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PROPOSAL OF ISOLATION MEASURES FOR MOUNTAIN VILLAGES BASED ON ANALYSIS OF DISASTER PREVENTION DRILLS

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ABSTRACT: As measures against the isolation of mountain villages, it is the mainstream to enable two-way communication between residents and the local government by installing satellite mobile phones and answer back function of disaster prevention radio, that is, to secure information transmission means. However, due to sediment-related disasters, isolation may occur even within the village, the heavy snowfall or sediment may prevent the installation of satellite mobile phones and disaster prevention radios. Therefore, we propose to arrange a wireless communication network and an information terminal that has a WiFi function and is easy to operate and to proceed with the construction of a wireless communication network (public assistance) along with the safety confirmation (mutual assistance) by the residents of the village, and confirmed by a practical disaster prevention drill. It was clarified that it is important to establish a safety confirmation system and secure a means of communication between the government office and the village by wireless communication.

Keywords: Isolation measures, Mutual assistance, Public assistance, Safety confirmation, Mountain village

1. INTRODUCTION

Many types of natural disasters occur in Japan such as tsunamis, earthquakes, typhoons, and landslides. More than 17,000 villages may be stranded due to these natural disasters in national land, for example, in Yamanashi Prefecture, 493 villages may be isolated due to road blockages caused by earthquakes[1].

Disaster Countermeasures for being stranded are not only hard measures but also soft measures like early warning evacuation. When a sudden disaster occurs, it should be aiming to evacuate to a safe community center. Living in an unfamiliar shelter can be stressful, especially for the elderly. It is better If can evacuate to the village public hall, because it can easily get the supplies from the home nearby, and if the home is not damaged, it is possible to live at home. In addition, the life of the village public hall is not so stressful because it is a neighbor who is acquainted with each other. If someone is injured, or suddenly ill, it needs to be taken to a hospital. if there is a shortage of supplies such as food and medicine, support must be requested.

Local governments are promoting the introduction of satellite mobile phones to villages that may be isolated to secure communication means in the event of a disaster. Since satellite mobile phones communicate via satellites, unlike fixed-line phones and mobile phones, they have the advantage of being less susceptible to line congestion and power outages. However, satellite mobile phone has some demerits, firstly, it must point their antennas in the direction of the artificial satellite to capture the radio signal. Secondly, it cannot be used in a room without a window unless taken outdoors, and it is impossible to make a call on a cloudy day. finally, since satellite mobile phones are generally installed in public halls, it is necessary to go there to use them.

Therefore, we setup local wireless network and information system, examined the effects of differences in information transmission means such as mobile phones, landlines, satellite mobile phones, and disaster prevention administrative radios on disaster response such as safety confirmation and rescue requests in disaster prevention drills.

2. METHODS

2.1 Survey Site

The survey sites are located at Hachinoshiri district, Ichikawa Misato Town, Yamanashi Prefecture, shown in Fig.1. It is a mountain village and a landslide area, if a large earthquake occurs, the road may be blocked by the landslide and the village may become isolated. The evacuation center is in the gymnasium of Elementary School and

Junior High School in the Kurosawa area at the foot of the mountain.

In January 2014, a practical disaster prevention

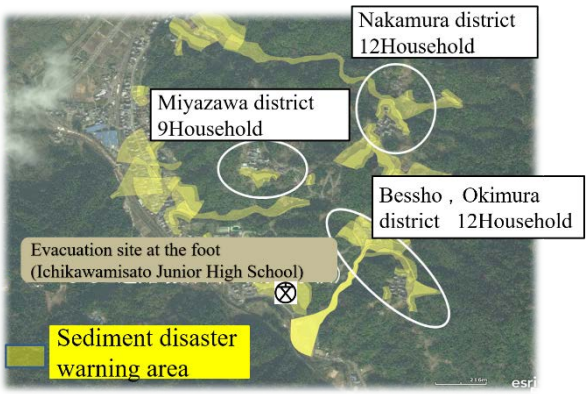

Fig.1 The survey site in Yamanashi Prefecture

drill in these sites was conducted on the condition that the district was isolated and mobile phones could not be used due to line congestion. "Safety confirmation using ICT, rescue request" was executed in "Safety confirmation system derived by residents themselves". Risk Communication using the CAUSE Model has been conducted in disaster isolation measures, to make the residents get the consensus of evacuating from the village when a disaster occurs.

2.2 Risk Communication

Risk Communication, in general, means that accurate information on the risks surrounding society is shared among governments, experts, companies, and citizens to communicate with each other.

Risk Communication is required when regarding problems that involve certain risks such as fostering public understanding of disasters and environmental problems and still require sharing of awareness among related parties, and when it is necessary to recognize safety measures and share cooperative relationships.

Risk Communication in disaster prevention shares information on disaster risk among stakeholders such as the government and citizens, and mutually understands the information provided by residents to the government and the information and service contents provided by the government to the residents. It is a process of working together to promote and mitigate risks as much as possible. In this process, the parties concerned do not hide the information, share all the good and bad information, and discuss and solve the bad things.

By communicating with each other and building a cooperative system through Risk Communication even before a risk arises, it is possible to mitigate the risk when it occurs.

Along with improving self-help and mutual assistance, building disaster countermeasures in collaboration with residents and the government will lead to the improvement of regional disaster prevention capabilities. "Workshop on home evacuation as an isolation measure" was held as an initiative to carry out Risk Communication using the CAUSE Model.

The CAUSE model is a method proposed by Professor Rowan of George Mason University in the United States for Risk Communication education for regional crisis managers. CAUSE is an acronym for Confidence, Awareness, Understanding, Satisfaction with proposed Solutions, and Enactment arranged in the order of C, A, U, S, E[2].

Targeting the Hachinoshiri area of the mountain village, the local community and the government collaborated to form a consensus on evacuation at home[3]. First, we built a relationship of trust with university teachers, students, municipal disaster prevention officers, and residents (Confidence).

Next, make people aware that they have the option

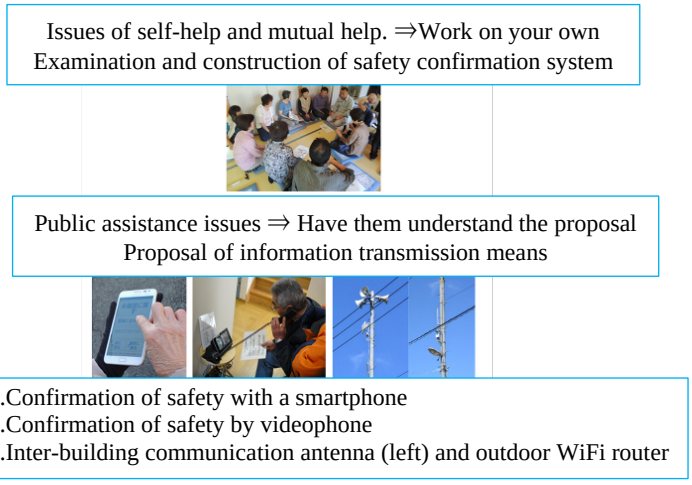

Fig.2 safety confirms by communication means

of evacuating at home in the event of a disaster (Awareness). Finally, make people understand the advantages and disadvantages of staying in a village in the event of an earthquake disaster (Understanding).

If the problem is solved, stay in the village depending on the degree of damage (Solution). The residents discussed by themselves and took out the solutions also conducted.

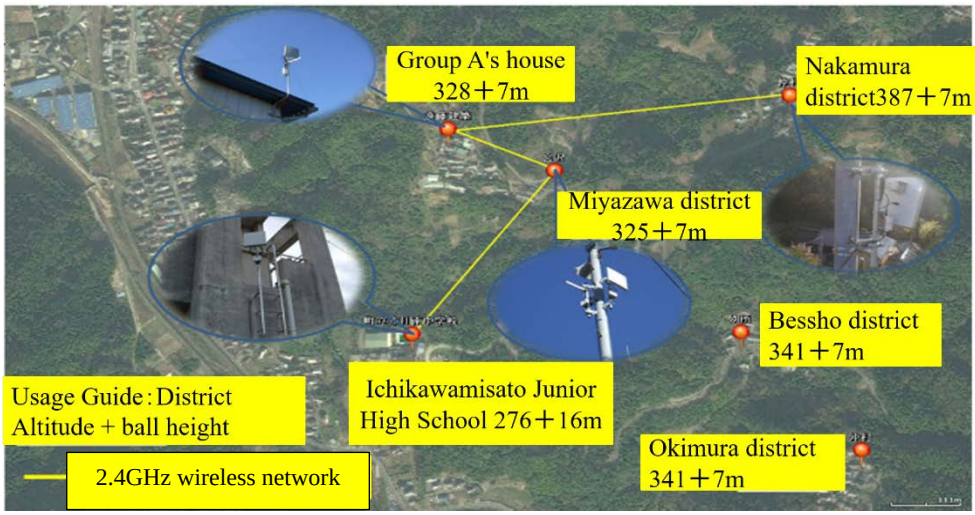

Fig.3 Wireless network built in the villages

2.3 Wireless Networks and Information Systems

Considering the characteristics of mountainous areas, it is considered that a wireless network that builds a wireless connection by radio waves instead of cables in the event of a disaster is applicable. It is expected that fixed-line phones will gradually be replaced by mobile phones (smartphones), and wireless communication will be carried out by anyone anywhere.

It is indispensable to build a wireless network as a countermeasure against the isolation of mountain villages instead of satellite mobile phones. But the wireless network has not been constructed in the Bessho area and the Okimura area, because of many radio obstacles in this mountainous area.

Professor Suzuki proposed a method of designing a wireless network in advance on a desk that reflects topographical conditions to build a wireless network as a countermeasure against the isolation of mountain villages[4-10]. Group the mountain villages, obtain and prepare the necessary data in advance for the wireless network of the mountain villages where it is difficult to conduct on-site reconnaissance and radio wave surveys, and then limit the number of relay stations to two between base stations and use GIS. So, we proposed an algorithm for designing a wireless network using it, shown in Fig.3.

Then, the wireless network design method was applied to 29 isolated villages in Ichikawamisato Town. As a result, we were able to construct a wireless network that connects nine villages by installing three relay stations and a wireless network that connects six villages by installing one relay station. In particular, regarding the wireless network of the group including the Hachijiri area, the wireless network could be constructed in Okimura and Bessho, which could not be constructed even if the telecommunications carrier examined it locally, and the user could be proved.

2.4 Phones in the Village

Before the actual disaster prevention drill, we visited all households one by one in the Hachinoshiri district, in order to understand the means of information transmission for each household. Hachinoshiri district consists of Miyazawa, Nakamura, Bessho / Okimura, and the number of households in each district is 10, 15, and 12 households.

On November 17, a survey on information and communication methods for residents conducted home visits to 34 households in the Hachinoshiri area, only 3 households could not visit at home(Table 1).

Regarding the results of the survey, among all Hachinoshiri households, 7 households have 15 smartphones, and 23 households have 38 ordinary mobile phones. Regarding the contracted mobile phone companies, DoCoMo has 27 cases, au has 20 cases, and SoftBank has 2 cases. For model types, see DoCoMo's MicroSD, f-10a, f88ies, f-08c. There were au MicroSD, Koos, sony Xperia, sol21, etc, shown in Table 2 and Table 3.

We checked from the homepages of the three carriers and found that only 21 units could receive the Earthquake Early Warning Area Mail. It was

also confirmed that 31 households have 31 fixed-line telephones as another means of communication. It is shown in Table 4.

Before the actual disaster prevention drill, the residents of Hachinoshiri used four smartphone phones and five videophones borrowed from Yamanashi University to register their safety and report the damage situation and found out the schedule.

Table 1 Households in the Hachinoshiri area

Total	Visited	Absent
37	34	3

Table 2 Ordinary mobile phone in 23 households

Total	docomo	au	softbank
38 units	23 units	13 units	2 units

Table 3 Smart mobile phone in 7 households

Total	docomo	au	softbank
16 units	4 units	10 units	2 units

Table 4 About the fixed-line phone

All fixed-line phone	31
Use of mobile mail function	10
Don't use email at all	10
Terminals that can receive Earthquake Early Warning Area Mail	21

3. RESULTS

3.1 Results of Disaster Prevent Drills

On January 11, 2014, a practical disaster prevention drill started at 9 o'clock in the Hachinoshiri district of Ichikawamisato Town, Yamanashi Prefecture, shown in Fig.4 and Fig.5. The occurrence of an earthquake and the issuance of evacuation advisories were communicated by the voice from the disaster prevention radio. At the same time, emergency earthquake messages were transmitted by mail and SNS.

Since we registered the information on the establishment of the disaster countermeasures headquarters and the issuance of evacuation advisories, it could be started to confirm the safety of residents. The safety of the residents was confirmed by the system decided by each village and reported to the government office by IP phone, SNS, videophone, and satellite mobile phone.

After the training starts, the residents implemented the safety confirmation system for each group and promptly confirmed the safety. Some residents in the group have a videophone or smartphone, and when they confirm their safety, they register the safety information on the Ichikawamisato SNS and inform the town of the safety information. In addition, the injured residents and the residents whose houses have collapsed and whose safety is unknown are found, and a rescue request is made to the town.

The precondition is that the mobile phone call function cannot be used due to line congestion or the destruction of the base station due to an earthquake

Fig.4 Disaster prevention drill in Bessho

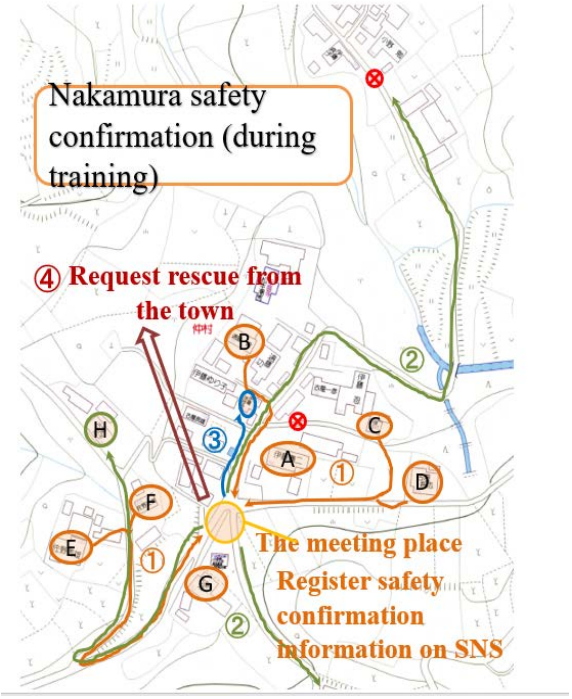

Fig.5 Disaster prevention drill in Nakamura

In addition, a simulated disaster was generated in the district according to the scenario.

Signs, traffic cones, and people closed the road to block the passage of residents. It was assumed that all the roads leading to the outside of the area were cut off and the Hachinoshiri area was isolated. A practical disaster prevention drill using ICT (Information and Communication Technology) was conducted for the residents of Hachinoshiri. Planned for the first time so that information can be exchanged smoothly in the event of a disaster. Residents used smartphone phones and other devices to register their safety and report on the damage situation using the information sharing system being developed by the University of Yamanashi.

It was confirmed that the safety confirmation based on the safety confirmation system was carried out (Enactment) in each group from the behavior observation and questionnaire survey of each inhabitant. It was confirmed that 95% of the residents carried out the safety confirmation.

(1) All the residents were not aware of the voice speakers of the disaster prevention radio, emergency bulletin mail, IP phones (videophones, smartphones), and SNS, and the certainty was not satisfied. By adding a call (safety confirmation), it was found that all the residents in the Yanojiri area were able to be aware of the evacuation information.

(2) As a result of investigating all mobile phone types owned by residents in the Hachinoshiri area and sending an Earthquake Early Warning Area Mail, in areas where the radio waves of mobile carriers are relatively weak, it is also within the area. However, it turned out that the Earthquake Early Warning Area Mail could not be received.

(3) When evaluated in the entire Yanojiri area, in the case of calls using IP phones and response actions using SNS, safety confirmation in the village, information transmission to the town hall, information sharing between the town hall and the fire department, safety information on SNS, It was confirmed that the input of damage information was effectively achieved.

3.2 Evaluation of Information Transmission Means

From the questionnaires conducted in the Yanojiri district practical disaster prevention drills, these means can be used for disaster response such as safety confirmation/rescue requests. The evaluation of communication means as a disaster isolation measure in mountainous villages is described as the following indexes.

(1) "Time" from the disaster to the time when the government office contacts the fire department

The total time taken for the response action in the process of the government office contacting the fire department from the disaster for each condition of the communication means is defined as the "time" from the disaster until the government office contacts the fire department.

The time required for response actions using ICT and mobile phones was set based on the results of the training survey. The time required for a walk visit was calculated using the time required for walking (80m / min). Landline phone that could not be investigated in the Hachinoshiri district practical disaster prevention drill. The time required for response actions using satellite mobile phones and disaster prevention administrative radio, and the time required for rescue requests from the government office to the fire department is set as table 5 and Fig.6.

Table 5 The time required in different methods

Methods	Time
Calls using ICT	3 Minutes
Enter safety information and damage information into SNS	1 Minute
Calls using mobile phones	3 Minutes
Calls using landlines	3 Minutes
Calls using satellite mobile phones and disaster prevention administrative radio	5 Minutes
Based on SNS information, the government office requests the fire department to rescue the residents	1 Minute
Based on the report by telephone, the government office requests the fire department to rescue the residents	5 Minutes

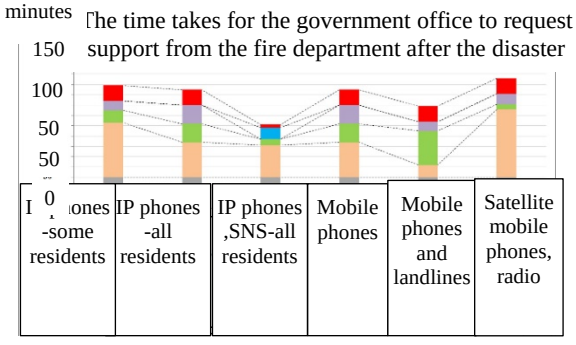

Fig.6 Time of different communication means

(2) "Number of activities" from the disaster to the time when the government office contacts the fire department

The latest route from the disaster to the office contacting the fire department is extracted, and it is defined as the "number of activities" from the disaster to the office contacting the fire department. The types of activities are shown below.

1.Gather at the meeting place, confirm the safety
2.Visit on foot, confirm the safety
3.Use communication equipment to confirm safety
4.Enter safety information by SNS
5.Resident's report safety to the government office
6.Rescue from the fire department

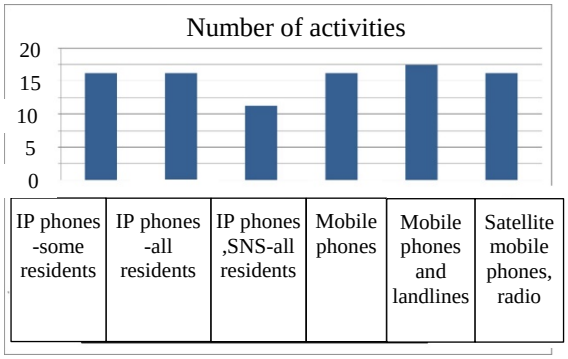

Fig.7 Number of activities

(3) The "stage" from the disaster to the time when the government office contacts the fire department

The contents of the response actions at each stage, which are color-coded, are organized, and the evaluation index is whether the government office is surely performing the rescue request to the fire department, shown in Fig.8.

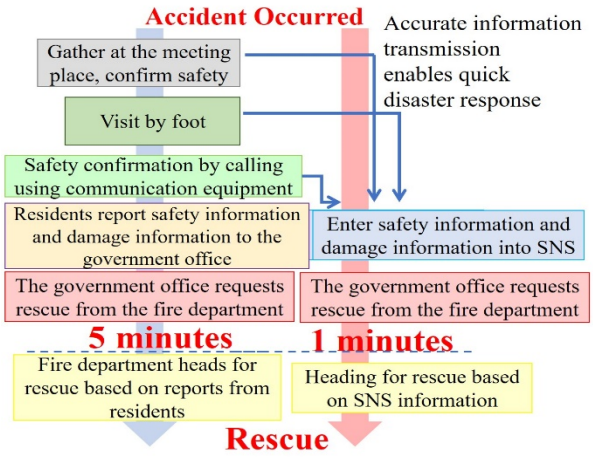

Fig.8 The flowchart of stage

Using the three evaluation indexes of "time", "number of activities", and "stage" from the time of the disaster until the government office contacts the fire department, the impact of the differences in the five information transmission methods on disaster response was confirmed.

When evaluated in Miyazawa, Nakamura, Bessho / Okimura, and Yanojiri district, in the case of calling using IP phones and responding actions using SNS, safety confirmation in the village, information transmission to the town hall, It was found that the three stages of information sharing between the government office and the fire department were integrated into one stage of inputting safety information and damage information into SNS.

Under the preconditions of residents who do not have phones. Therefore, in the case of calls using IP phones and response actions using SNS, isolated households could not be confirmed the safety.

In "Calls using mobile phones and landlines," all residents in the Yanojiri area were able to confirm their safety. Therefore, if the usability of software such as IP phones and SNS is improved, the safety confirmation of all residents will be confirmed. It is thought that the "time" from the disaster to the government office requesting support from the fire department can be shortened and the "number of activities" can be reduced.

From the above, a system in which residents and governments collaborate in a WiFi environment built on a local area network using wireless is effective as a communication means for disaster isolation measures in mountain villages.

4. CONCLUSION

A practical disaster prevention drill in the Hachinoshiri area was conducted. As a measure against the isolation of mountain villages, it was clarified that it is important to establish a safety confirmation system and secure a means of communication between the government office and the village by wireless communication.

To reduce the damage to people caused by disasters, different communication means are necessary, and local area network using wireless is effective as a countermeasure for the isolation of mountain villages on disaster response such as safety confirmation and rescue requests.

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