DEVELOPMENT OF A SNOWSTORM VISIBILITY INFORMATION SYSTEM FOR ROAD USERS

M. KANEKO, H. TAKECHI, M. MATSUZAWA
Civil Engineering Research Institute for Cold Region, Japan
kaneko-m22ae@ceri.go.jp, hiro-takechi@ceri.go.jp, masaru@ceri.go.jp
T. KAWANAKA
Muroran Development and Construction Department,
Hokkaido Regional Development Bureau, Japan
kawanaka-t22aa@hkd.mlit.go.jp

ABSTRACT

In recent years, snowstorm-induced traffic hindrance has occurred in regions where there have been few snowstorms in the past. Such snowstorms occur due to rapidly developed low-pressure systems.

Because snow-control facilities such as snow fences and snowbreak woods cannot address such sudden and extremely harsh snowstorm problems and their development is cost- and time-intensive, in 2009 we at the Civil Engineering Research Institute for Cold Region (CERI) developed the Snowstorm Visibility Information Website, which provides visibility information to support driver decision-making. We developed a method of forecasting road visibility distance under snowstorm for the upcoming 24 hours, and we started 24-hour visibility forecast provision in 2013. The number of the visits to the site has been increasing year by year, and there have been dramatic increases since the introduction of the 24-hour forecast.

Generally, road surveillance cameras are used to obtain road condition information. However, road surveillance cameras are expensive to install and operate. We developed and tested a system that collects information from general road users via a site to which cell phone users upload data and that collects road images that are automatically captured by smart phone from a vehicle on the road.

1. INTRODUCTION

In recent years, snowstorm-induced traffic hindrance has occurred in regions where there have been few snowstorms in the past. Such snowstorms occur due to rapidly developed low-pressure systems. Because snow-control facilities cannot address such sudden snowstorm problems, their development is cost- and time-intensive. To address this issue, we at the Civil Engineering Research Institute for Cold Region (CERI) have developed a method for forecasting road visibility distance under snowstorm and providing information via Web to support decision-making on driving. Generally, road surveillance cameras are used to obtain road condition information. However, road surveillance cameras are expensive to install and operate. We developed and tested a system that collects information from general road users via a site to which cell phone users upload data and that collects road images that are automatically captured by smart phone from vehicles on the road. This paper reports on the outline the Snowstorm Visibility Information System and on the results of test operation.

2. SNOWSTORM VISIBILITY INFORMATION SYSTEM WEBSITE

2.1 History

To support road users' decision-making on driving under snowstorm conditions, CERI developed a method that estimates the road visibility distance from weather data (snowfall intensity, wind velocity and air temperature)[1] and started information provision on visibility hindrance under snowstorm via our Website "Snowstorm Visibility Information System" in 2009. When the system was launched, Hokkaido prefecture was divided into 46 areas. We provided the "nowcast visibility distance," the present visibility distance estimated from the weather data, for these 46 areas (Figure 1).

In February 2013, we modified the system. To make such modifications, we conducted a road user questionnaire survey to identify their preferences for the unit size of area for information provision and on the timing of visibility information provision. Regarding the unit size of area for information provision (Figure 2), 94% of respondents desired that information be provided by each municipally or on the basis of a smaller grid area, such as 1 km X 1 km. We changed the basic unit of information provision from by 46 divisions per prefecture to that on the basis of municipality. Large municipalities were further divided. The number of divisions rose to 203, from 46. Regarding the desired lead-time of visibility information provision from the time of user's visit to the Website, 94% of respondents (excluding duplicate responses) desired that information be provided with 1 to 6 hours of lead time (Figure 3). This indicates a high need for forecast information. We modified the forecast information provision as follows: Hourly forecasts are provided up to 6-hour forecast; and 9-, 12- and 24-hour forecasts are provided.

In addition to these modifications, out Web page was also redesigned on February 1, 2013. The pages "Winter Route Information" and "User Uploaded Information on Snowstorm," which had been separate, were combined into the same page so that users can more easily find main information from the list. Figure 4 shows the Website after the modifications (http://n-rd.jp/). The Meteorological Service Act and The Ordinance for Enforcement of The Meteorological Service Act mandate that the provision of weather-related information in Japan be done by certified and accredited meteorologists. Between 6 a.m. and 9 p.m., the three meteorologists in our office check and confirm the visibility forecast before releasing it. Visibility is provided according to a 5-scale rating system that is based on our study of driving behaviour under snowstorm conditions [2]. The rating of visibility is indicated by colour.

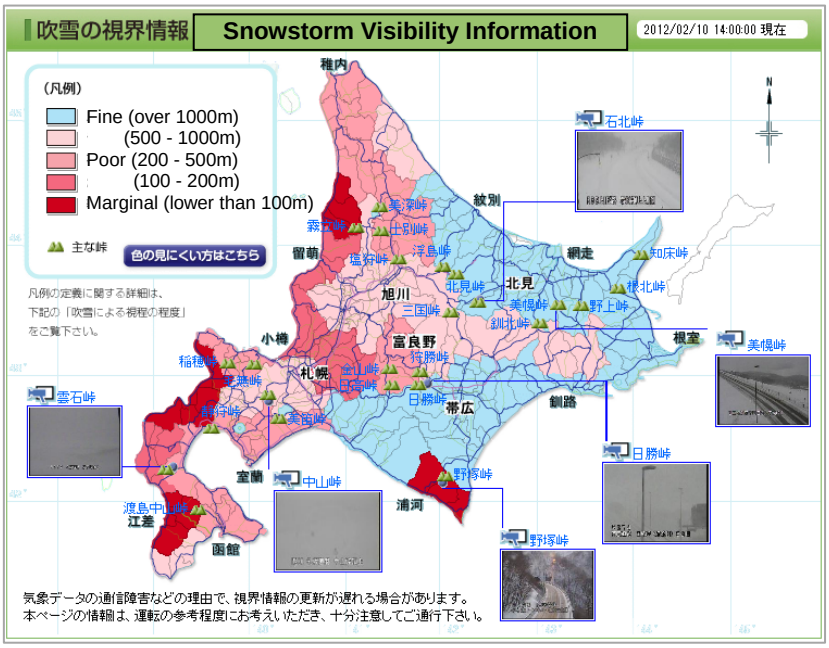

Figure 1 - Snowstorm Visibility Information Website (before modifications)

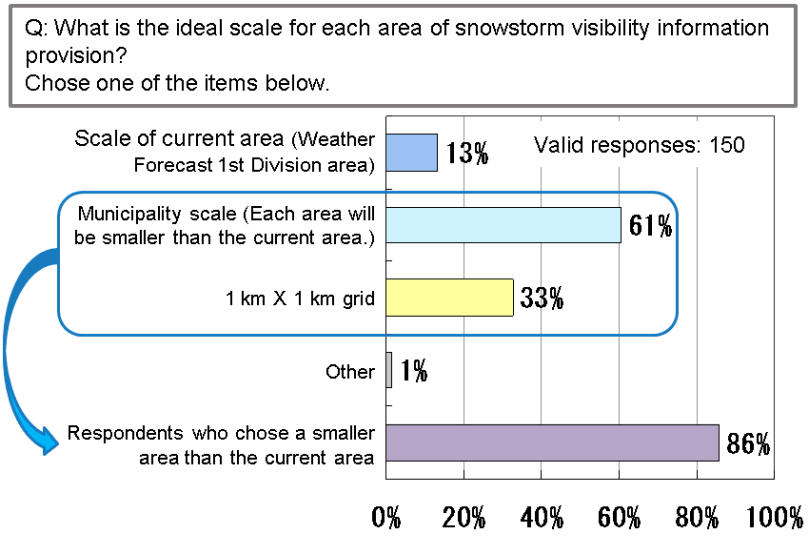

Figure 2 - Questionnaire survey on the ideal size for each unit area of information provision: Questions and responses

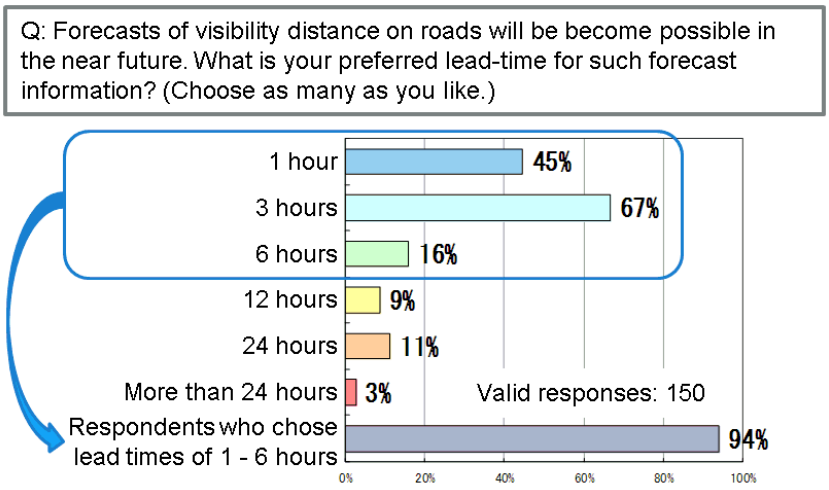

Figure 3 - Questionnaire survey on the forcast lead times preferred by road users: Questions and responses

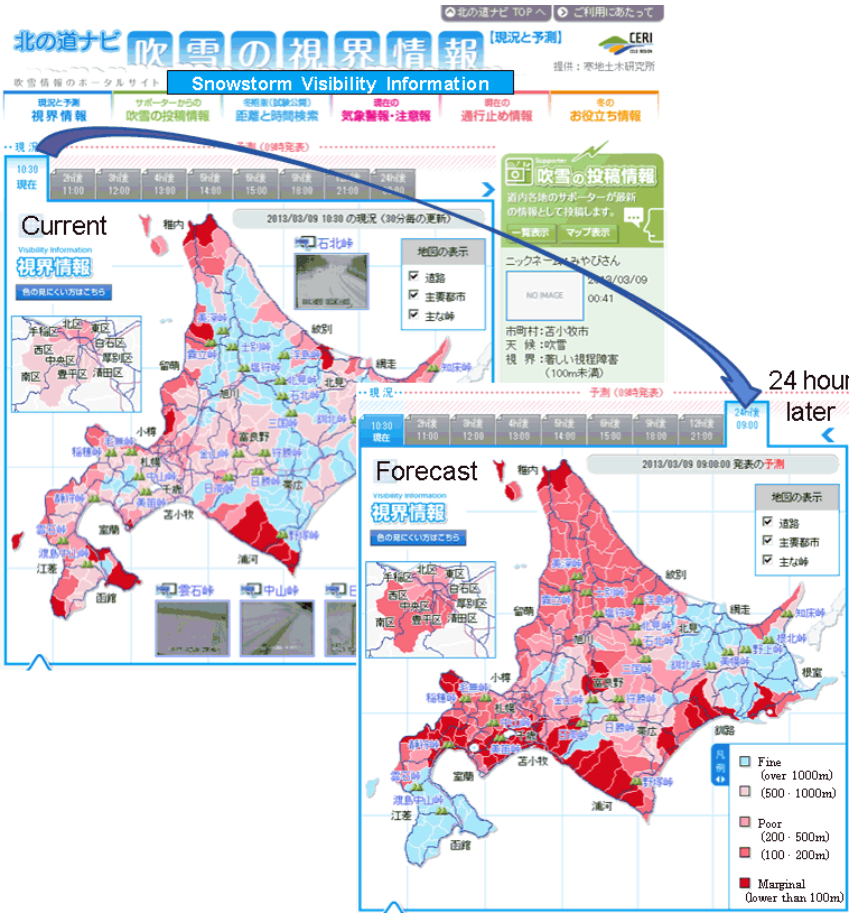

Figure 4 - Snowstorm Visibility Information Website (after modifications)

2.2 Number of visitors to the Snowstorm Visibility Information Website, and visitors' evaluations of the forecast information

The daily average of visits to the Snowstorm Visibility Information Website was 426 visits in the 2010/11 winter, 616 visits in the 2011/12 winter and 1,098 visits in the 2012/13 winter (Winter: Dec. 1 through March 31 of the following year). Visits have been increasing year by year. After visibility forecast information started to be provided, visits greatly increased to as many as 1500 visits per day. Figure 5 shows the number of daily visits since February 2013, when the Website was modified. On March 2 and 3, 2013, severe snowstorms struck all of Hokkaido. Eastern Hokkaido was hit particularly badly; it suffered from snowstorm disasters. The number of daily visits to the Website reached 5,000. During the following week (on March 9 and 10, 2013) when another snowstorm hit the Sea of Japan side of Hokkaido, the number of daily visits reached nearly 6,000, which was the highest on record. Such increases in the number of visits to the Website show that road users actively use visibility information for decision-making. The questionnaire survey conducted immediately after the forecast information provision was started shows that the 72% of respondents highly rated the forecast information (Figure 6). To mitigate snowstorm disasters, it is important that information provision affect driver behaviour and decision-making. Our future plan includes the study of how the information content, the provision method and the information description affect driver behaviour.

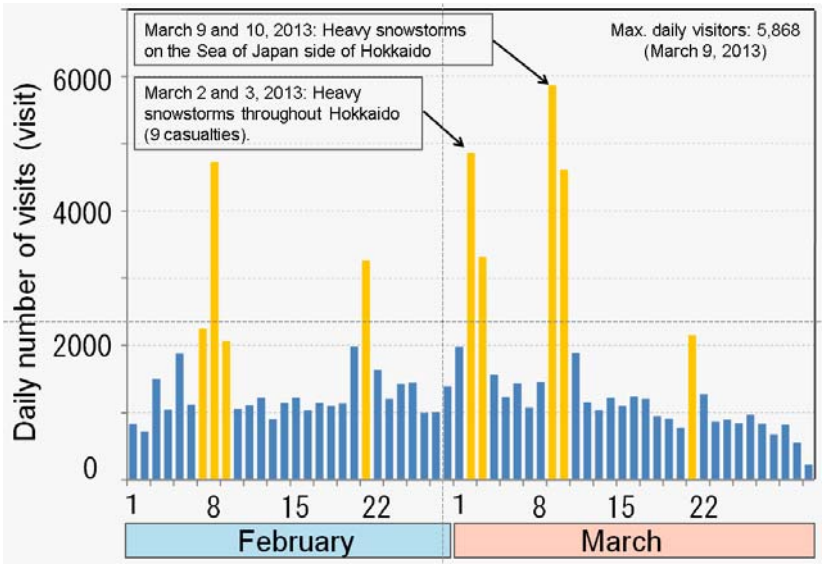

Figure 5 - Changes in the number of visitors to the Snowstorm Visibility Information Website after visibility forecast information provision was started

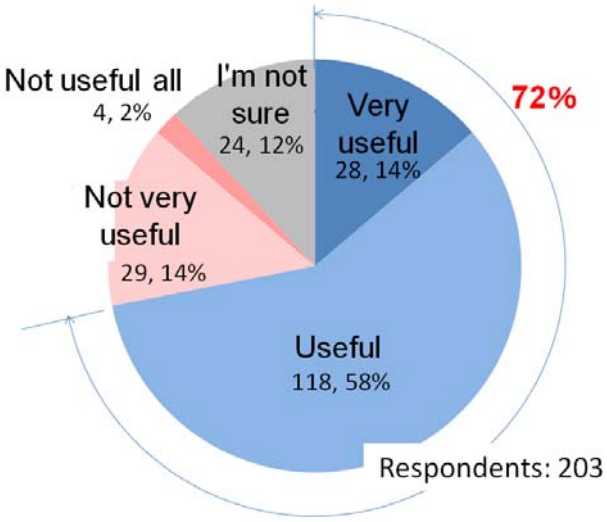

Figure 6 - Questionnaire survey on the evaluation of visibility forecast information

3. SYSTEM FOR USER-UPLOADED SNOWSTORM INFORMATION SHARING

Road administrators have been installing road surveillance camera systems to obtain accurate road condition information. However, road surveillance cameras are expensive to install and operate. The Snowstorm Visibility Information Website provides visibility forecasts based on weather data; thus, it may not be able to forecast localized poor visibility. We developed the System for User-Uploaded Snowstorm Information Sharing, a system that collects information from road users via a site to which cell phone users upload data (Figure 7). The system enables us to collect information from roads where there are no road surveillance cameras and where localized poor visibility occurs, and to disseminate such information. With this system, road users upload information on locations of poor visibility, such as the name of the route or the municipality where the poor visibility occurs, the visibility distance, the weather, the user's comments on the conditions (optional) and photos (optional) using a PC or cell phone; such information is sorted, and then it is accessible by general users at the website of the System for User-Uploaded Snowstorm Information Sharing (http://time-n-rd.jp/fuyumichi/info). The user-uploaded information is provided in the form of a table. However, when the GPS of

the cell phone provides the geographic coordinates of the user, the location where the user uploaded the data is automatically indicated on the map. To avoid intentionally errant or inappropriate data uploading, only pre-registered road users can upload information.

For FY 2012, 206 volunteer road users registered for the system. Their uploads totalled 224. Their information provision was concentrated during traffic problems from severe snowstorms, confirming the feasibility of road information collection from road users. However, their uploads on visibility information were not numerous enough. We will promote data uploading among the volunteers and will develop a smart phone software application that facilitates much easier data uploading.

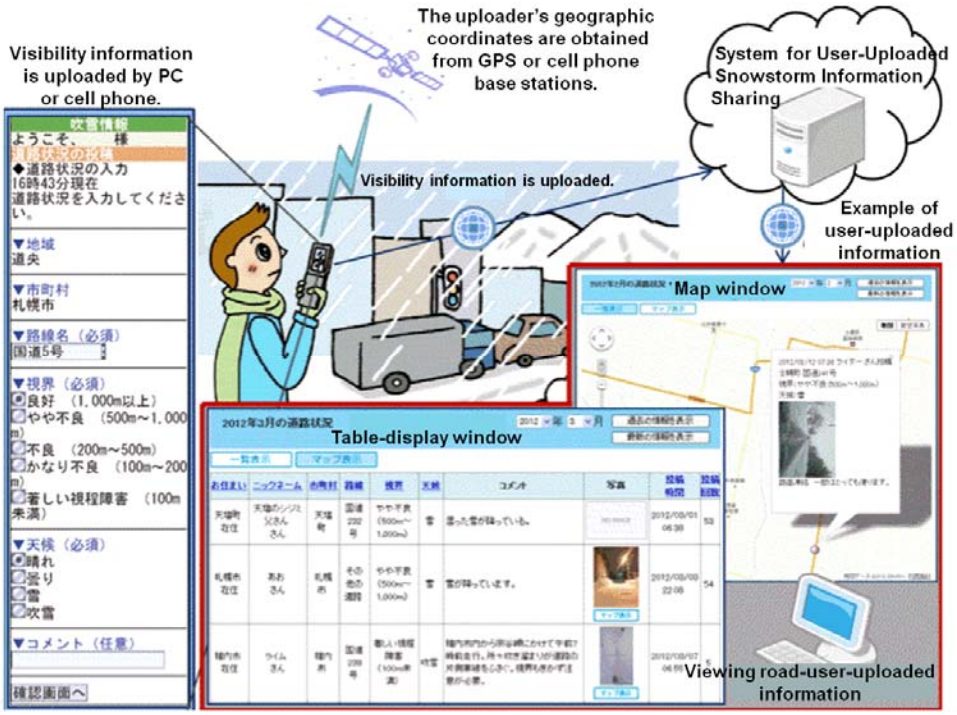

Figure 7 - Outline of the System for User-Uploaded Snowstorm Information Sharing

4. AUTOMATIC ROAD IMAGE CAPTURING AND UPLOADING SYSTEM

Test operation of the System for User-Uploaded Snowstorm Information Sharing confirmed the feasibility of collecting information from road users. However, the frequency of their information uploads is insufficient. An interview survey of the drivers who registered as volunteers revealed that when they are driving under poor visibility conditions, it is not possible for them to take photos, to input poor visibility data or other such data, or to upload such data. This is because they need to concentrate on driving.

To address these issues, we developed the Automatic Road Image Capturing and Uploading System, with an eye to its installation on commercial vehicles such as buses, taxis and trucks that are regularly driven for businesses. The system captures road images at a regular interval, obtains the geographic coordinate information at a regular interval and automatically sends the data to a server. Because all smart phones, which are widely used these days, have these functions, we developed a smart phone software application that automatically captures road images and uploads the data. Test operation of the system was made in the winter of FY 2012 by installation the system in a van owned by CERI (Figure 8). With this smart phone software application, the user first sets the image capture interval and the size of the image to be captured in the “settings”

window. The user then places the phone on the dashboard of the vehicle and press "start" to begin capturing images automatically. When an image is captured, the latitude and longitude coordinates that are obtained by GPS are uploaded to the server together with the captured image. The server automatically builds a database and displays the uploaded information on a map at the request of the user (Figure 9). Test operation confirmed the successful automatic uploading of large numbers of road images and the display of such information on a map. However, the following issues were identified for general introduction.

- Some images include accident scenes or the number plate of the vehicle ahead of the test vehicle.
- Road images without poor visibility were also captured.
- Images other than those of roads and snowstorms were captured (such as images captured while the driver was resting).

Our future study will address these issues.

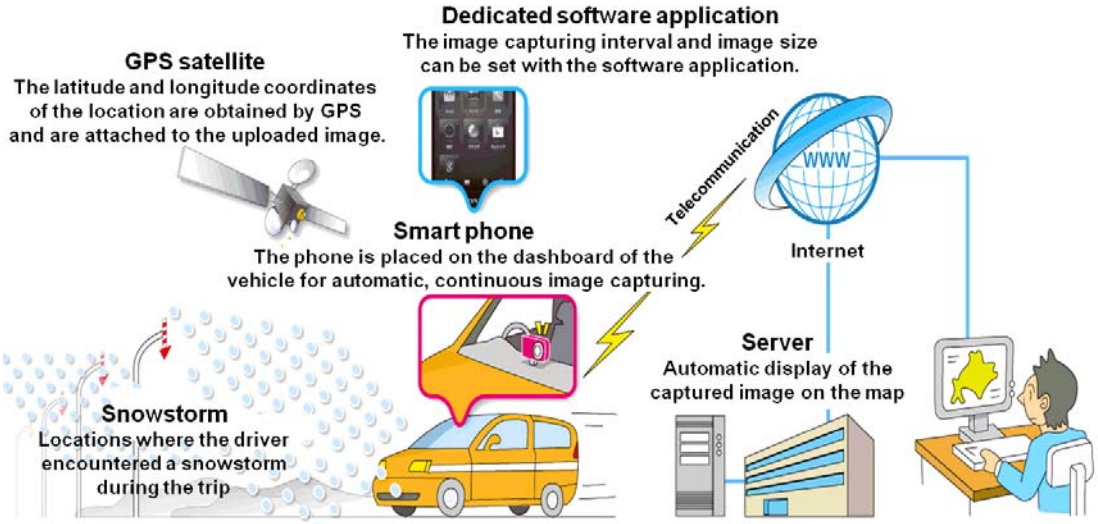

Figure 8 - Automatic Road Image Capturing and Uploading System

Figure 9 - Window that shows the uploaded image (Map window)

5. CONCLUSION

We have provided users with road visibility information forecasts from the current time to up to 24 hours via the Snowstorm Visibility Information System Website. The Website provides visibility distance information that is forecast from weather data. However, the weather data may not able to provide information of localized poor visibility. Therefore we developed the System for User-Uploaded Snowstorm Information Sharing, a system in which road users upload and share poor visibility information using a PC or a cell phone, and we developed the Automatic Road Image Capturing and Uploading System, a system to be installed on commercial vehicles that operate regularly. We test-operated these two systems. Our future study will address improvements of the content, the methods and the information provision discriptions that alert road users to make decisions for safer behaviour.

REFERENCES

1. M. Matsuzawa, et al. (2002). A study of Methods to Estimate Visibility Based on Weather Conditions. Seppyo. The Japanese Society of Snow and Ice. Vol. 64, No. 1, pp. 75-85.
2. Y. Kajiya, et al. (2004). A Study on Driver Behaviour During Poor Visibility Due to Snowfall/Snowstorm. Proceedings of Cold Region Technology Conference, Vol. 20. Hokkaido Development Engineering Center, Inc. pp. 325-331.