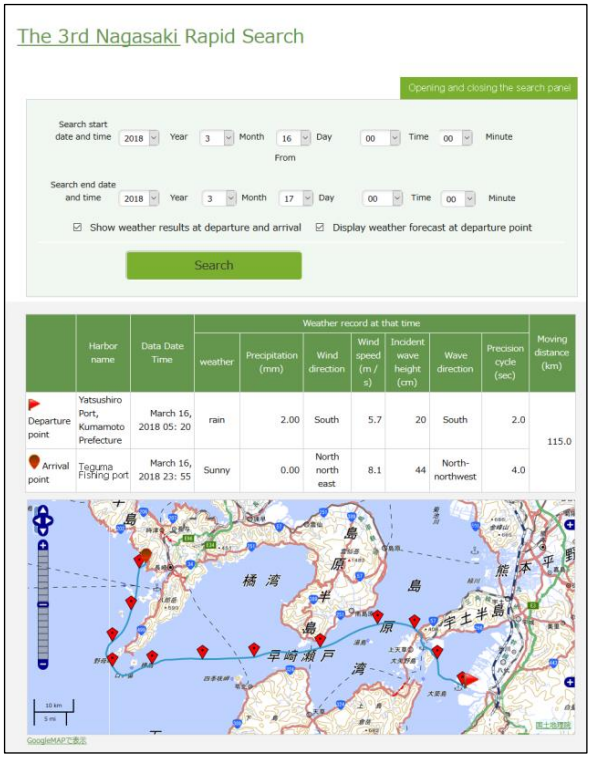

Figure 9: Navigation History and Weather Information

6. CONCLUSION

Construction of the work vessel location and navigation information system with weather information for port restore and construction port quickly. The Nagasaki Harbor Fishing Port Construction Association manages the location navigation information system of 35 work vessels. The Nagasaki Harbor Fishing Port Construction Association can dispatch the necessary work vessels to restore and construct port quickly. In order to take measures to large-scale disasters throughout Japan, it is necessary to participate in this system on not only 35 working vessels in Nagasaki prefecture's area but also working vessels in all over Japan.

References

Shimpei NAGANO, Masaaki WADA(Dr.), Shuichi TANAKA, Minoru NAKATA, Kouki ABE, Masayuki TAHARA and Akira NAGANO(Dr.). CONSTRUCTION AND OPARATION OF INFORMATION SYSTEM FOR POSITION AND NAVIGATION OF WORK SHIP. Journal of JSCE B3(Marine development),Vol 73(2017) No.2 I_977-I_982(in Japanese with English abstract)