

# Study on the Present Condition of Outdoor Lighting System for the Disaster Prevention

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## SUMMARY:

When a huge tsunami occurs in the night, very serious damage is predicted. If the light is lost, we feel trouble in the judgments of the surrounding circumstances and decision of the next action. The light source for acquisition of visual information is indispensable in an emergency and disaster. Therefore we performed the questionnaire survey about lighting and visual information in the night of the local governments designated to promote disaster prevention areas in Japan.

*Keywords: Out door lighting, Gide sign, Tsunami, Evacuation, Guidance.*

## INTRODUCTION

For the assessment of damages in earthquake hazards, the number of human casualties is assumed to be largest if an earthquake occurs at 6 p.m. on a weekday during the winter because of higher probability of fire. However, although the loss of lifeline such as power outage is expected, the occurrence of extensive blackouts and its impact on the human damages at the time of large earthquakes has not been largely studied yet. The tsunami disaster caused by the Sumatra Earthquake in December 26, 2004, left much human damages exceeding 200,000 deaths despite that it occurred during the day. Similarly, the Tohoku Earthquake occurred at 2:46 p.m. on March 11, 2011, caused massive tsunami producing numerous casualties even though it occurred during the day. We can imagine that it would leave much destruction behind it if it occurred at night.

On the other hand, it has not been assumed that prolonged and wide-area blackouts will occur due to a massive earthquake under the circumstance that the form of everyday evacuation routes is largely changed. For that reason, the government has not set up only the emergency lighting system for average houses but also made legislative preparations to promote the installation of outdoor disaster-prevention lighting system such as street lights equipped with emergency power supply that ensures and support the safety of evacuation routes to emergency shelters. The authors conducted a questionnaire research to reveal the implementation status of disaster-prevention lighting system in the areas where large damages are predicted in the wake of Tokai Earthquake, Tonankai Earthquake and Nankai Earthquake.

## 1. OUTLINE OF THE QUESTIONNAIRE RESEARCH

### 1.1. Outdoor Disaster-Prevention Lighting System

The current Fire Service Act and Building Standards Act make a stipulation of the outdoor disaster-prevention lighting system (guiding lights and emergency lighting system) for the purpose to maintain enough lights for safe and quick evacuation when the fire broke out at buildings where mainly accessed by the general public. However, it does not include outdoor and earthquake damages.

Here, we define street lights, lights and signs for guiding as the outdoor disaster-prevention lighting system(Fig.1), which are installed for the purpose of maintaining lights and smooth flow of evacuation guidance during evacuation. Generally, the following lighting systems, information and guiding signs are categorized into the outdoor disaster-prevention lighting system:

- (1)Street lights that work during blackouts
- (2)Street lights that work at temporary evacuation shelters during blackouts
- (3)Evacuation guiding signs installed outdoor
- (4)Evacuation guiding lights installed outdoor
- (5)Guide map indicating evacuation routes and shelters



**Fig.1** Outdoor disaster-prevention lighting systems.

To indicate phases of evacuation in a timeline after the occurrence of disaster, there is the phase of immediate aftermath that is within three hours after the occurrence, the phase of emergency evacuation that is within three days after the occurrence, the phase of expeditious evacuation that is after three days of occurrence and the phase of restoration and recovery. At the phase of immediate aftermath and emergency evacuation, the top priority is to secure human lives and rescue operations and temporary to extensive emergency evacuation are implemented. Next, the emphasis is shifted to the confirmation of the safety, information gathering and medical services. The outdoor disaster-prevention lighting system is mainly required to secure lights immediately after a disaster strikes to secure human lives and at the phase of emergency evacuation.

Here, we have implemented a questionnaire research for the purpose to study how the local governments take measures to secure lights outdoors in an emergency at the phase of immediate aftermath, which is an extreme emergency, as well as strategies of evacuation guidance.

## 1.2 Surveyed local government

The central government has placed the full weight on the preparations for natural disasters by listing municipalities with lower sea embankments and areas expected to see the earthquake of a lower 6 or more and 3 meters of tsunami (or run-up of 2 meters or more) in Tonankai and Nankai earthquakes as Promotion Areas for Measures against Tonankai and Nankai Earthquake Disasters (Fig.2). By the same token, against Tokai Earthquakes, the central government lists the target areas as Areas under Intensified Measures.

The measures for the evacuation of citizens during evening hours taken by local governments include the preparation of hard aspects such as securing nighttime visibility of evacuation routes and installation of lighting systems and signs for guiding people to shelters and the preparation of soft aspects such as the implementation and support of nighttime evacuation drills to promote abilities of disaster prevention in communities. We have implemented a questionnaire survey to study the current situation of the preparation of both aspects.

As of 2007, 412 municipalities are listed as the seismic regions of Tonankai and Nankai earthquakes and 173 municipalities are listed as the seismic regions of Tokai earthquake. We used websites of each municipality to search for departments in charge of disaster-prevention and distribute and collect questionnaires through mail. We collected answers from 419 municipalities for the area of Tonankai and Nankai earthquakes and 215 municipalities for the area of Tokai earthquake with the collection rate of 51.3% including overlapped data. We received the most answers from Administration Division (45.7%), followed by Disaster Prevention Division (26.7%), Crisis Management Division (19.0%), and the Division of Citizen, Safety and Security, etc (8.6%), indicating more than half divisions concurrently serve other operations.

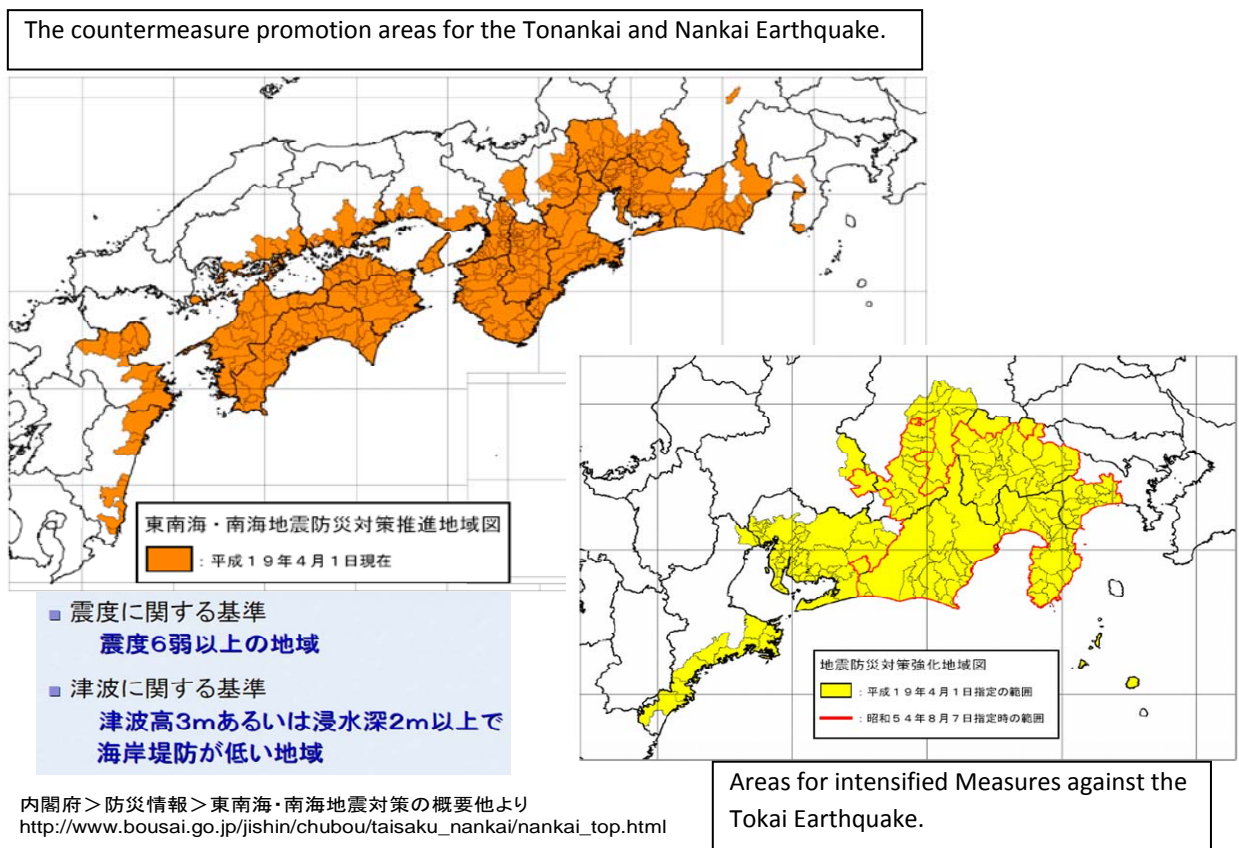


Fig.2 Surveyed maps by local government.

### 1.3 Questionnaire items

Main questionnaire items are described as below:

- (1) About the assumption of the occurrence of the wide-area blackouts within the regional disaster prevention planning
- (2) About the installation of street lights that work during blackouts
- (3) About the implementation of outdoor evacuation guiding signs and its status
- (4) About the implementation of outdoor evacuation guiding lights and its status
- (5) About the implementation of guide map showing evacuation routes and shelters

## 2. RESULTS OF THE QUESTIONNAIRE SURVEY

### 2.1 Collection of the questionnaire survey

From the results, we found that Wakayama Prefecture has the highest response rate of 79.3%, showing that they have a high level of awareness toward evacuation at the time of earthquake. Second is Osaka Prefecture (67.6%), followed by Ehime Prefecture (66.7%). It does not necessarily mean that the high response rate indicates they are keen toward earthquake countermeasures, however, it turned out that we received less answers from the Tokai earthquake areas as a whole.

### 2.2 Voluntary organizations for disaster prevention

Most of the local governments have their own voluntary organizations for disaster prevention. However, there are variations in the contents of activities. Voluntary organizations for disaster prevention are the organization created by citizens at their own initiative, meaning that there are discrepancies among the awareness of citizens. Additionally, despite the existence of voluntary organizations for disaster prevention, there is variability of the rates of holding voluntary organizations among municipalities and some areas in a municipality do not have a voluntary organization for disaster prevention depending on a community. Furthermore, there are some local governments that do not know about the establishment of voluntary organizations for disaster prevention. It shows that the government relies on the autonomy of voluntary organizations too much, causing the difference in temperature for disaster prevention among communities.

Although the voluntary organizations for disaster prevention conducts an evacuation drill, only the half of them provide information about evacuation routes using a disaster prevention map and regional safety map.

### 2.3 About the assumption of the occurrence of the wide-area blackouts within the regional disaster prevention planning

Although about 50% of local governments expect damages from possible blackouts, in fact, its content is not substantial(Fig.3). In contrary, many local governments anticipate damages to the lifelines(Fig.4). Such as the operation of shelters and countermeasures against disasters, they prepare for securing power supply of the major administrative branch of the government despite that they are less prepared for the blackouts occurred during evacuation activities outdoors such as the interference to evacuation activities(Fig.5) and rescue work(Fig.6). We found that they are not prepared for the blackouts occurred in an urgent situation such as evacuation activities and rescue work.

In regard to the assumption of the occurrence time of blackouts, many local governments expect blackouts to last for over a day. Only a half of the local governments expect the occurrence of blackouts in the wake of massive earthquake, resulting in a low percentage for the areas of Tonankai and Nankai earthquake.

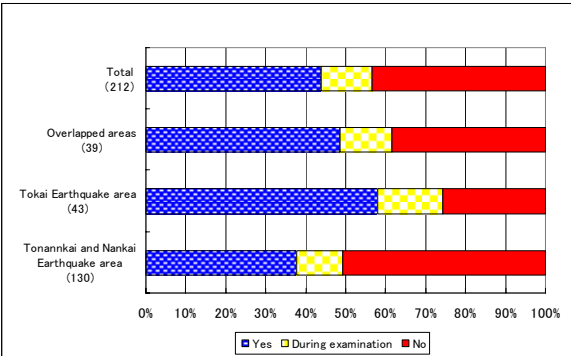


Fig.3 Assumption of the occurrence of the wide-area blackouts.

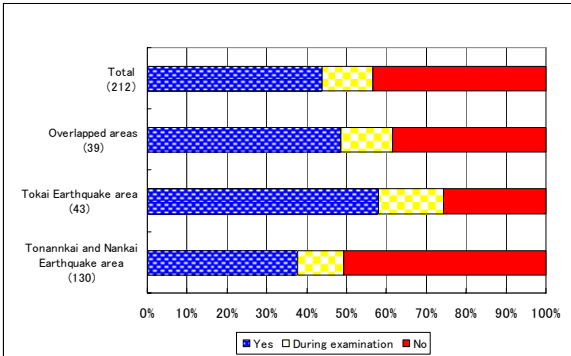
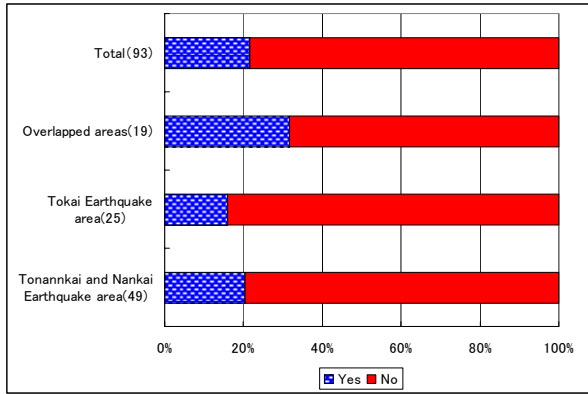
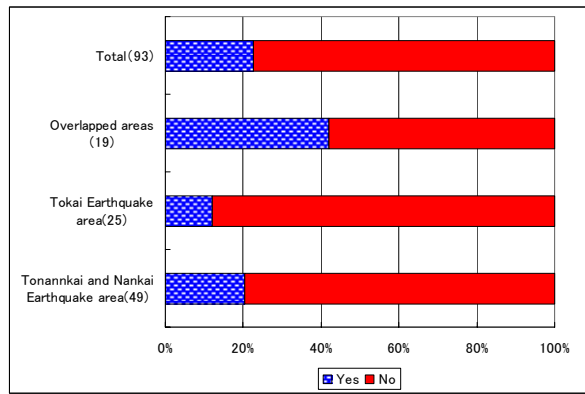


Fig.4 Anticipate damages to the lifelines.



**Fig.5** Evacuation activities.

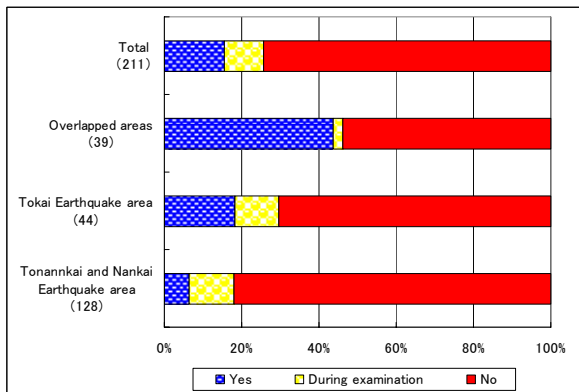


**Fig.6** Rescue works.

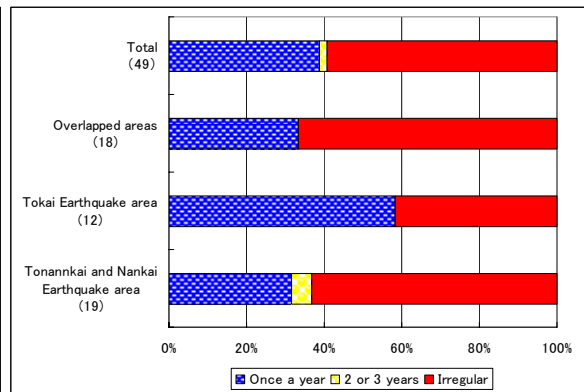
## 2.4 About the implementation of an evacuation drill at night

The author would appear that it is valid to implement night time evacuation drills for local residents to recognize the obstacles of evacuation routes. Although most of the local governments implement disaster drills, only 15% of them conduct drills at night (Fig.7). As for the frequencies of drills, forty percent of the local government conducts drills annually (Fig.8). As reasons of not implementing night time drills, seventy-two percent pointed out the dangers associated with night time drills, followed by its necessity being not recognized.

As for the primary responsibility of drills, drills are let by the government in the areas of the Tokai earthquake and drills are let by voluntary organizations for disaster prevention in the areas of the Tonankai and Nankai earthquakes in most cases. In comparison, the areas for the Tokai earthquake have a higher implementation rate, indicating that the one positively implementing the night time drills under the responsibility of the government has better implementation rate.



**Fig.7** Implementation of evacuation drills at night.



**Fig.8** Frequencies of night time drills.

## 2.5 About the installation of blackouts-proof street lights

Most of the local governments are delayed in the installation of street lights that work during blackouts. Even for local governments that have installed blackouts-proof street lights, some of them have installed only one (Fig.9).

## 2.6 About the installation of blackouts-proof lights at shelters

As with the blackouts-proof street lights, most of the local governments are delayed in the installation of blackouts-proof lights at shelters. However, the installation rate is higher for the areas of the Tokai earthquake (Fig.10).

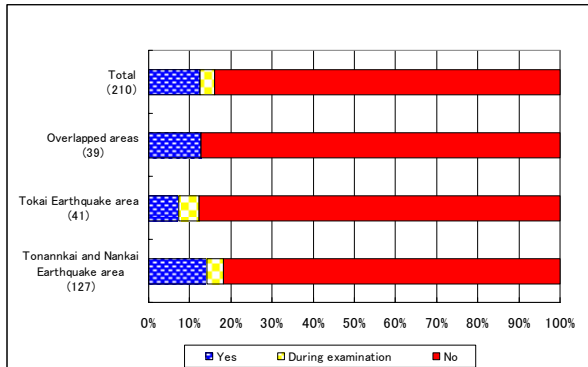


Fig.9 Installation of blackout-proof street lights.

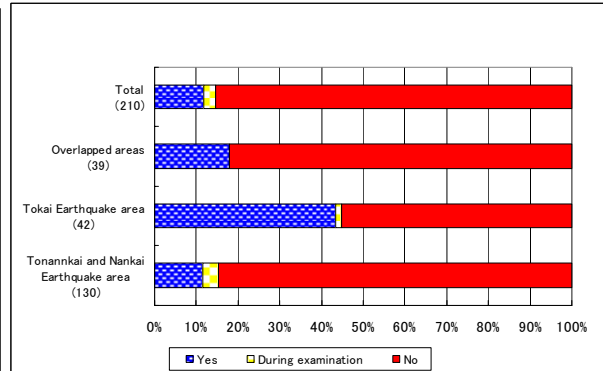


Fig.10 Installation of blackout-proof lights at shelters.

## 2.7 About the outdoor evacuation guiding signs

As for the outdoor evacuation guiding signs, it has a higher installation rate compared to other facilities (Fig.11). However, most of the signs that are already installed are normal signs and there are only few signs that correspond to an earthquake occurred at night (Fig.12).

As for the types of guiding signs, the areas of Tonankai and Nankai earthquakes have many guiding signs that are self-illuminated and afterglow phosphorescent. It would appear that it is because the government listed the areas of the Tonankai and Nankai earthquakes as the Promotion Areas for Measures against Tonankai and Nankai Earthquake Disasters in 2002, which is more recent than the designation of the areas of the Tokai earthquake, and facilities that are more sophisticated have been implemented there.

The government generally bears the responsibilities and the cost of installation. Due to issues such as budget, it would appear that it is difficult for voluntary organizations for disaster prevention to bear the cost. For that reason, it would be better if the government takes the responsibilities. As for maintenance, it is mostly on an irregular base or not implemented.

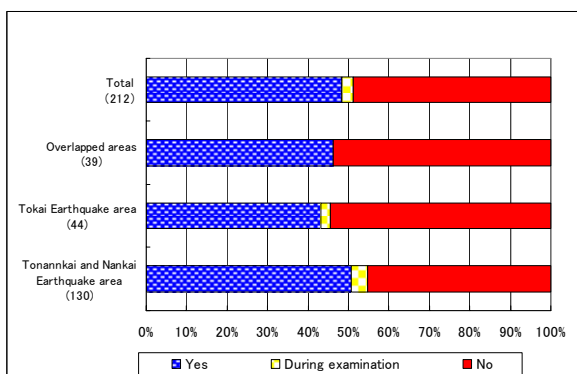


Fig.11 Installation of outdoor evacuation guide signs.

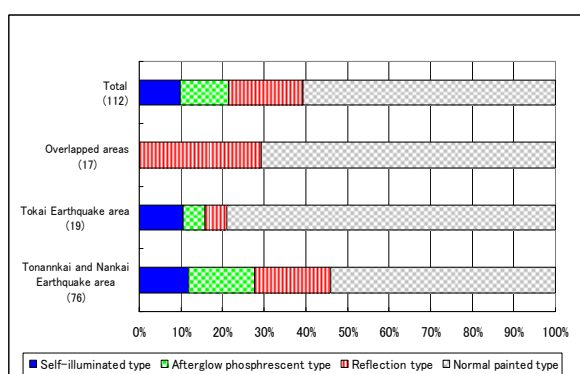


Fig.12 Types of outdoor evacuation guide signs.

## 2.8 About the implementation of outdoor evacuation guiding lights

As with the blackouts-proof street lights, about 10% of the local governments have installed the outdoor evacuation guiding lights, indicating it is less advanced(Fig.13). We can think of reasons associated with its costs. Most of the guiding lights that have been already installed use LED lights(Fig.14). As with the outdoor guiding signs, the current situation is the government merely conducts the maintenance of the guiding lights.

The maintenance of street lights, guiding signs and guidance map have not been upgraded regularly and most of the local governments do not update it regularly or not at all. It is assumable that most of them may be deteriorated even they have been installed. Particularly, there is fear that the guiding signs and lights in the coastal regions that are expected to hit by tsunami might be deteriorated due to salt damage and have poor functions.

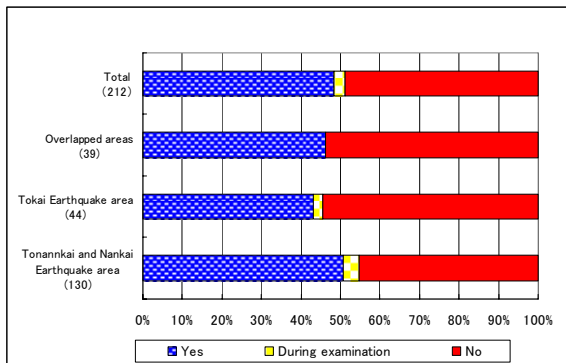


Fig.11 Installation of outdoor evacuation guide signs.

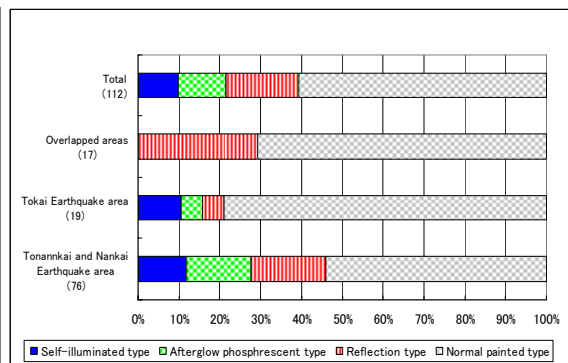


Fig.12 Types of outdoor evacuation guide signs.

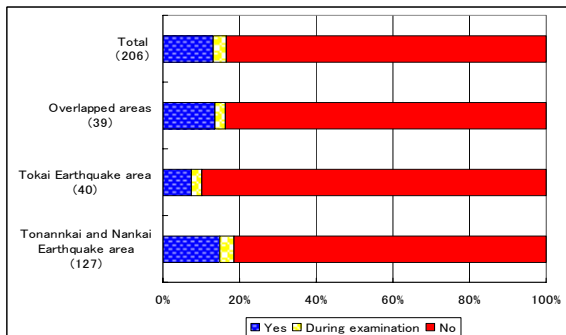


Fig.13 Implementation of outdoor evacuation guide lights.

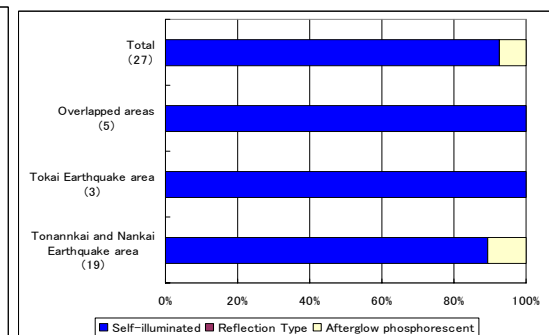


Fig.14 Type of outdoor evacuation guide lights.

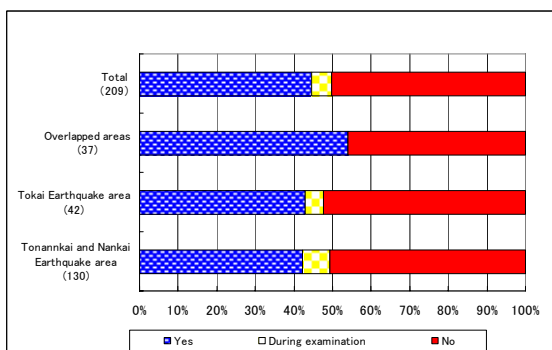


Fig.15 Implementation of guide map showing evacuation routes and shelters.

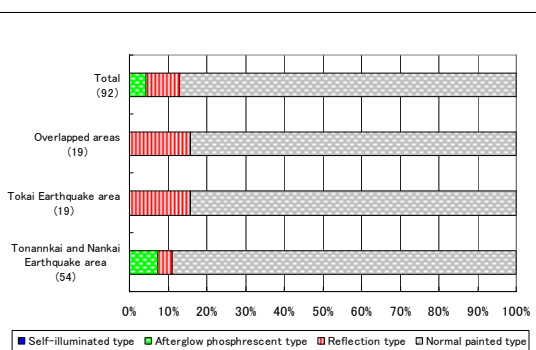


Fig.16 Type of guide map showing evacuation routes and shelters.

## **2.9 About the implementation of guide map showing evacuation routes and shelters**

The results showed that about 50% have implemented evacuation guide maps but as with the guiding signs, most of them are normal signs(Fig.15). As for the guide map that have been already installed(Fig.16), there is no self-illuminated guide map, however, including under consideration, some of the guide map types include self-illuminated type, showing that we can expect its advancement in the future.

## **2.10 About the request of local governments in regard to securing lights at the time of disaster**

The following shows the opinions received from the people in charge of disaster prevention, which were provided in a free description column:

- We think it becomes difficult to provide evacuation guidance if blackouts occur at night. We also think it is important to secure power supply at shelters at an early stage.
- Basically, we do conduct the maintenance of street lights and anticrime lights of the roads but not the lights for disaster.
- It is impossible to do the maintenance independently due to a severe fiscal circumstance. If we could get support from the central government, we would like to give thought to it.
- Although we are looking into the installation of lighting system that uses natural energy, we cannot do so because they cost too much.
- We think it is important to increase the number of solar powered street lights indicating evacuation routes to shelters in the future.
- We would like to have simple guiding lights for evacuation that can be maintained and managed by the voluntary organizations for disaster prevention. There is a scattering of residential sections in the intermountain region and it is difficult to implement it under the current situation.
- We think it is necessary to implement the outdoor disaster-prevention lighting system not only for the aspect of crime prevention but also for the safety of community. However, with the severe fiscal circumstance, it is difficult to maintain the budget.
- We have been implementing power generators and floodlights at shelter locations. However, we feel the need for the assistance from the central government because it is an independent project and has a low efficiency rate.

## **2.11 About the number of staff who are in charge of the budget and disaster prevention**

There is a great variation of budgets relating to comprehensive disaster prevention such as 500,000 yen to several millions of yen depending on a local government. In comparison, larger cities tend to have more budgets than towns and villages. As for the number of staff who are in charge of the budget and disaster prevention as a regular operation, many local governments answered 1 to 5 staff. Some cities with larger population have more than 10 people working in the sector. For smaller cities, more people are in charge of other operations concurrently.

## **3. CONCLUSION**

It has been pointed out that it is difficult to implement the disaster readiness due to the absence of legal evidence although they understand the necessity for local governments to obtain lights at the time of disaster. In addition, there are many responses that there is nearly empty of information relating to disaster-prevention lighting systems and that the form of guiding lights, signage of guiding signs, installation methods and locations are not uniformed among local governments that are in the same prefecture, indicating there is no corroborative implementation guideline nor legal evidence of upgrading in regard to securing lights at the time of evacuating at night. In addition, depending on a local government, there is a considerable amount of difference in disaster-prevention related budget and the number of staff who are in charge of disaster prevention, indicating a widening of regional differences in disaster prevention countermeasures. At present, the estimation of damages is under



review for a massive earthquake such as Tonankai and Nankai earthquake disaster and an epicentral earthquake at the capital area. Even for local residents, it is absolutely necessary to secure the lights of evacuation routes for evacuation while walking through clutters on the streets and collapsed houses along with vulnerable people such as the elderly, small children and the injured at night. Furthermore, not only the local residence, there are many daytime visitors in larger cities (it is expected to be 3.5 million people in the Tokyo metropolitan area). In order to guide evacuees who are not familiar with the area's geography without confusion, it is vital to indicate evacuation routes as well as securing of lights at shelter locations such as evacuation routes, parks and open areas. It emphasizes the indispensableness of countermeasures against prolonged and wide-area blackouts at the time of earthquake.

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