COMMUNICATION NETWORK SUPPORT AT DAMAGED AREA

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Abstract: When the great earthquake struck Kobe in the mid-90s, cellular phones had not yet emerged as a change technology. Then in 2007, at the Niigata earthquake, communications, including packet communications, did not work properly for reason of damage to the Base Transceiver Station. This led to major blackouts and so on. We now see that a supporting network of volunteer ships from the sea at disaster can help in a crucial way. We propose a concept of creating communication network support from shipboard in the damage area.
We sent questionnaires to 47 municipalities according to their communication method during the earthquake in Niigata 2007. [24 replied.] The question is which communication system was used, and the frequency of usage.
For any long distance communication at a disaster area, it enables a vessel to be used as a relay base. Such as the internet in the hit area can suffer considerable damage and can be effectively disabled. We can communicate from an isolated area by relaying wireless communications as a repeater. It could become a valuable tool by serving as an emergency communication route within the possible large area of a disaster.

Keywords: immediate countermeasure at disasters, supports by ships, water supply, simulation, model

1. Introduction

The Great Hanshin-Awaji earthquake occurred on January 17th 1995. Land transportation infrastructure was heavily damaged. In the disaster, the method used to send supplies to the damaged areas were by land and air transportation. However, in the case of Kobe, the landing of helicopters was not permitted, this due to the danger of aftershock. Also land transport had a difficulty time because of destroyed roads and traffic blocked roads. Instead of land, therefore marine transport played a good part. At The Great Hanshin-Awaji earthquake ships carried supply and casualties. Ferries moored at quays in the harbor became accommodations for victims. Many kinds of ships played a major role, from immediate countermeasures to the recovery.
As many earthquakes occur, Japan is called “Jishin Taikoku” which means a country of earthquake. In Tokai, Nankai and Toh-Nankai area, which face to the Pacific Ocean, big earthquake have happened every 100 to 150 years. Nankai and Toh-Nankai earthquakes have a possibility to occur of more than 80% within 50 year period[1)].
When these earthquakes occur then the possibility of a tsunami is very high. This earthquake can lead to serious damage and loss.
By constructing an organized support network damage can be reduced.

2. Objectives

In order to construct an immediate support network of ships at a disaster, the supplies that might be needed can be transported to the damage areas can be estimated.
When disaster strikes, municipal response can be paralyzed. Lifelines, such as water, gas, electricity may stop. After disasters water, fuels, foods, clothes, medicines, rescue teams, medical staff, such as doctors and nurses are soon needed to be carried into the damage areas. By using a system dynamics computer program, number and time required carrying commodities by ship, can all be simulated. To confirm the effective supports by ships from the sea, this research will simulate its efficiency using system dynamics.

3. Supports by Ship at Disasters

3－1 *Great Hanshin-Awaji Earthquake*

Many ships, especially small ships were used in different ways during the Hanshin-Awaji earthquake. These ships were used as:

① Transportation of supplies by the fishing boats of Japan Fisheries Association, plus volunteers
② Supplies and human resources carried by ships chartered by various companies
③ Emergency shuttle bus for maritime transportation
④ Commuting ships tending anchored large ships
⑤ Establishment of the sea lane by small, high-speed boats
⑥ Transportation of supplies and backup members of rescue crews by fireboats
⑦ Transportation of workforce and casualties by patrol boats, and so on

Transportation of supplies and supporting personnel using ships started from the day following the earthquake. Various ships such as tugs, water boats, plying boats, fishing boats, and patrol boats were all used for transportation. According to statistics, supplies brought to Kobe port by sea, by the end of February, reached about 30,000t [2)]

3－2 *Response of Fishing Ports as Supporting Base Ground*

Fishing ports are scattered throughout the shore. Fishing boats have a tight turning circle are berthed at the ports. So, it is believed that these ports could play an important role as supporting bases to bring in supplies and human resources to the damaged area, and transport the victims.
In order for fishing ports to serve as a support base, it is necessary to cooperate with neighboring fishery administrations and fishery associations and construct a network for disaster. Additionally, it is also necessary to create an information infrastructure for communication with fishing ports as a supporting base, and to inform on the post-disaster situation, immediately. In order to construct a network between fisheries areas, there need to be preparation of fishing port as disaster prevention facility.
Fishing ports can handle seaborne transport supplies and evacuees immediately after any disaster. Transport

commodities while public facilities until restoration after the earthquake has occurred. [3].
At the great Hanshin-Awaji earthquake the route of transported supplies to Kobe and Awaji from the fishing ports of neighboring prefectures is shown in Figure 1.

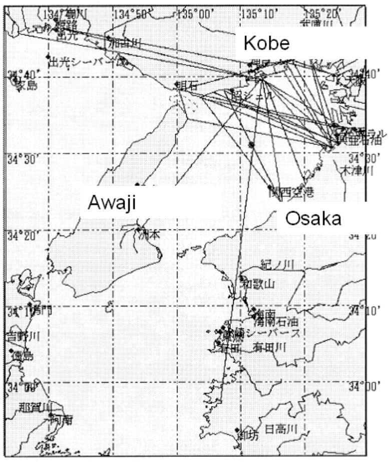

Fig. 1 Routs of supporting for Kobe by small ships at the earthquake [1]

4. Nankai Toh-Nankai Earthquake

Nankai and Toh-Nankai areas on the main island of Japan are facing the Pacific Ocean. In these areas, a major earthquake can occur every 100 to 150 years. The scale of magnitude has 8 classes. The government “Earthquake Research Committee” announced the possibilities of earthquakes in the Nankai and Toh-Nankai areas at 50% in next 30-years and 80% in next 50-years; September 1, 2004 [1] .
The next Nankai earthquake is predicted to strike near Kochi prefecture at an intensity of 6 or more, in the Japanese scale [4].
Moreover, the earthquake will cause a tsunami in all coastal areas of Kochi. The tsunami will be 3 meters to over 10 meters and predicted to reach coastal area in Kochi within 3 to 30 minutes. These earthquake and tsunami bring widespread damage to the whole area of Kochi, and access with neighboring areas would be majorly disrupted [4] .

5. Support network of volunteer ships deployed to a disaster

Well organized support from the sea could hold the greatest potential for effective support systems in any kind of disaster that may happen in Japan. In order to construct an immediate, support network, we researched into the case of Kochi city, in Shikoku Island. Figure 2 is an image of the supporting network [5].
During ordinary times this network will spread the idea of volunteer shipping, educate and train those joining the network, and create a map which will show the place where small ships can gather, off shore.

① Once disaster happens, a volunteer ship network will collect information from on-site headquarters and others, in the damaged area.

② Collected information will be analyzed and released by the volunteer ship network.

③ People joining the network can get information such as on how many and what kinds of supplies are required; where the safe shores and beaches are, and so forth

④ In the early scenes, after a disaster; medicines, water, food and rescue teams are placed at the highest priority

By constructing this supporting network, information exchange will become smooth and more effective. Support from the sea by small vessels will be easily possible. It will be a centre for countermeasures onse the disaster has struck. This informational exchange is very important, for this supporting network [6].

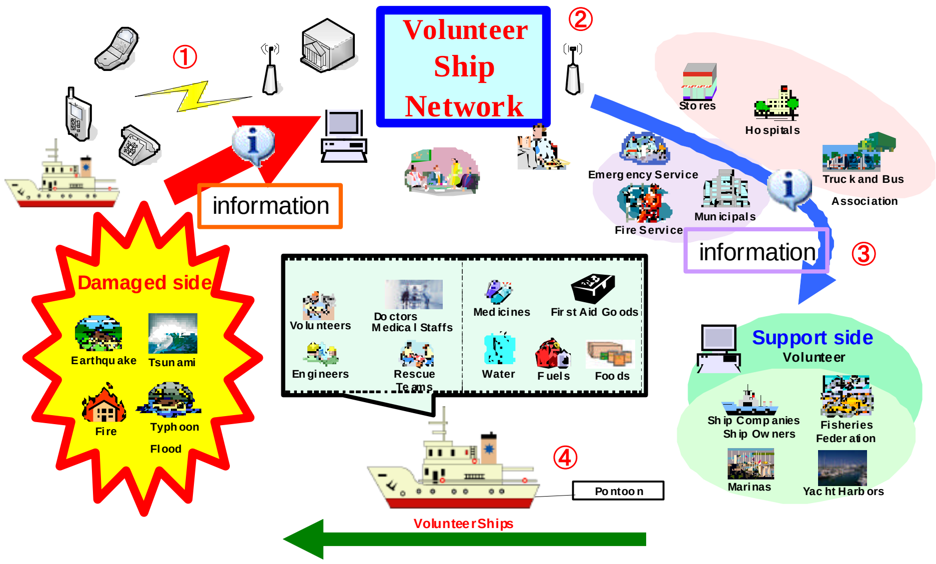

Fig. 2 Image of the supporting network of volunteer ships from the sea

6. Method of Simulation on the System on the System Dynamics

6－1 *Outline of Simulation Model*

Tokai and Toh-Nankai earthquakes are predicted in the near future. If this earthquake hits, we worry about critical damage in Pacific area of the Western Japan. Thus, we built a supporting model for Kochi prefecture. Then, we start the simulation based on the model, and discuss the number of volunteer ships, quantity of supporting supply carried, and the required time necessary.

Many uncertain things happen at a disaster, so we simulate situations including many indefinite factors. We used

Powersim Studio, an application under Windows computer, for modeling and simulation, based on system dynamics. In this simulation, we try to get quantity of supporting supplies carried to devastated area by calculation. The scenario of simulation set is as follows. Supporting supply is carried from ports located near Kochi City by volunteer ships. This time, we confine supporting supply to water. Conditions of ship size and loading capacity are about the same for every ship. Under this condition we research for the quantity of supporting water carried to Kochi.

We use many variables such as port scale, distance, water volume, etc., so as to build our simulation model. The model is composed by one main model and twenty-six sub-models to make it easier to grasp. The sub-model simulates each port, so it is easy to extend the simulated circumstance by extending the sub-models.

6－2　D*ata of the Variables.*

Figure 3 shows locations of 26 ports.

Since we cannot find the value of the number of ships, we assume that the number of ships of these ports is 100. The size of all ships is 3 tons. Assuming weight of 1 person as 70kg, 3 ton ships of max capacity 10 people can carry 700kg. At least 2 people have to be on board for safe transport and also safety margin have to be considered. So 500kg was set as a capacity for supplies.

So, all the vessels carried 500 liters of water and these ships carry it to Kochi City.

Considering the number of sufferer, at Hanshin earthquake disaster, the number of sufferers was about 210 thousand people [7]. The population of Kobe city was about 1,500,000 [8] . Assumed the same percentage (14%) of total. Kochi city population (333,000 [9]), the suffering people is about 50,000. It is said that one person needs 3 liters of water per 1day for the first 3 days [10]. Thus, Kochi City needs about 450 thousand liters of water for 3days, in total.

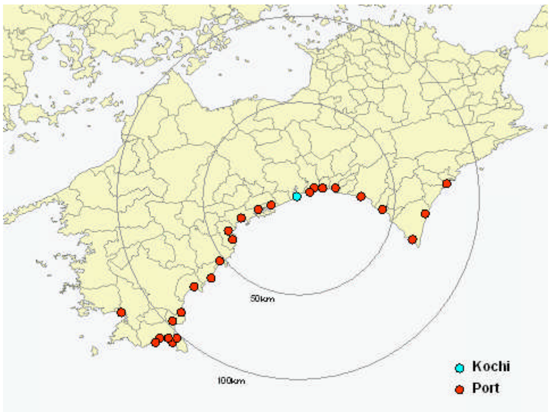

Fig. 3 Location of ports

7.　Simulation Result

Figure 4 is the simulation result of ships loaded with water arriving at a destination. The solution is given by repeating the simulation 1000 times using Monte Carlo simulation.
From the simulation, 18-hours is average time needed to carry 450,000 liters of water to Kochi City from undamaged ports, after the disaster. In the simulation, the fastest time required was 12-hours; the slowest was 21-hours. Ports or ships supposed to support may be damaged and cannot therefore serve.
Support from the sea after the disaster can supply enough water to Kochi City, where 14% of citizens in Kochi city have became victims. This shows the efficiency of support from the sea by ships.
As to future work constructing the supporting network, surveying the number of supportable ships and improving this simulation model has to be done.
As a major earthquake in West Japan is expected to happen, in order to minimize damage, the construction of a support network from the sea has a high priority. Improved simulation model will be able to propose more effective support by simulating usage of ships by basic mind of 5W1H at disasters.

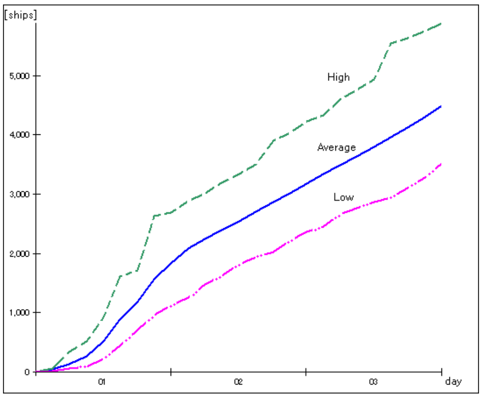

Fig. 4 The number of arrival ships in every 3 hours

8. Communication network support on shipboard

In the case of communication exchange between networks, the use of packet communications of a cellular phone as an excellent way of communication. This has been established ever since The Niigataken Chuetsu-oki Earthquake. From the above background, we propose a concept of communication network support on ship, at the damage area.
Generally, as a communication method, fixed telephone cellular phone and the internet, radio (amateur radio etc.) are mentioned. Most familiar to us is certainly the phone. A fixed telephone uses an ISDN system and an analog by the telephone circuit of a cable formula. These communication means have both good points and bad points. If 100 calls concentrate the analog formula of a fixed telephone in 1 second, congestion will occur. However, even if electricity failures, a minimum voice communication is securable. A cellular phone can talk on the run since it is a radio formula. Moreover, by separation of a voice circuit and a packet circuit, as for regulation of a packet, it becomes loose from a sound, also at the time of a calamity.

9. Questionnaire survey

We sent a questionnaire to 47 governments and municipalities of Ishikawa, Fukui, and Toyama prefecture concerning their communication method at the time of The Noto Hanto Earthquake of 2007. [32 answers[11]]. Of these 24 answered the question in which way communication was used and frequency of usage. Table 1 shows result summary.

Table 1. Numbers and usage & Communication way

	use	no use
fixed telephone	19	3
cellular phone	15	3
PC (Internet)	13	7
maritime radio		17
ham radio	1	17
others	3	

Usage rate of fixed telephone and cellular phone are high because they have become highly popularized. In some regions, fixed telephone and cellular phone were seldom connected or disconnected. So, they were used for special communications by government or ham radio. Special Communication System is the network of national and local public entities. They were installed to collect disaster information and ensure a communications means during an emergency.

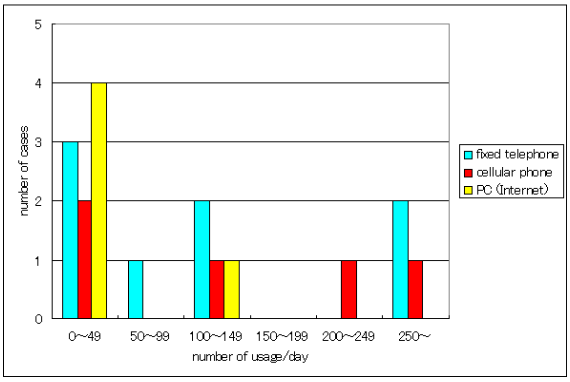

Fig. 5 The frequency of usage by communication method, on the day

Figure 5 is the results of the frequency of usage by communication method on the day of the disaster. Fixed telephone is used the most frequently. 2 municipalities used it more than 250 times, followed by cellular phone. PC was less frequency used.

10. Outline of network

Informational exchange is very important at the time of disaster. At that time of the 1995 Great Hanshin-Awaji earthquake, cellular phone was not then generally popular. However, after that, information exchange by cell-phone at the disaster is felt more possible as cellular phone use has hugely grown. So, each cellular phone providers now can divide voice communication from packet communication and set up online bulletin boards and voice mail service at disasters. Unfortunately in 2007 at The Niigataken Chuetsu-oki Earthquake, communications including packet communication became impossible because of the reason of damage done to the Base Transceiver Station. Result: major blackouts and alike. Some parts of the city were isolated from communication. Now, we realize that a support network of volunteer ships from the sea at disaster is a real improvement. In this case, communication exchange between networks of a cellular phone is a fine way of communication. Since problems like this occur, the necessity of examining the communication of when and when not to use cellular phones has emerged. Using of the Internet, and not only for the exchange of E-mails, but also for audio exchange; that will be most helpful. From the above background, we propose a concept of building a communication network support, by sea, in the damage area.

According to the questionnaire result, PCs had the highest frequency of use. Next were fixed telephones and then the cellular phone.

For long distance communication, use of a vessel as a relay base for those areas which suffers great damage and thus become unable to use the Internet. Furthermore, this network has the advantage that ships are maneuverable. They can also provide a power supply and wireless LAN devices at a very low cost.

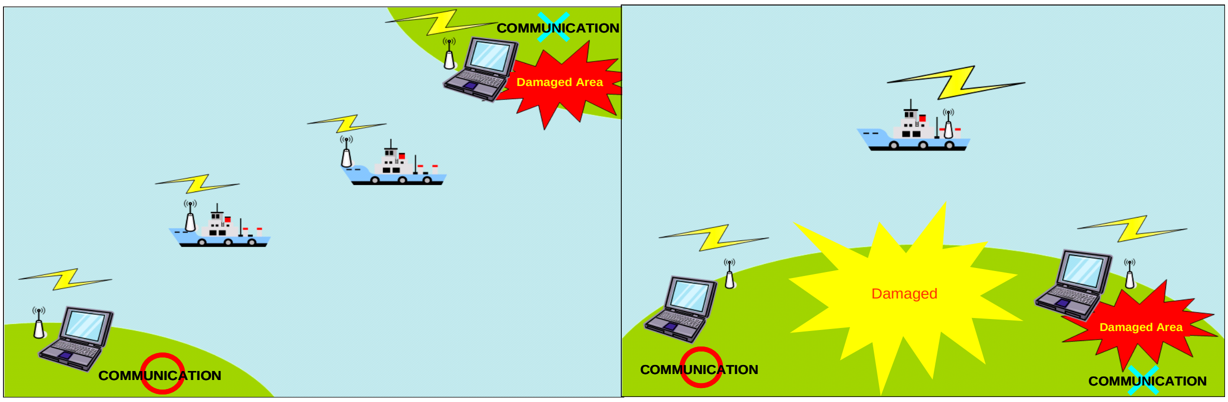

Fig. 6 Image of communication network support on ship at damaged area

11. Future work

This network has the advantage that ships are maneuverable and it can also provide a power supply and WLAN devices at low cost. It is conceiving of such a construction of a coast area communication network, using ships, and small-scale experimental verification was performed. We carried out the check of operation of the communication at a short distance.

It is hoped that to enable prompt information exchange as an immediate countermeasure after disaster strikes is useful in the transmission of safety information and getting information out about the damaged area. Moreover, with a supporting network of volunteer ships, from the sea, it may become a standard technique of serving an information-communication function during an emergency, and as a way to get information concerning shore conditions for volunteer ships, also help to the immediate needs of the shocked survivors.

By constructing this supporting network, information exchange will become smooth and yet more efficient. Support from the sea by small ships is possible. It will be useful for a first countermeasure after a disaster.

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