Mission of NILIM

FUKUDA Yukihiro, Director-General, NILIM

"As the only national research organization in the social infrastructure and housing field, our goal is to use technology as the driving force to create an attractive country and society that are safer, more secure, and more vigorous, both now and in the future.", this is the mission of NILIM. I feel that the year 2024 truly reminded us of this mission and that we engaged in achieving this mission.

Responding to the Noto Peninsula Earthquake that occurred in January 2024, and the heavy rain disaster that occurred in the same area in September 2024, NILIM dispatched experts to the affected area just after the disaster and supported the local governments, etc. of the affected area. As these disasters damaged a wide area in many different ways, NILIM dispatched experts from all the research fields that NILIM has. I believe that our staff supported various activities at the government's response. On-site HQs were opened within the Ishikawa Prefectural Office and from Tsukuba city and that we accomplished NILIM's mission using all the abilities NILIM had. We were also able to do necessary research and give appropriate advice under difficult circumstances.

Previously I worked in Kochi Prefecture where the bridge girder of an expressway in the prefecture was carried away due to a landslide resulting from the heavy rain disaster in July 2018. At that time, we were able to restore the expressway within one year, thanks in part to the bridge experts that were dispatched by NILIM and took appropriate measures. Now that I have changed my position from the one who receives support to the one who gives support at NILIM, I have recognized once again that it would be important for NILIM to have highly skilled experts who are able to support affected areas.

In addition, through our experience with various disasters and accidents, we have identified new issues, analyzed them and reflected on lessons learned regarding technical standards and policies. The Figure below shows the history of disasters and accidents in the road structure field and of technical standards used in responding to such disasters. We have repeated the cycle of disasters and accidents, survey, research, standardizing technology and implementation at affected areas, and as a result been able to reinforce our country's infrastructure.

For example, at the time of Noto Peninsula Earthquake, though substantial damage occurred to roads, we did not identify any serious damage to the bridge itself. We were able to determine that the damage was minimized thanks to the revision of technical standards and measures taken in advance. It is valid evidence to confirm that the direction of previous earthquake countermeasures for bridges was effective. On the other hand, a certain damage occurred at the joint between bridges and earthworks, which was a new issue, and we are studying countermeasures for that. Though we are still recovering from the 2024 Noto Peninsula Earthquake, it will, in future, be recorded as one page in the history of disaster, recovery / restoration and reinforcement, and our current approaches will also be recorded in the same page.

From the word "infrastructure", we tend to imagine such infrastructure as facilities or physical structures including water supply and sewage, roads, ports, airports, Sabo facilities, embankment and dam. In addition, "infrastructure" as a system includes activities to plan, construct and maintain those infrastructures, and laws, budgets, standards and technologies to recover from disasters. Moreover, NILIM is a part of the "infrastructure" as a system which in its broader sense, is responsible for such roles as supporting the restoration of damaged facilities infrastructure or reflecting on the knowledge learned from disasters to technical standards. I believe that each of NILIM's staff is a part of "infrastructure" as member of technical experts.

This report introduces NILIM's research and broad development. These research results are used as a base for technical standards, improving the safety of infrastructure and becoming an important tool to contribute to improving on-site productivity. It is NILIM's important role to collect these results, and maintain and reinforce these research structures.

So far, we have made and revised technical standards based on the introduction of new technologies and experiences learned from large-scale disasters. This work has been done through the collaboration between senior researchers who are familiar with the past revision history and young researchers. We are currently working on revising various technical standards taking into account the damage that occurred in Noto Peninsula Earthquake, and I believe young researchers participating in such works will take a leading role in next revisions.

I believe it is also an important mission for NILIM to always retain experts who can properly offer advise at disaster areas and to continue to have experts who can revise technical standards with an understanding of the past revision history.

It is necessary to develop future experts, in addition to retaining experts for each field, to engage in research and development during normal times and to support affected areas at the time of emergency. Moreover, it is also important to have human resources and structures to support such experts from a logistical standpoint so that they may smoothly do their work. NILIM should be an organization that incorporates all such functions.

Next year, NILIM will celebrate the 25th anniversary since its establishment, I would like to reinforce our human resources and structure, ensuring research to support affected areas using NILIM's overall ability for its mission, "to create an attractive country and society that are safer, more secure, and more vigorous, both now and in the future".

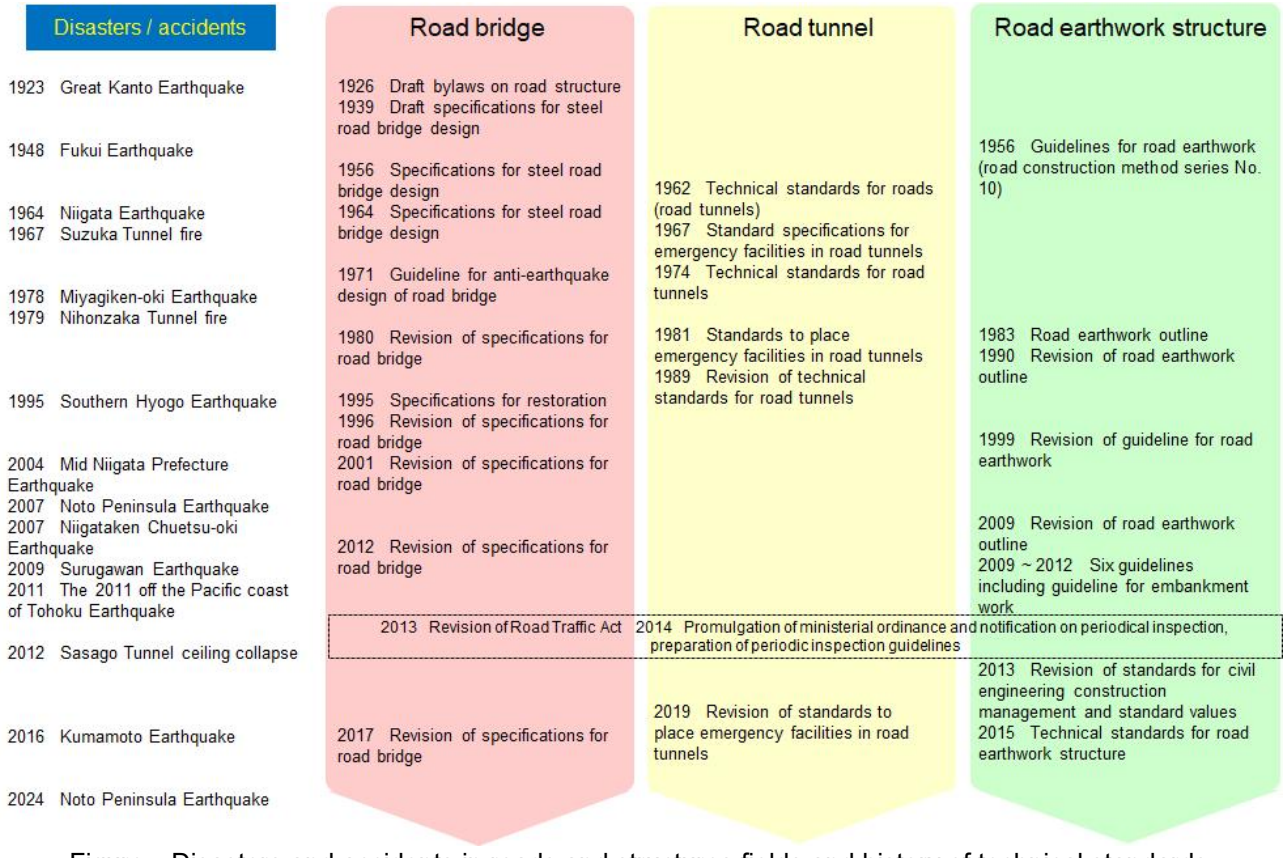


Figure Disasters and accidents in roads and structures fields and history of technical standards

Feature Article

Damage Situation on Dams Caused by 2024 Noto Peninsula Earthquake and NILIM's Activities

River Department

In this earthquake, shakings were observed at dams in the wide area mainly in Noto Peninsula, and particularly at the dams, close to the hypocenter, where strong shakings were observed, abnormalities were reported. NILIM's River Department made on-site survey to ensure safety, etc. for the dams, responding to MLIT's request. Over there, we gave advice on required countermeasures, etc. to members of Ishikawa Prefecture, who managed the dams and offered continuous support from technical aspects such as analyzing various data obtained on-site and sharing them with related personnel in a timely manner.

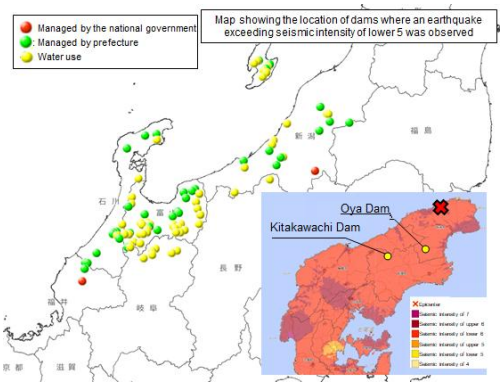
1. Temporary inspection results and initial responses

At the time of this earthquake, there were 96 dams where an earthquake exceeding seismic intensity of lower 5 was observed at nearest observation points of Japan Meteorological Agency. Therefore, NILIM engaged in collecting information such as satellite data remotely just after the disaster.

In addition, each dam's management office reported the results of temporary inspections one by one. Though they did not find any abnormality at many dams, there was report of abnormalities from 2 dams that Ishikawa Prefecture was responsible for managing.

NILIM believed it was necessary to ensure safety of these two dams at actual locations, and made on-site surveys several times, responding to the call for dispatch of TEC-FORCE by MLIT.

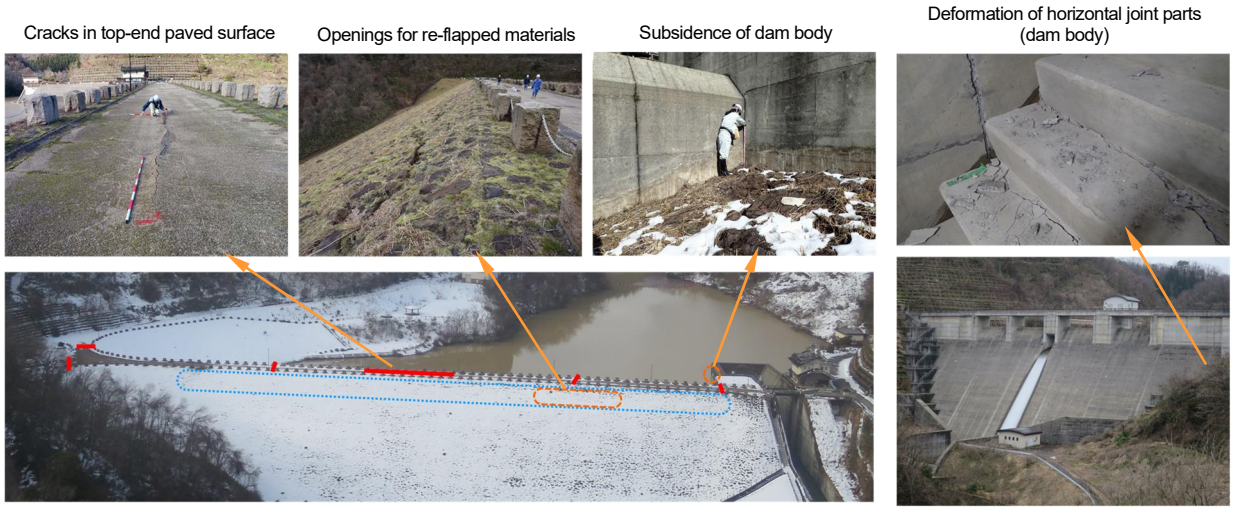
Photos of on-site survey (Oya Dam, January 11, 2024)



Distribution of dams where an earthquake exceeding seismic intensity of lower 5 and the location of dams that abnormalities were reported

2. Dam's deformation confirmed at on-site survey

At Oya Dam (rock-fill dam), we identified cracks in top-end paved surface in addition to subsidence of dam body, deformation of openings, etc. for re-flapped materials protecting the surface, and we conducted further detailed surveys and acknowledged that it was necessary to ensure safety of the dam. At Kitakawachi Dam (concrete dam), though we found light deformation at horizontal joint parts of the dam body, we acknowledged that there was no issue in its safety, as such deformation was usually assumed from the dam's structure and here was such abnormality as water leakage.



Oya Dam

Kitakawachi Dam

3. Survey to ensure safety

At Oya Dam where several deformations were identified, we conducted further detailed surveys to ensure the dam's safety. As for the subsidence of the dam body, we confirmed that the height required from the structural standard was secured, though the subsidence occurred in the wide range.

As for the plural cracks found in the dam's top-end paved surface, we conducted excavation survey to verify if such cracks had reached the core of the dam body functioning as water-stopping of the dam or not. As a result, we confirmed that the cracks stayed only on the paved surface and no cracks or slacks were found in the dam body.

As for deformed openings for re-flapped materials in the downstream side of the dam, we removed a certain part and verified the condition of its backside. As a result, we could not identify any deformation in the dam's body (dam body rock zone) suspected of slipping in the dam's body.

From the above-mentioned results, we confirmed that none of such deformations would damage the dam's safety.

Excavation survey at cracked areas on dam's top-end paved surface
(no damage in the dam body)

Survey for the backside of deformed openings for re-flapped materials
(No deformation suspected of slipping on the dam's body)

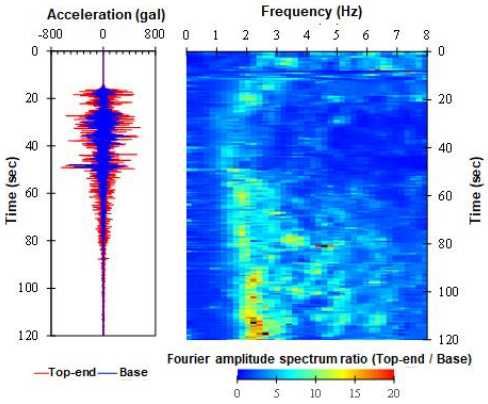
4. Analysis of various data

To ensure dam's safety at the time of earthquake, various measurement data obtained on-site on a daily basis for dam's safety management will be important information for judgment in addition to direct confirmation of damage situation at the actual location. For this earthquake, we also collected and analyzed these data and utilized them at the maximum for judgment on the safety of the dams where deformations were identified on-site.

For example, at Oya Dam, the infiltration capacity for the dam body and for the base is periodically measured to monitor the dam's water stopping function. Though we found a small change in such data due to this earthquake, we confirmed that it was within the range of past measurement values by analyzing the change before and after the earthquake and by comparing the data with past records when the storage water level rose or at the time of past earthquake. Based on such results and the fact that there was no turbidity in infiltrated water suspected of outflow of the materials of the dam body or the base ground, we concluded that there was no issue with the dam's water stopping function.

In addition, based on the seismic ground motion recorded in the seismograph placed at the base part or top-end part of the dam, we analyzed the impact to the soundness of the dam body focusing on changes in vibration characteristics. As a result, we found that though the natural frequency showing the rigidity of the dam body temporarily decreased due to strong shaking, it gradually recovered thereafter.

Based on these points and the results of on-site surveys, we concluded that there was no structural damage to the dam on its safety.



Waveform of earthquake ground motion

Changes in vibration characteristics of dam body (the light color represents the natural frequency)

Seismic ground motion recorded at Oya Dam and its analysis results

In this earthquake, we concluded that the safety of the dam itself was not damaged even with the dams having suffered strong shaking through the above-mentioned surveys and analyses. However, as for the management of dams, there were a lot of difficulties such as roads to access the dams, communication methods, temporary suspension of external power supply and sediment inflow to river channel, and the dam operation having restoration and reconstruction in mind was required as water supply source to the downstream areas affected by the earthquake while watching over aftershocks.

NILIM would like to publicly communicate this experience and the approaches, sharing them with those who engage in the management of dams, so that the dam management offices can appropriately identify the situation of dams and take necessary measures in such an emergency, and NILIM would like to reinforce the preparation for next disasters, continuously studying better backup structure in technology aspect.

☞Related articles are as follows (introducing related articles of the Department in charge)

- Reports on damage, etc. to civil engineering facilities in 2024 Noto Peninsula Earthquake, Material of National Institute for Land and Infrastructure Management, No. 1320 / Material of Public Works Research Institute, No. 4459, March 2025

Feature Article

Development of Method to Identify Land Shape just after Disasters Using SfM-MVS

Introduction of research

Sabo Department

1. Background

At 2024 Noto Peninsula Earthquake, several landslide dams were identified. When landslide dams are formed, it is important to identify the land shape situation just after the disaster for judging the necessity to emergency survey based on the Act on Sediment Disaster Countermeasures for Sediment Disaster Prone Areas, for determining survey route to the disaster area and for identifying such risk information as flood simulation caused by landslide dams.

However, in the affected areas, in a few days after 2024 Noto Peninsula Earthquake, it was difficult to identify immediate land shape information due to such reasons that we could not measure the reference point due to crustal deformation and that the access to the affected areas was restricted due to damages to main roads.

Therefore, Sabo Planning Division, Sabo Department of NILIM studied a method to identify the land shape information using only the limited data obtainable just after the disaster, using landslides caused by Noto Peninsula Earthquake (Ichinose machi, Wajima city) as study subject.

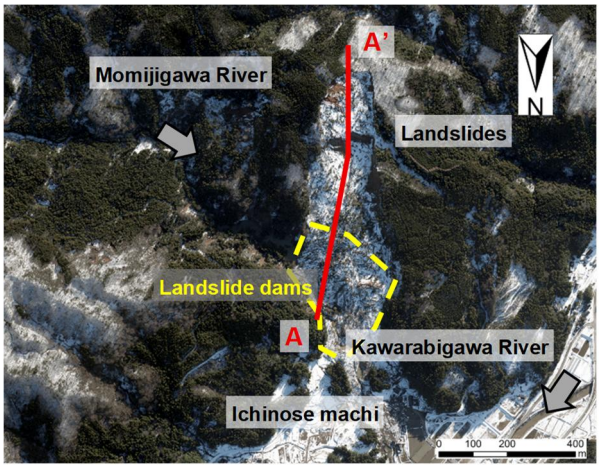


Figure-1 Location of landslide dams at Ichinose machi

2. Method

We created a three-dimensional model by making SfM (Structure from Motion) analysis using images captured from videos taken from helicopter by Hokuriku Regional Development Bureau just after the disaster (January 2nd).

As the images captured from the videos do not have location information, it is indispensable to set ground control points used as reference for absolute coordinates, however, it is difficult to make position determination at the affected areas just after the disaster.

Therefore, we estimated X,Y and Z at locations having no changes visually by comparing DSM (Digital Surface Model) data before the disaster with ortho images before and after the disaster. Then, we made ground control points on such locations and made SfM analysis.

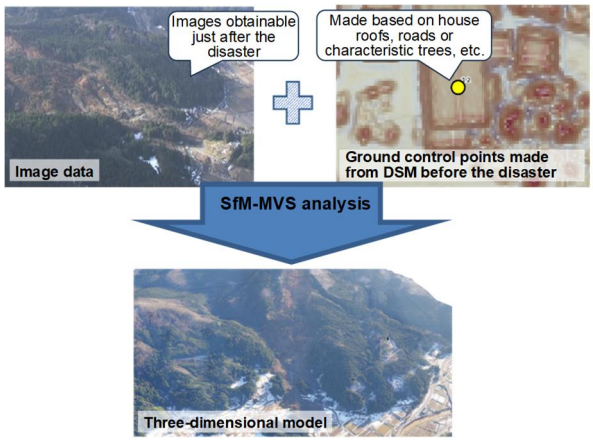


Figure-2 Creation image of three-dimensional model

3. Conclusion

We compared the three-dimensional model created for subject slope where a large-scale landslide was identified with the laser profiler measurement results conducted thereafter (DEM after the disaster) using longitudinal section (Figure-1 red line).

Though there were partial errors, the land shape mostly matched, therefore, we confirmed that it had a possibility of being sufficiently used to identify risk information just after the disaster.

Though this method has such a condition that the land shape information (DSM) before the disaster is required, we believe it will be a help to identify the disaster damage situation and the land shape just after the disaster when there is a limitation in collecting information.

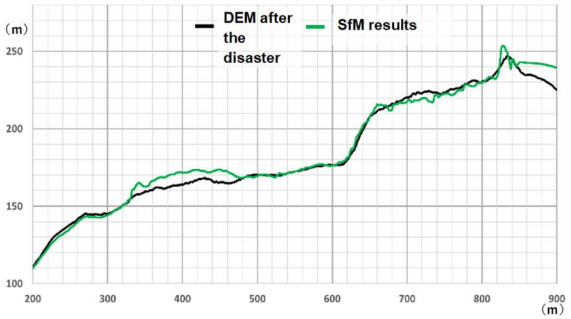


Figure-3 Longitudinal section of landslides

Introduction of activities

☞ Related information is as follows.

- NILIM material No. 1320, “Reports on damage, etc. to civil engineering facilities in 2024 Noto Peninsula Earthquake” (p8-1 ~p8-39)
- Civil Engineering Journal VOL 66 No. 7 “Survey report on sediment damage situation in 2024 Noto Peninsula Earthquake”
- Civil Engineering Journal VOL 67 No. 5 “Survey report on sediment damage situation in ”2024 September Oku-Noto heavy rain”

Feature Article

Calculation and Sharing of Route Travel Time Using ETC2.0 Probe Information in the Area Affected by the 2024 Noto Peninsula Earthquake

Road Traffic Department

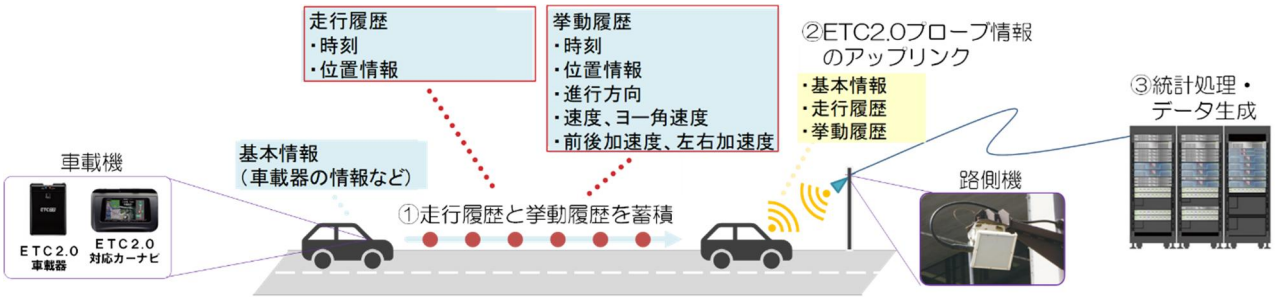
Presentation of our research

The Road Traffic Department conducts research and development of systems for grasping the road traffic status from ETC2.0 probe information (see below). After the occurrence of the 2024 Noto Peninsula Earthquake, we have made efforts to calculation and share the route travel time between major bases by using the above systems, with a view to having such time utilized as a rule of thumb for the travel time in the affected area, and others.

At ordinary times, the Regional Development Bureaus also carry out analysis of the road traffic status, using the "Final Processed Data (data available for use 30 days later)" of ETC2.0 probe information. Since the Earthquake was especially a large-scale disaster, the NILIM set up a system for performing operations from obtaining data to the calculation of the route travel time in the shortest possible time, thereby enabling travel time information to be provided in a more timely manner as a quick report. In addition, the system has also features such that the "Data Obtained by Stream Processing (available for use 1 - 3 hours later)" has been used for the calculation of the route travel time for the first time in this study, which was used for the grasping of "with or without a traffic record" until the present.

What is ETC2.0 probe information

The development of ITS (Intelligent Transport Systems: advanced road transport systems) is promoted proactively, which build integrated systems of humans, roads, and cars using the cutting edge information communications technologies, toward the mitigation of traffic congestion and the reduction of traffic accidents. The NILIM examined the "mechanisms for collecting vehicle location information (roadside units, onboard units, and the functions of communication between vehicles and roads, etc.," with a view to grasping the problems on road traffic and utilizing the mechanisms for the examination, evaluation, etc. of the measures, in the joint research with 27 entities such as onboard unit manufacturers, and prepared drafts of standards and specifications that should be prescribed in common (March 2006). As a result of this, the sale of onboard units started in 2009, and the installation of roadside units started in 2011, and the collection of the "location information of vehicles equipped with ETC2.0 onboard units (ETC2.0 probe information, see Fig.-1)" started in the same year, 2011. The rate of propagation of ETC2.0 onboard units at present is about 14% (cumulative number of cases of new setup as of March 2024: 11 million/number of vehicles equipped with the unit: 83 million).



① ETC2.0 onboard units accumulate the "travel histories, behavior histories, etc. (ETC2.0 probe information) of vehicles".

② "Roadside units for collecting information from ETC2.0 onboard units" are installed on the roads, and when a vehicle equipped with an ETC2.0 onboard unit passes through a roadside unit, ETC2.0 probe information is uplinked.

③ By performing statistical processing of the ETC2.0 probe information on multiple vehicles, data showing the average travel time in each time zone and in each section is generated. The route travel time is calculated by totaling this data, while considering the differences in travel time zones.

Fig.-1 Illustration of ETC2.0 probe information

Calculation and sharing of route travel time information

Following the route shown in Fig.-2, the calculation of the route travel time was made every day, in a cycle where a data file up to the noon was obtained at 12:30 and calculation was completed at around 13:30. The calculation results were posted on the website of the Ministry of Land, Infrastructure, Transport and Tourism: "2024 Noto Peninsula Earthquake Road Recovery Visualization Map" and on the NILIM Intranet as well for use by disaster responders within the Ministry. An example of the route travel time between Nanao City and Anamizu Town is shown below (Fig.-3, Fig.-4). By means of this, it has been made possible to provide the latest information around 15:00, that serves as a rule of thumb for the travel time on the "return route in the evening on the day (southbound)" and on the "outward route in the morning on the day (northbound)."

Fig.-2 Example of a route subject to the calculation of route travel time

北行き※（穴水町方面）	9時台	13時台	17時台
1月18日（木）	約2時間	約1時間10分	約1時間
1月19日（金）	約2時間10分	約1時間20分	約1時間10分
1月20日（土）	約1時間30分	約1時間	約1時間
1月21日（日）	約1時間	—	—
南行き（七尾市方面）	**9時台**	**13時台**	**17時台**
1月18日（木）	約40分	約40分	約1時間20分
1月19日（金）	約40分	約1時間	約1時間40分
1月20日（土）	約1時間	約50分	約1時間20分
1月21日（日）	約40分	—	—

Fig.-3 Illustration of a posting on the MLIT website

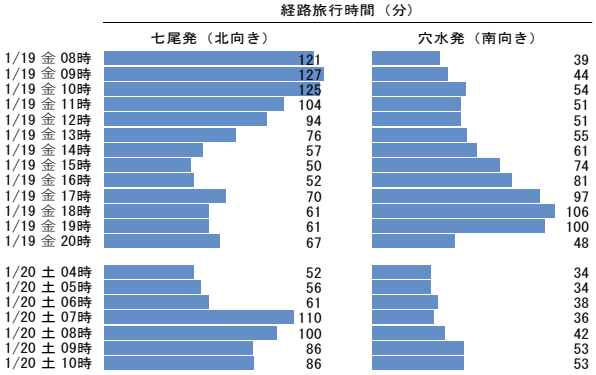


Fig.-4 Illustration of a posting on the NILIM Intranet

Fig.-5 Illustration of a posting of the route subject to the calculation of route travel time

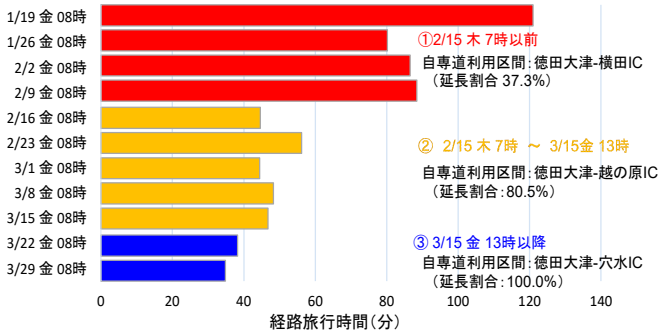


Fig.-6 Transition of the route travel time (between 8:00 and 9:00, Nanao → Anamizu)

Fig.-7 Example of data transmitted by NILIM on X (formerly Twitter)

On the Intranet, the location map of the route subject to calculation was posted in a form that enables the change history to be checked according to the traffic control. An example of the "Nanao → Anamizu" route is shown above (Fig.-5). In view of the travel time of the above route (between 8:00 and 9:00 on Friday), the situation can be seen in which the travel time decreased with the progress of road recovery (Fig.-6).

In addition to the above, updated information about the route travel time on the above website was transmitted by NILIM on X (formerly Twitter) (79 cases from January 23 to March 13; Fig.-7). The number of views was 772.5/case (maximum 3,225/case) on average, "Good" was posted 7.1/case (maximum 30/case) on average, and there were reposts (retweets) of 3.3/case (maximum 18/case) on average.

Feature Article

Response to the Noto Peninsula Earthquake - Activities Related to Road Structures -

Road Structures Department

The Road Structures Department dispatched staff to the areas hit by the 2024 Noto Peninsula Earthquake immediately after its occurrence, and investigation of the status of disaster damage to road structures was carried out, and at the same time the staff provided advice on recovery and a proposal, etc. for the orientation of the revision of the technical standards. This article presents an overview of such investigation, etc.

Introduction to the activities

1. Emergency investigation and support for technical evaluation

In order to swiftly respond to an emergency request, specialty staff for road structures were dispatched to the site on the day following the date of occurrence of the earthquake and started the activities.

In cooperation with the Hokuriku Regional Development Bureau, the Public Works Research Institute, etc., the statuses of damage in a wide range were grasped through investigation, etc. by means of a helicopter flying overhead, and at the same time advice was provided to the road administrator, concerning technical evaluation of various types of structures that suffered large-scale damage, such as the Otani Tunnel where the tunnel liner spalling occurred, and risks of secondary disasters.

Photo-1 Investigation by flying overhead over the areas where large-scale slope failures occurred

Photo-2 Investigation of the tunnel where the large-scale liner spalling occurred

2. Investigation for understanding mechanisms of disaster damage and for grasping new challenges

Ground motions were evaluated from the viewpoints of impact on road structures, and verification was carried out on the fact that expected performance was demonstrated in bridges designed after the Southern Hyogo Prefecture Earthquake after which the seismic design standards were significantly revised, and others.

On the other hand, mechanisms of disaster damage were analyzed concerning characteristic damage to various types of structures such as that in the connecting section on the abutment back face, and new problems related to a review of the technical standards, etc. were grasped.

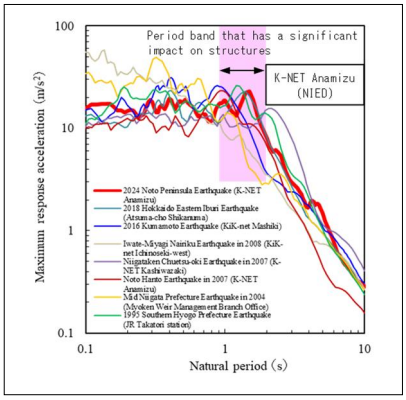


Figure Comparison of acceleration response spectra with those of the earthquakes in the past

Photo-3 Investigation of mechanisms of disaster damage in the connecting section on the abutment back face

3. Advice on the method of recovery and a proposal for the orientation of the revision of the technical standards

We participated in the Road Recovery Technology Study Committee as members of the Committee, providing advice on the method of recovery based on the mechanisms of disaster damage, and at the same time made a proposal for the orientation of the revision of the technical standards disaster damage in the Subcommittee on Road Technology meeting of the Council for Social Infrastructure by summarizing the disaster damage in the meeting.

Photo-4 Road Recovery Technology Study Committee

We will continue to provide support for the road recovery in the Noto Peninsula and make the revision of the technical standards well into the future, by utilizing the knowledge, etc. that has been accumulated in our organization.

☞For more detailed information, visit:

- Civil Engineering Journal, Vol. 66 No. 8 "Statuses of Damage to Road Structures in the 2024 Noto Peninsula Earthquake and Efforts to Be Made in Future"
- 22nd Road Technology Subcommittee, Document (https://www.mlit.go.jp/policy/shingikai/road01_sg_000688.html)
- Technical Note of National Institute for Land and Infrastructure Management, No. 1320 Report on Damage to Infrastructures by the 2024 Noto Peninsula Earthquake

Feature article

Analysis of the Causes of Damage to Building Structures in the 2024 Noto Peninsula

Building Department

○In order to analyze the causes of damage to building structures in the 2024 Noto Peninsula Earthquake and to examine the direction of the measures to be taken, the NILIM has established a committee consisting of experts of building structure, called the "Committee that performs analysis of the causes of damage to building structures in the 2024 Noto Peninsula Earthquake," in collaboration with the Housing Bureau of the Ministry of Land, Infrastructure, Transport and Tourism and the Building Research Institute.

○The Committee carries out analysis of the cause of damage for each of the structure types (wooden, reinforced concrete, foundation ground, steel frame made, non-structural members, tsunami damage, seismic isolation structure) of buildings, by collecting organizing the results of site surveys conducted by the NILIM and the Building Research Institute as well as the results of survey implemented by various institutions, and publicized an interim summary on November 1, 2024.https://www.nilim.go.jp/lab/bcg/kisya/html/kisya20241101.htm

Research introduction

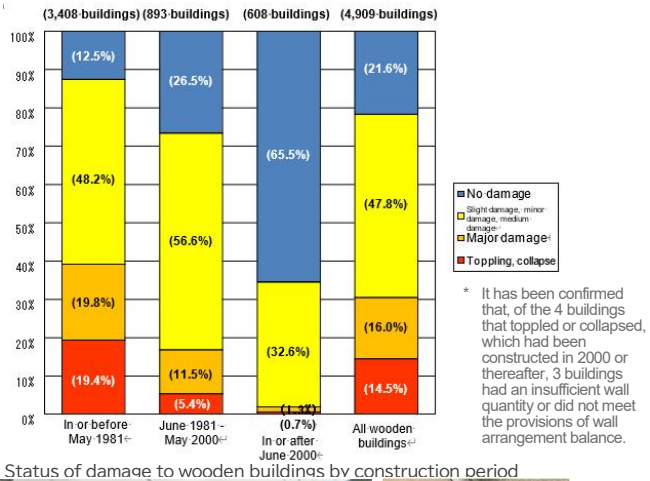
1. Status of damage to wooden buildings

In the city areas of Wajima City, Suzu City, and Anamizu Town where there was great damage to buildings, we analyzed the tendencies of damage by using the results of complete enumeration conducted in collaboration with the Architectural Institute of Japan.

- The percentage of toppling of wooden buildings conforming to the former seismic standards was remarkably higher than that of wooden buildings after the introduction of the new seismic standards. In the wooden buildings after the introduction of the new seismic standards, the percentage of toppling was extremely low in 2000 and thereafter in which the specifications of joints have been clarified.

* The construction years are classified into before 1981 conforming to the former seismic standards, 1981 and thereafter in which the new seismic standards were introduced, and 2000 and thereafter in which the current provisions have been applied

- The percentage of damage to wooden buildings that underwent seismic retrofitting was lower than that of the wooden building conforming to the former seismic standards that did not undergo seismic retrofitting, and damage was mitigated by seismic retrofitting.
- In houses that obtained seismic grade 2 or grade 3 under the Housing Performance Indication System and houses that obtained approval of a long-term excellent house, there were no houses that suffered toppling, collapse, or major damage, and most of them suffered no damage.



Status of damage to wooden buildings by construction period

* It has been confirmed that, of the 4 buildings that toppled or collapsed, which had been constructed in 2000 or thereafter, 3 buildings had an insufficient wall quantity or did not meet the provisions of wall arrangement balance.

Building that toppled and blocked the road

No metal brace

<Direction of the measures to be taken>

・Further facilitation of seismic retrofitting

- Familiarization of the "Safety Ensuring Measures Manual for Wooden Housing" concerning wooden buildings conforming to the former seismic standards
- Familiarization and propagation of the "Efficient Seismic Diagnosis Method" that are applicable to, of the wooden buildings conforming to the new seismic standards, those not conforming to the specifications that were clarified in 2000
- Provision of support by means of the Housing and Building Safety Stock Formation Project, Etc

2. Status of damage to reinforced concrete buildings

- Regarding reinforced concrete buildings supported on pile foundations, one of them toppled, and several of them were inclined. As for the factors of damage, a decline in supporting force of the piles due to damage, movement of the piles during the earthquake, but they are not clear at present.
- In the reinforced concrete buildings conforming to the former seismic standards, damage was identified such as shear destruction of columns, destruction of column-beam joints, and shear destruction of mullion walls.

Shear destruction of a column

Toppling damage to a reinforced concrete building

Inclination damage to a reinforced concrete building

<Direction of the measures to be taken>

・For buildings conforming to the former seismic standards, further facilitation of seismic retrofitting

・Analysis of the cause of inclination/toppling damage to reinforced concrete buildings supported on pile foundations

3. Status of damage to steel frame buildings

- Among steel frame buildings, 3 buildings conforming to the former seismic standards toppled or collapsed.

Collapse of 2nd and 3rd floors of a steel frame building

Layered collapse of the 1st floor of a steel frame building

<Direction of the measures to be taken>
- For buildings conforming to the former seismic standards, further facilitation of seismic retrofitting

4. Status of damage to non-structural members, effects of seismic retrofitting

- Detachment of the entire ceiling was not identified, but the fall of part of the ceiling plates and detachment of steel-made substrates were identified. Falls of interior walls, exterior walls and damage to glass were observed.
- Regarding the buildings that had undergone seismic retrofitting, there was no damage of toppling or collapse, and the effectiveness of the retrofitting was confirmed.

Ceiling collapse damage

Exterior wall detachment damage

Exterior glass breakage damage

Reinforced concrete building that had undergone seismic retrofitting (no toppling/collapse damage)

<Direction of the measures to be taken>
- For existing ceilings falling under the category of specified ceilings, further facilitation of seismic diagnosis and seismic retrofitting
- Familiarization of precautions for design and construction to prevent damage to interior and exterior walls

5. Continued usability of buildings

- Regarding buildings with seismic isolation structure, no damage to the structural frame was identified.
- In a ward having seismic isolation structure of a hospital, no tip-over damage of furniture, and the continued use of functions after the earthquake was pursued.

Photo: Japan Society of Seismic Isolation (general

Status of a hospital ward having seismic-resistant structure after the earthquake

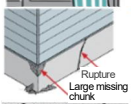
Status of a hospital ward having seismic isolation structure after the earthquake

<Direction of the measures to be taken>
- Promotion of the utilization of "Functional Continuity Guidelines for Buildings That Serve as Disaster Management Sites, Etc."

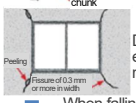
- Wooden housing in areas shaken greatly by the earthquake may have lowered structural capacity due to damage.
- Familiarization of the "Safety Check of Wooden Housing After an Earthquake" is required so that it can be determined if residents can continue to live there.

Pamphlet of the "Safety Check of Wooden Housing After an Earthquake"

Windows have become hard to open and close



There is great damage to the foundation



Damage to exterior wall is relatively great

When falling under any of the above, consult the municipality or an expert.

6. Seismic zoning factor and damage to buildings

- The seismic zoning factor used in the structural calculation of a building is set to 0.7 to 1.0 based on the size and frequency of ground motion in the past. On the other hand, large earthquakes have occurred frequently in recent years in regions with a low seismic zoning factor as well, and the northern part of Noto has a seismic zoning factor of 0.9.

* The seismic zoning factor is a factor used when calculating the seismic force used for design when performing the structural calculation of a building. Based on the records of earthquakes in the past in each region, a value of 0.7 to 1.0 is determined for each region, based on the degrees of earthquake damage in the past, and the sizes and frequency of the earthquakes that occurred.

- In the 2024 Noto Peninsula Earthquake, regarding the buildings that are considered to have been constructed by performing structural calculation using the seismic zoning factor after the introduction of the new seismic standards, damage such as toppling due to the seismic zoning factor was not identified.

<Direction of the measures to be taken>
- Study of how the standards using the seismic zoning factor ought to be based on the situation where large ground motion occurred frequently in a region where the seismic zoning factor is less than 1.0, verification of the status of damage to buildings caused by ground motion in such region, the intent of the Building Standard Law that specifies the minimum standard.

○In future, we will continue to conduct studies about analysis of the causes of damage to the inclination and toppling of reinforced concrete buildings supported on pile foundations as well as investigation and analysis of the relationship between earthquake damage and continuous usability, and others.

☞For related articles, refer to:
- Survey of fire damage caused by the 2024 Noto Peninsula Earthquake (pp. 13 - 14 of this document)
- About damage to wooden buildings in the 2024 Noto Peninsula Earthquake (pp. 68 - 69 of this document)

Feature article

Survey of fire damage caused by the 2024 Noto Peninsula Earthquake

Urban Planning Department

○Overview

In the 2024 Noto Peninsula Earthquake that occurred on January 1, 2024, it was reported that a total of 17 fires resulting from the earthquake occurred in Niigata Prefecture, Toyama Prefecture, and Ishikawa Prefecture. Among them, remarkable damage occurred in Kawai Town, Wajima City, Ishikawa Prefecture.

The National Institute for Land and Infrastructure Management and the Building Research Institute conducted a site survey to confirm the status of damage of this fire upon request from the Housing Bureau of the Ministry of Land, Infrastructure, Transport and Tourism.

Research introduction

1. Confirmation of the range of damage and situation of firestopping by the site survey

The burnt area was identified by the site survey, and at the same time the statuses of buildings inside and outside the burnt area (building structure, earthquake damage, deformation and discoloration caused by fire) and their separation distances, road widths, and the situation of vacant land and trees were confirmed (photo).

In addition, based on the site survey and news images of news media as well as the information transmitted on the Internet by individuals such as SNS, the range of fire spread by time was estimated (Fig.-1).

Photo Examples of buildings remaining in the fire spread area

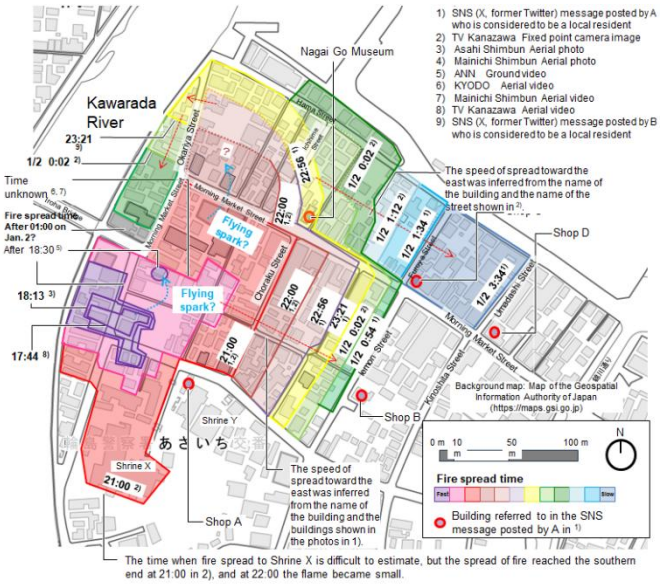


Fig.-1 Fire spread dynamics

2. Confirmation of the range of spread of sparks

In order to confirm the situation of spread of sparks during the fire, we checked the range where extinguished charcoal remained around the burnt area (Fig.-2).

Extinguished charcoal was concentrated in the northern side of the burnt area, and the size of the extinguished charcoal collected on the site was relatively larger in a nearby place located true north of the burnt area, and many relatively small and thin pieces were collected in a place far from the areas. Similarly, many relatively small pieces were collected on the northeastern side.

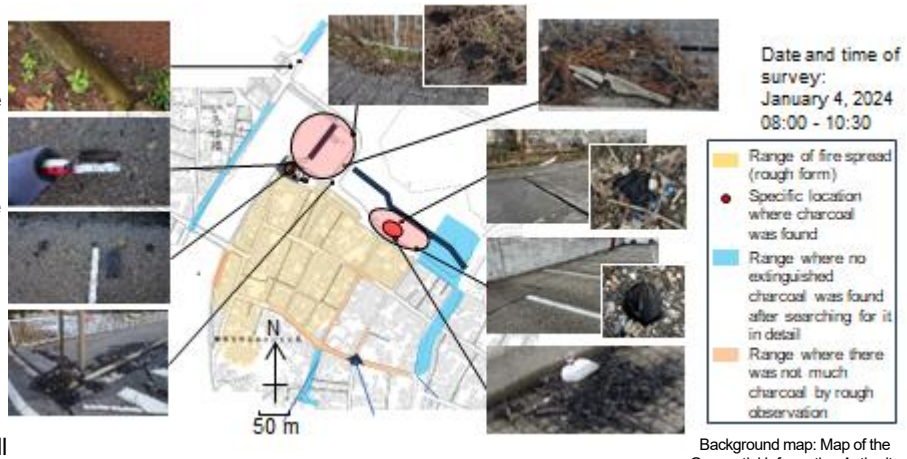
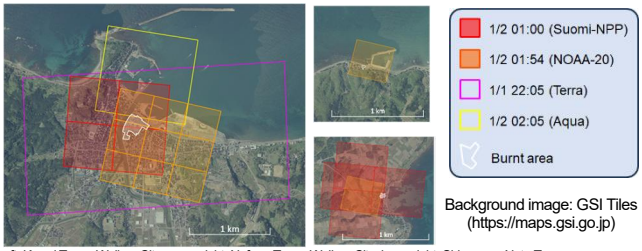


Fig.-2 Situation of the spread of sparks

3. Detection of a region where a large-area fire occurred by an artificial satellite

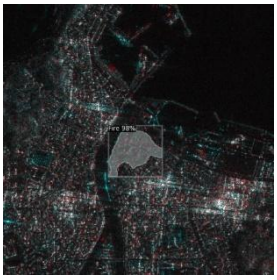
During the occurrence of a large-scale earthquake, it is difficult to grasp the entire situation of damage, and therefore large-area observation information by means of an artificial satellite is effective. In the earthquake being considered, we tried detection of fire regions based on the observation data by means of the NASA and NOAA satellites equipped with infrared sensors (Terra, Aqua, Suomi-NPP and NOAA-20). As a result, it was confirmed in the early stage before dawn on January 2 that large-scale fires could have occurred in Kawai Town, Wajima City, Nafune Town, Wajima City and around Shiromaru, Noto Town, and such information was utilized as reference information in the implementation of the site surveys.



Left: Kawai Town, Wajima City; upper right: Nafune Town, Wajima City; lower right: Shiromaru, Noto Town

Fig.-3 Results of detection of fires by means of satellite infrared data

We also conducted a study of the detection of fire regions by means of a satellite SAR (Synthetic Aperture Radar). The satellite SAR actively irradiates radio waves that pass clouds onto the ground surface and measures the strength of the reflection, and therefore it enables observation of the ground surface at night or in a situation where there are clouds. As a result of using the images observed before and after the earthquake by the ALOS-2 satellite of JAXA in the large-scale fire region in Kawai Town, Wajima City, and applying deep learning techniques, the results of inference that nearly match the burnt area confirmed by the site survey were obtained, and the possibility of the grasping of a detailed fire range by means of the satellite SAR has been confirmed.



Background image: Pseudo color image created by allocating the observation data* with ALOS-2 before the earthquake (Oct. 19, 2021) to the red band, and by allocating the observation data* after the earthquake (Jan. 9, 2024) to the green and blue bands*JAXA: https://www.eorc.jaxa.jp

Fig.-4 Results of inference of the burnt area by means of the satellite SAR data

4. Analysis of the tendency of fire occurrence

We confirmed to what extent the frequency of occurrence of earthquake-related fires in the 2024 Noto Peninsula Earthquake was as compared with the earthquakes in the past (Fig.-5). Here, the PGV (Peak Ground Velocity: maximum ground movement speed) that is an index of the intensity of shaking with the number of fire occurrences (fire occurrence rate) per unit floor area of a building. It can be confirmed that, among the earthquakes compared, the fire occurrence rate of the 1995 Southern Hyogo Prefecture Earthquake was particularly high. It can be considered that this was related to the fact that, in the 1995 Southern Hyogo Prefecture Earthquake, toppling damage of buildings caused by shaking was especially conspicuous. Whereas, the distribution of the data points of the 2024 Noto Peninsula Earthquake was not deviated greatly from the distribution of the data points of the past earthquakes. Although there is a common point that there was a lot of toppling damage of buildings, from the viewpoint of the fire occurrence rate, we can see that the 1995 Southern Hyogo Prefecture Earthquake and the 2024 Noto Peninsula Earthquake have different features.

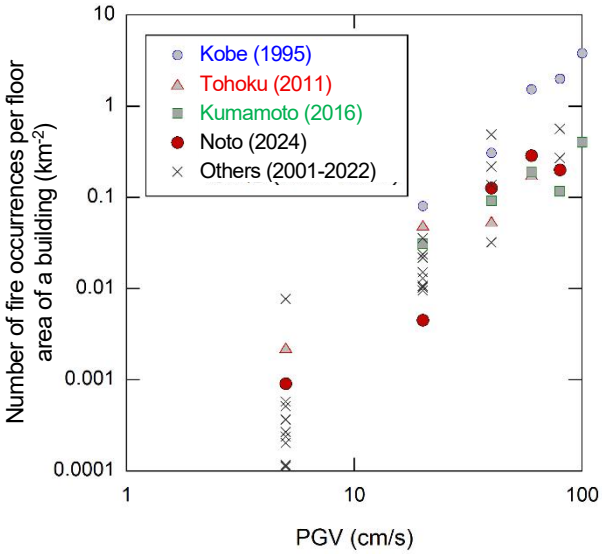


Fig.-5 Relationship between PGV and number of fire occurrences per unit floor area

○Conclusion

Regarding the city area fire that occurred in Kawai Town, Wajima City on January 1, 2024, we presented the results of analysis of fire spread dynamics, analysis of artificial satellite data, and analysis of the tendency of fire occurrence as compared with the earthquakes in the past, focusing on the site survey conducted on January 4 in the same year.

We express our sincere condolences to people who suffered damage caused by the earthquake and the fires that occurred after that.

☞For a related article, refer to:

• Quick Report of the Field Survey on the Building Damage by The 2024 Noto Peninsula Earthquake, Technical Note of NILIM No. 1296 (P. 6-1 to P.6-27)

What Are the Strengths of the NILIM?

MIYATAKE Koji, Executive Director for Research Affairs

(Key words) comprehensive strength, Noto Peninsula Earthquake, disaster prevention and reduction, maintenance, infrastructure DX, green society, satellite data

1. Response to the 2024 Noto Peninsula Earthquake

The year 2024 for the NILIM started with response to the Noto Peninsula Earthquake. All of the sections including 10 divisions and 2 centers in the research departments were involved in on-site damage investigation and technical support for recovery and reconstruction, and 3 departments in the administrative departments provided support for such activities.[1)]

The Disaster Management Headquarters meetings were held every day from January 1, the status of the damaged areas and the status of response of each section was shared, and the activity policy hereafter was checked whenever necessary.

Dispatch of researchers to the damaged areas (the emergency disaster management dispatch team) also started in the early morning on the next day, and 549 person-days in total were dispatched to the site by the middle of June. Also, 34 person-days were dispatched to the site during the heavy rainfall disaster in September as well. Altogether, the number of dispatched personnel reached an historical high, being nearly equal to that at the time of the Great East Japan Earthquake.

In the response to damage to water supply and sewerage facilities, based on the fact that the water supply administration would be transferred to the Ministry of Land, Infrastructure, Transport and Tourism on April 1 and thereafter, and since preparations were under way to rename the Sewerage Department to the Water Supply and Sewerage Department and to newly establish the Water Supply System Division, the Sewerage Department was engaged in damage investigation and support for recovery and reconstruction of the water supply and sewerage facilities.

In particular, due to the topographical features of a peninsula, it was difficult to recover and reconstruct the water supply and sewerage facilities. Consequently, as a destination organization of the NILIM, the Noto Water Supply and Sewerage Reconstruction Support Division was established in Nanao City in the damaged areas, thereby providing a system of support for local governments at the front line.

Furthermore, the Port, Coastal and Marine Department checked the statuses of damage to ports and harbors, and by presenting the usable range. As a result large vessels were able to dock alongside the piers in the Nanao and Iida Ports within 2 days following the disaster.

In addition, a matter worth noting is e that the Road

Photo A scene of a Disaster Management Headquarters meeting (January 25)

Traffic Department provided new support taking into consideration the needs at the site. This was made possible by taking measures such as calculating the time required for movement between major cities and towns by the time zone every day, by utilizing the ETC2.0 probe data, and providing information on a website for various organizations engaged in activities in the damaged areas.

Thus, researchers in various fields with varied expertise demonstrated "comprehensive strengths" in a unified manner.

In terms of human resource development, the staff of the Hokuriku Regional Development Bureau who had participated in training held by the Sabo Department as concurrent work performed simplified simulation calculation that they had learned in the training. They presented the range where inundation could occur in blocked river channel areas as a rapid assessment report. The staff who had worked for the Road Structures Department on loan from the Bureau provided technical guidance at the site regarding emergency recovery of road structures that had been damaged. They utilized their experiences while they worked on loan, thereby providing support for the road recovery and reconstruction activities. The fact that the experienced staff that had worked at the NILIM played important roles in the disaster response at the site can be said to be one of the "comprehensive strengths" possessed by the NILIM.

We also are proceeding with several studies, based on the findings obtained from the disaster and problems that were identified in light of the current technical standards, about how the findings and problems should be utilized in the technical policies hereafter. For details, refer to the videos of the FY 2024 NILIM Lecture Meeting on the NILIM website.[2)]

We recognize these as "comprehensive strengths" in a time series in which the NILIM tries to reflect the

findings and problems that have been identified through the Noto Peninsula Earthquake in the technical policies hereafter, based on the knowledge and experiences that were accumulated by our predecessors in disasters in the past.

2. Cross-functional activities

The NILIM established Research Committees regarding the cross-functional 4 subjects for the promotion of policies according to the needs of society: "Disaster Prevention and Reduction," "Maintenance," "Infrastructure DX" and "Green Society Realization," and engages in reporting the preceding cases in each Division.

Regarding Disaster Prevention and Reduction, we discussed sharing of the findings and problems obtained in the Noto Peninsula Earthquake and the strengthening of equipment and systems, and put them into practice.

Regarding Infrastructure DX, we are proceeding with "Project DX," in which staff will acquire DX literacy, in order to proactively utilize DX and realize efficient research activities and fulfillment of work.

Regarding Green Society Realization, the Research Center for Infrastructure Management created and publicized the "draft of the GHG emissions calculation manual during construction in the field of infrastructure" for quantitatively evaluating the effects of greenhouse gas emissions reduction. Then we implemented it in the Regional Development Bureaus as a trial, and vigorous research was pursued by the Building Department to further propagate the introduction of wooden structure in medium- and large-scale buildings and medium- and high-rise buildings, as well as by the Port, Coastal and Marine Department concerning the growth technology of blue carbon ecosystems.

Regarding Maintenance, more than 10 years have elapsed from 2013 named by the MLIT as the First Year of Infrastructure Maintenance Era, and attention is focused on measures to combat infrastructure deterioration due to the large-scale road subsidence that occurred in Yashio City, Saitama Prefecture in the end of January 2025, which is believed to be caused by a broken sewer pipe. Discussions need to be deepened hereafter as to how infrastructure management ought to be.

In addition, we promoted research on the utilization of satellite data that is considered to be effective in common with all the Research Committees. In particular, as the efforts adopted in BRIDGE of the Cabinet Office, we were engaged in the development of data analysis technology such as rapid awareness when disasters occur and the creation of standard specifications, guides and guidelines for the promotion of on-site implementation of such technology. Also, regarding the utilization of a small SAR satellite constellation, utilization of ALOS-4, trial of the Japanese version of the Disaster Charter, we seek collaboration with the Space Development Strategy Headquarters of the Cabinet Office, the Japan Aerospace Exploration Agency and the National Research Institute for Earth Science and Disaster Resilience, to put such projects into practical use.

Thus, "comprehensive strengths" are also important that utilize cutting edge technologies such as satellite data as well as generative AI, and robots for the optimization, advancement, and increase in efficiency of a series of technologies related to housing and infrastructure improvements.

3. Collaboration with other institutes

The NILIM is closely collaborating with the Public Works Research Institute, the Building Research Institute and the Port and Airport Research Institute, etc. in research activities when a disaster occurs as a matter of course even in ordinary times.

Furthermore, the NILIM conducts joint research concerning subjects with which it can be expected to obtain excellent results efficiently by collaborating with other institutes. In 2024, it collaborated with 76 institutes in total in 21 research projects. Collaborating institutes include many institutes in fields other than housing and infrastructure such as information-related and robot-related, and research focused on protecting lives and living, supporting economic activities, and protecting comfortable living, through collaboration with institutes in many fields.

In addition, the NILIM also accepted 55 visiting researchers from construction consultants, construction businesses, manufacturers, local governments and public interest corporations, with an increase of one researcher over the previous fiscal year.

The visiting researchers have a wide range of experience, such as on-site investigation including that on disaster sites and site visits to the experimental sites of other Divisions.

Collaboration with institutes in many fields such as these can also be said to be one of our "comprehensive strengths."

4. Conclusion

Through the efforts in 2024, I have touched upon the topic of "comprehensive strengths" that are the strengths of the NILIM. These "comprehensive strengths" are the strengths of the NILIM, which are considered to be the motive force that realize safe and secure national land and society, as the unique national research institute in the fields of housing and infrastructure.

We would like to show the presence of the NILIM in future as well, by sustainably developing the strengths that have been inherited generation after generation by adapting to the times.

☞For more detailed information, visit:

1) Statuses of activities of the NILIM in the 2024 Noto Peninsula Earthquake
http://wwwdisaster.nilim.go.jp/saigaitaiou/R601jishin/saigai_R601jishin.html

2) FY 2024 NILIM Lecture Meeting
https://www.nilim.go.jp/lab/bbg/koen2024.html

NILIM's Activities to Support Management of Water Supply and Sewerage Pipes

SANMIYA Takeshi, General Manager Water Supply and Sewerage Department

(keywords) anti-earthquake measures, measures against deterioration, inspection survey, preventive maintenance, database

1. Introduction

The administration for construction and management of water supply was transferred from the Ministry of Health, Labor and Welfare to the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in April 2024 and the Water Supply and Sewerage Department and Water Supply System Division were established at NILIM. In addition, on January 1, 2024, preceding the transfer, the M7.6 magnitude earthquake that struck the Noto region occurred (hereinafter referred to as Noto Peninsula Earthquake) and much of the water supply and sewerage facilities were damaged in the north area of the Noto Peninsula. With the objective of supporting the affected cities and towns, Noto Water Supply and Sewerage Reconstruction Support Division was established in Nanao city (the details of this achievement are described on page 119 of this document).

Now that the penetration rate of wastewater treatment facilities including sewerage exceeds 90%, it is not yet sufficient to ensure sufficient measures to continuously maintain both water supply and sewerage system in the future including anti-earthquake measures and measures against deterioration. In this report, I will explain survey and research results, that NILIM is currently making, contributing to these measures.

2. Survey and research that contribute to reducing disaster damage similar to the damage caused by earthquakes

The Noto Peninsula Earthquake damaged 136,000 houses, at the maximum, and caused a water outage. The water pipelines were restored on May 31, 2024, and the discharge function of sewerage pipelines was secured on April 25, 2024, so restoring the systems took around 5 months and 4 months, respectively. NILIM dispatched its staff to the affected areas just after the earthquake to ensure support to local governments affected by the disaster to help with temporary restoration and to conduct a survey on the disaster situation. (Figure-1)

In the Committee's report [1] that reviewed anti-earthquake measures for water supply and sewerage system (Chairman: Satoshi Takizawa, Professor of The Tokyo University Graduate School) created by MLIT, it was pointed out that the delay in ensuring anti-earthquake measures for facilities was a substantial factor contributing to the amount of damage. NILIM

Hearing on disaster situations (January 3rd: at the Ishikawa prefectural office)

Survey on disaster situations (January 13th: in Hakui city)

Survey on disaster situations (February 12th: in Wajima city)

Second survey on reviewing support status (February 13th: in Uchinada machi)

Figure-1 Approaches by NILIM's Sewerage Department (at that time) to Noto Peninsula Earthquake

plans to analyze disaster trends such as liquefaction in accordance with pipe specs such as pipe type, diameter, soil nature, micro-topography and earth covering as well as whether there exist anti-earthquake measures or not, using the database for earthquake damages to sewerage pipelines accumulated through research into earthquake disasters up until the current day. We assume that the local governments will ensure anti-earthquake measures to critical facilities such as shelters and hospitals used as disaster control centers, or the most critical facilities. High priority is given to the facilities that would cause a loss of function to the entire system if their ceased to function. Additionally, we would like them to review the vulnerability of their facilities to disasters using the above-mentioned analysis results. After the Noto Peninsula Earthquake, it was tantamount to restore the water supply and sewerage system comprehensively and promptly. We would like to ensure prompt execution of temporary restoration when disasters strike by streamlining applicable technologies, in addition to analyzing the survey method used to determine the reasons for disasters and for disaster prone situations, the time required for temporary restoration, the cost and other issues.

3. Survey and research contributing to measures to prevent the deterioration of pipelines

We have around 490,000km of sewerage pipeline

stock (as of the end of FY2022) and we estimate that their deterioration will rapidly accelerate in the near future. In such a situation, it is important to optimize the sustainable assurance of pipeline system functions and its cost through an appropriate management cycle such as inspection, survey, plan making, repair and renovation. NILIM publicly discloses [2] a database streamlining such information as pipe type, number of years elapsed and deterioration evaluation results including corrosion by collecting TV camera survey results, etc. for sewerage pipelines from local governments possessing such data that is freely available. Even if there is not sufficient inspection data available including TV camera survey results from local governments that have a plan for sewerage pipelines. Additionally, NILIM discloses a relative estimation of the soundness rate showing the proportion of "soundness level ranking the soundness of pipeline facilities by systematically classifying the status of sewerage pipeline facilities". It incorporates data regarding the total pipelines and the years elapsed (hereinafter referred to as "soundness rate prediction formula"). We present the soundness rate prediction formula and the urgency-importance matrix shown in the graph describing the formula seen in Figure-2. It is based on data covering around 310,000 spans for 60 local governments (as of May 2021). We continue to periodically update the data.

In addition, every year we review the total management length of sewerage pipelines and the occurrence of road collapse caused by sewerage pipelines. In this review, we summarize pipe type, earth covering, collapse factors, abnormal situations such as breakage and joint misalignment and present examples of preventive measures for road collapse caused by sewerage pipelines. [3]

Moreover, we created "sewerage pipeline simulation facilities" in FY2021, reproducing a life-size pipeline to verify the function of devices that can inspect and survey the inside of sewerage pipelines, and to enable local governments to select survey devices suitable for usage when conducting a sewerage pipeline survey. They also promote further technological development by private companies. We prepared a "catalog for sewerage pipeline survey devices" in July 2024 based on experiments using this facility. (its details are described on page 97 of this document).

Also, we made a questionnaire survey, for water supply utilities all over Japan to identify the execution status of deterioration evaluation for water pipelines, and to evaluate the deterioration level for each pipeline based on pipe type, burial period and burial environment, etc.

Through the above-mentioned surveys and research, we continue to support local governments to establish the method of efficient preventive and maintenance management for water supply and sewerage pipelines. Also to develop inspection and survey technologies.

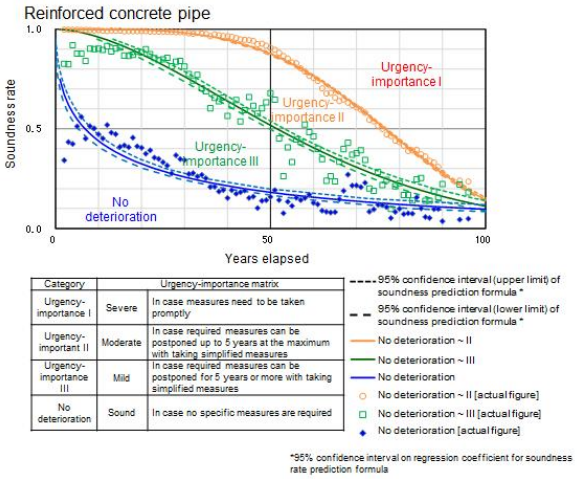


Figure-2 Soundness rate prediction formula (reinforced concrete pipe) and urgency-importance matrix

4. Conclusion

On January 28, 2025, there was a large-scale road collapse in Yashio city, Saitama Prefecture which resulted in a tragic accident where a driver with his truck fell into the collapsed hole. At the moment I was writing this article, the rescue of the truck driver as well as the sufficient analysis of the cause were not yet determined. The cause of the collapse was damage to the sewerage pipeline in the area, and we believe the root cause was the pipeline's corrosion. This accident reminded us that the water supply and sewerage system are an important infrastructure closely linked with our daily lives and substantially related to our living. NILIM would like to continue to develop its research activities and give support to system management bodies so that local governments can appropriately and efficiently manage their water supply and sewerage system.

☞Detailed information is as follows.

1) MLIT homepage: The Committee to review anti-earthquake measures for water supply and sewerage system, August 2024 https://www.mlit.go.jp/mizukokudo/sewerage/mizukokudo_sewerage_tk_000874.html

2) NILIM homepage: Database for deterioration of water supply and sewerage pipelines, soundness rate prediction formula, referred to on February 25, 2025 https://www.nilim.go.jp/lab/ebg/rekka-db.html

3) NILIM homepage: The total management length of sewerage pipelines and the occurrence of road collapse caused by sewerage pipelines, referred to on February 25, 2025 https://www.nilim.go.jp/lab/ebg/kanbotsu.html

Ten Challenges on Technical Policies for Rivers and Coasts which Need to be Addressed in the Near Future

KAWASAKI Masaki, General Manager River Department

(keywords): technical policies for rivers and coasts, climate change, integrated river basin water management, sediment management, nature positive

With a backdrop of changes in both the natural and social environment including frequent flood damage due to climate change, imminent large-scale earthquakes, a decreasing population and declining birthrate as well as an aging population, it is more and more urgent to promote technical research and development to support policy deployment based on a philosophy of integrated river basin water management including river basin disaster resilience. As of February 2025, I present the following 10 major challenges in river and coast fields which need to be addressed in the near future. The NILIM's River department has been working on policies in close coordination and role distribution with related institutions such as Water Management and Land Conservation Bureau of MLIT, Public Works Research Institution, NILIM's Sabo Department.

1. Establishment of a river channel design method that integrates water management and the environment

We aim to achieve river management, improving the safety of water management, preserving and creating a rich river environment and ensuring efficient maintenance and management by establishing a river channel design method integrating water management and the environment. To accomplish that we are comprehensively studying, designing and constructing methods and construction goals for river channels at each river from such multi-dimensional viewpoints as water management and the environment. Moreover, we take into consideration water utilization, maintenance and management.

Photo: Hydraulic model experiment to understand polarization process of river channel

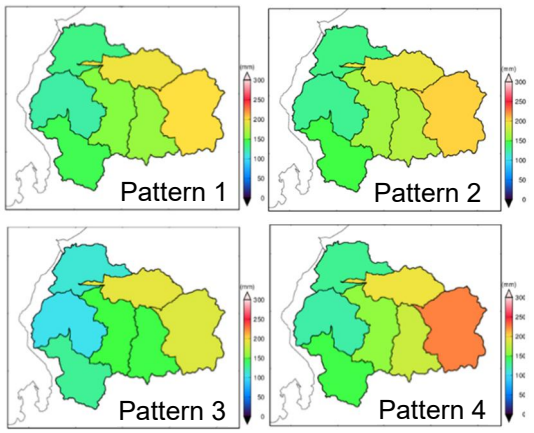
2. Improvement of prediction accuracy for sediment movement and sediment management technologies by understanding sediment dynamics

Working beyond project barriers among Sabo projects, dam projects, river projects and coast projects having sediment management issues, we aim to solve sediment issues in each field and to maintain sustainable quicksand by working on understanding sediment dynamics and efficient and effective sediment management measures with quicksand.

3. Clarification of next development reflecting the impact of climate change on basic policies

We seek to clarify the next development in river, Sabo and water resources fields including a review of river maintenance basic policies and maintenance plans utilizing the current precipitation change ratio by visualizing the impact of climate change using new climate prediction data and by studying preparation method for water management plans.

Figure-1 Examples of auto-detection of future and typical spatial rainfall distribution from large-scale ensemble climate prediction data

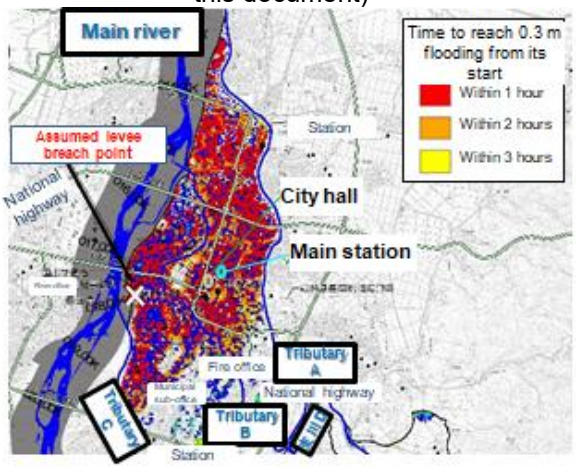


4. Visualization of change in flood risk for inland and river waters by selecting countermeasures taken for river basin water management

We aim to establish a method to confirm that the countermeasures including measures to mitigate disasters are optimal along the entire river basin and to establish countermeasures against such a risk taking into account that there will be certain areas where the situation locally deteriorates beyond the current status (organizing approaches).

Figure-2 One example of hazard index map by flooding scenario (refer to pages 54 and 55 of

this document)



5. Development of methods to improve effectiveness of evacuation activities by understanding flooding situations

We aim to ensure more accurate and more prompt disaster responses (including facility operations and drainage works by MLIT) by the Japanese government and local governments and to establish a society where companies and residents can take appropriate actions that include evacuation, making their own judgement by making it possible to predict and detect the possibility of floods and flood locations. Also to make real time reporting of flood situation (the range of flooding, flooding depth, etc.) and to make extended predictions in the future.

6. Dam's positioning taking into consideration increased external force due to climate change

For the safety and the function of dams and related facilities, we aim to propose devised works through systematic designing to reasonably secure required capability based on appropriate prediction and evaluation of the impact of an increase in external forces due to climate change.

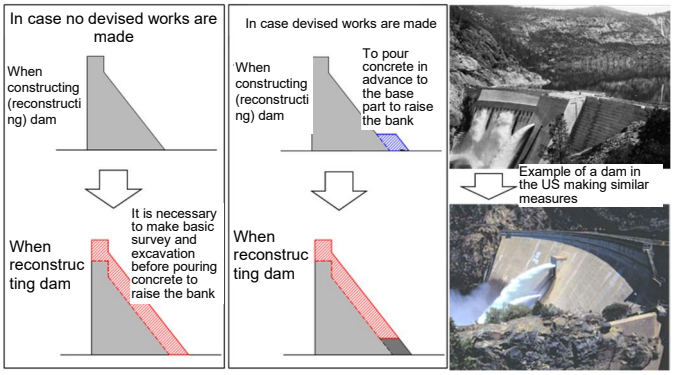


Figure-3 Devised works of dam body design preparing for future reform
(One example of bank raising-up)

7. Development of damage estimate technologies for landslides and floods

We aim to show estimates of flood damage areas taking into consideration such impacts as the potential closure of bridges caused by sediment and driftwood in areas having a propensity for landslides and floods, and to promote hardware measures such as disaster prevention in advance.

8. Quality improvement for high tide prediction

For "new climate information to prevent high tide disasters" considering waves washing up on the shore, we aim to establish a system and structure to publicly announce such information under cooperation among related institutions covering all the coastlines in Japan, by utilizing " wave height prediction" and "real time observation technologies for overtopping waves", etc. which are being newly developed, in addition to the current tide and wave prediction.

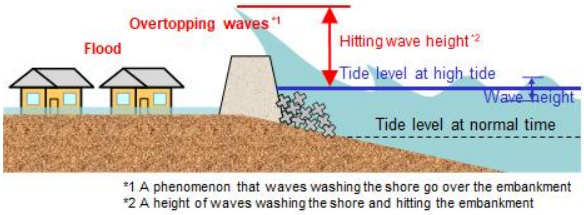


Figure-4 Flooding image after waves overtop the shore embankment

9. Study of river management methods considering the dynamism of flow volume and sediment flow

We aim to establish a society that achieves nature positivity along the entire river basin having a river as a core axis, in an attempt to harmonize a rich river environment with water management and water utilization. To accomplish this we need to secure river functions such as changes in flow volume and quicksand volume, which are important factors for a river environment.

10. Quality improvement for cost-benefit calculation method of water management projects

We aim to ensure flood risk evaluation, which is closer to the actual situation by improving the quality of cost-benefit calculation method for water management projects.

In the earthquake and the heavy rain that occurred in Noto Peninsula in 2024, it was made clear that we needed damage mitigation measures considering a series of disasters occurring within short intervals of each other . It is necessary to promote research and development for the above-mentioned challenges, trying to take initiative to utilize rapidly evolving digital technologies while flexibly responding to technology development and implementation needs.

NILIM's Activities for Improvement of Planning and Preparation Methods for Landslide and Flood Countermeasures

TAMURA Takeshi, General Manager Sabo Department

(keywords) landslides and floods countermeasures planning, climate change, simulation model

1. Introduction

Landslides and floods are a phenomenon where flooding of sediment and muddy water or of muddy water occurs, caused by the rise of a riverbed or a river blockage due to an accumulation of large volume of sediment generated by landslides and debris flow at a point downstream rather than the basin outlet. Fooling damages a much wider area, compared to debris flow (Figure-1). Landslides and floods have frequently caused substantial damage, having a tendency to occur more frequently since the beginning of the 2000s. [*1)] It is thought that this has been caused by the increased frequency of extremely heavy rains producing both a lot of sediment due to frequent landslides, and by floods carrying a large amount of sediment downstream. Both are impacted be high rainfall intensity and a high volume of total rainfall due to climate change.

MLIT has already identified river basins that have high landslide and flood risk all over Japan and is determined to accelerate landslides and floods countermeasures as preventative and efficient disaster prevention measures. The NILIM's Sabo Department is engaged in studying survey details and planning preparation method for countermeasures required for such a contingency.

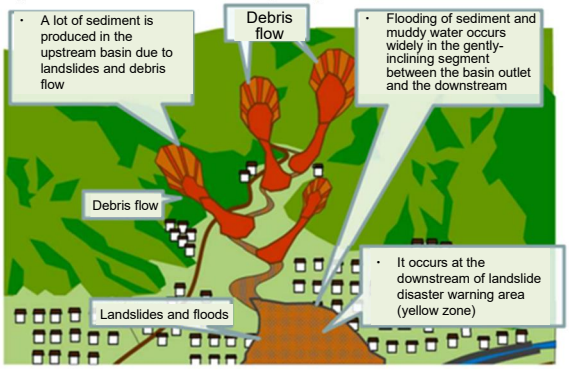


Figure-1 Image of landslides and floods

2. Difficulty in making plans for landslides and floods countermeasures

To prepare a strategic plan for Sabo facilities (planning for landslides and floods countermeasures) as landslides and floods countermeasures, it is necessary to predict a series of sediment movement phenomenon and potential damage caused. Furthermore, to predict how such a phenomenon would change by placing Sabo facilities, understanding where in the river basin and how much volume and quality of sediment would be produced and moved into river against the predicted level of rainfall, how the sediment would move down the river is difficult. Having ever-changing slopes and river width from the upstream to the downstream causing riverbed changes due to erosion and accumulation, from which part of river the flooding starts and how much damage is given to surrounding houses are all variables. We make such predictions based on these variables by creating a numerical simulation model. However, it is not easy to create a model that can be used for practical planning preparation that fits an actual river basin, as the river basin area as well as the river length subject to study are so large, the boundary conditions set are so diversified and the flow forms are so complicated.

As for the planning preparation method for landslides and floods countermeasures, the basic concept has been streamlined in the river and Sabo technology standards and NILIM's documents [2)], however, as those methods are adapted at each place and practical plans are studied, we need to consider such issues as accumulation of data on input conditions substantially affecting the calculation or way of considering various uncertainties such as sediment supply sources for calculation. It is necessary to further improve the planning preparation method so that the regional development bureau and prefectures can smoothly implement the planning preparation.

3. Contribution as a hub for study structure coordinating related institutions

To improve the preparation method for landslides and floods countermeasures planning, a study structure coordinating related institutions has been created as shown in Figure-2.

We have 37 river systems for which we study landslides and floods countermeasures. For planning the river systems we have direct Sabo projects and we have placed technical study meetings consisting of academic experts, MLIT's Sabo Department, NILIM's Sabo Department, regional development bureau and responsible offices. At this research meeting, the appropriateness of our study results are evaluated at each study stage and useful knowledge and issues are identified. We had 13 technical study meetings held during FY2024 and NILIM's Sabo Department

participated in all of them and gave detailed technical guidance, on how to prepare to regional development bureaus and responsible offices.

To summarize and streamline the knowledge and comments obtained at technical study meetings for each river system and to improve the planning preparation method for landslides and floods countermeasures, we have an additional opportunity (technical discussion meeting) to have opinions from academic experts who also participate in technical study meetings (basically held once a year). NILIM, as a secretariat, prepares, administers the meeting and streamlines the direction utilizing the opinions heard.

Utilizing the opinions obtained at the technical discussion meeting, NILIM's Sabo Department issues technical documents and engages in communication with other related institutions, such places as regional development bureaus. Feedback and new issues are identified there and then they are discussed at technical study meetings.

The technical discussion meeting connects the on-site practices and identification of issues with the improvement of planning preparation method for landslides and floods countermeasures at related institutions. NILIM's Sabo Department, as a secretariat, works as a hub within the study structure coordinating related institutions.

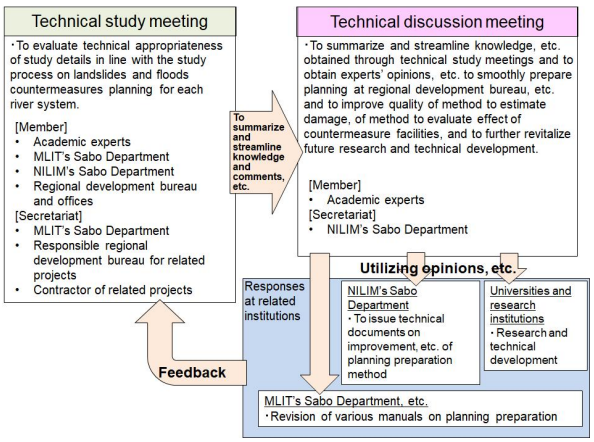


Figure-2 Structure to study landslides and floods countermeasures planning

4. Examples NILIM has as research theme

There is research and development NILIM's Sabo Department has as its own research theme utilizing opinions of the technical discussion meeting. I will explain three examples as follows.

Regarding the issue that the riverbed change calculation model cannot properly reproduce the phenomenon identified in actual landslides and floods (in particular, it cannot reproduce phenomenon such as sediment having a wide variety of particle sizes including minute particles that are carried down to the area having small riverbed slopes). We engage in research in order to improve the calculation model. As the initial stage approach for this research, we describe the research results while conducting hydraulic model experiment, as an article in this document. [3)]

As for the slope collapse sediment volume flowing into the river at the time of planned rainfall, we engage in research on its verification method. Currently, we use a method to empirically estimate the volume based on the actual data from past heavy rainfalls, however, we also consider a response to extremely heavy rainfalls that we have never experienced before due to climate change. We engage in research on methods to embedded-analytically estimate a physical model for slope collapse.

In addition, as for the housing damage estimation required for studying landslides and floods countermeasures planning, we engage in actual situation surveys to study the relationship between the sediment depth and the housing damage. Research into the relationship between the flow speed and water depth is reproduced by numerical simulation and actual housing damage.

5. Conclusion

As explained above, NILIM's Sabo Department continues to ensure improvement in the planning preparation method for landslides and floods countermeasures, contributing as a hub for study structure and making its own research and development.

☞Detailed information is as follows.

1) FY2023 summary of Sabo technology study meeting considering climate change, March 2024, p4 https://www.mlit.go.jp/river/sabo/committee_kikohendo/231225/r5torimatome.pdf

2) NILIM document No. 1048, November 2018 https://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1048.htm

3) Development of the calculation model to accurately predict sediment accumulation at the time of occurrence of landslides and floods, pages 58 ~ 59 of this document

Research and Development into how the Construction of Road Networks Contributes to Solving Social Problems

YOSHIDA Hidenori, Director, Road Traffic Department

(Key words) road network, service level evaluation, autonomous driving, zero accidents, decarbonization

1. Trends concerning the orientation of road policies

Road networks are the most fundamental social infrastructure that connect regions and facilities and support the movement of humans and goods as well as economic activities and lives. Roads are expected to fulfill various functions, not only for movement, but for lodging, bustle, environment, disaster preparedness, and others. They help realize a safe, secure, and affluent society, and also help respond to recent social problems such as population decline, aging, the growing intensity of disasters, climate change, and distribution crises.

The formulation of specific policies was developed through discussions in the Social Capital Development Council where proposals were made such as the "Road Policy Vision 'Landscape of Roads Will Change in 2040'" (June 2020) and "What the High Standard Highway Network Ought to Be, an Interim Summary" (October 2024).

One goal of the national government is the implementation of autonomous driving. It was put forth in the "Comprehensive Nationwide Development Plan for Digital Lifeline" (June 2024) that was an initiative for nationwide deployment of digital technologies. It was also specified in the "Government's Mid- to Long-term Plan Toward FY2030" (February 2024), which was devised to reform physical distribution issues, to enable the enactment of comprehensive measures including increasing vehicle size and autonomous vehicles.

On the basis of these, the "WISENET2020/Policy Collection" (October 2023), which summarized the specific road policies to be implemented hereafter, the "Road Sector Decarbonization Policy Book Ver. 1.0" (December 2024) toward decarbonization, and other policies have been prepared.

Recently, the "Bill for the Act for Partially Amending the Road Act" was submitted to the ordinary Diet session in February 2025. The content of this Act was as follows. In order to further a more comprehensive response to disasters based on the 2024 Noto Peninsula earthquake, in addition to ensuring safe and smooth traffic, other functions related to disaster preparedness for roads must be secured. Also, the reduction of environmental load through the promotion of decarbonization and other measures are declared to be a foundational part of road improvement. This Act specifies the plans devised to accomplish these goals.

Henceforth, some of the approaches of the Road Traffic Department based on the aforementioned road policies will be presented.

2. Road network evaluation utilizing digital technologies

While the improvement of road networks greatly advances, there are challenges such as traffic jams that occur unevenly in both location and time, redundancy in times of a disaster, and time disparity from region to region. In order to improve productivity and regional vitalization it is necessary to evaluate networks from various vantage points such as the smoothness of movement, and how to proceed with measures that take into consideration both hardware and software aspects efficiently by utilizing data and new technologies.

For this reason, the Road Traffic Department has decided to tackle the development of techniques for efficiently grasping and estimating the road traffic status by utilizing ICT and other technologies. Some of those include the development of indexes for evaluating service levels in a multi-faceted manner, the study of road geometric structure standards corresponding to the target levels in regard to such service levels, the establishment of techniques for the management of traffic supply and demand utilizing digital technologies.

FY2025 is the year of implementation of a Road Traffic Census. The extent of application of efficient techniques for grasping the traffic status will be expanded including traffic volume measurement tools using AI image analysis. We will also engage in the development of the indexes for the purpose of evaluating service levels such as smoothness of movement according to the road classification.

3. Efforts to make autonomous driving a reality

Due to a growing concern about an insufficient number of drivers to meet the demands of distribution and regional traffic, the realization of autonomous driving is awaited with great anticipation. The national government aims at implementation of Level 4 autonomous trucks from FY2026 onward to operate in distribution services. They also plan to increase the number of locations providing Level 4 autonomous driving movement services to more than 100 locations by FY2027 to meet the demands of transportation.

The development of autonomous driving vehicle control technologies is under way in which acceleration and deceleration as well as steering are performed by using information from onboard sensors. Whereas, it is difficult for the vehicle alone to detect information necessary for merging on an expressway, it is tantamount that the merging be supported by information provided from the road level.

The Road Traffic Department, through joint research with automotive and electrical equipment manufacturers and others, has been engaging in the development of technologies that alert drivers to obstacles ahead and provide information about vehicles running on through lanes during highway merging, by means of communications between the road and the vehicle. Based on the results of such development, in January 2025, merging support information provision systems were (in 3 locations) installed on the Shin-Tomei Expressway (Figure-1). It is planned that priority lanes for autonomous vehicles will be installed in March 2025, and demonstration experiments to provide merging support information for autonomous trucks will be started from May 2025 onward.

Figure-1 Experimental equipment for the provision of information on merging support (left: vehicle detection sensor, right: information provision facility)

Also, it is planned that, with regards to transportation services such as autonomous buses, studies will be conducted about how to improve techniques whereby road space being used by autonomous vehicles are easy to run and are safe and comfortable for other users as well. The results of these experiments will be studied and summarized in FY2026 as a draft for guidelines.

Figure-2 An example of autonomous driving movement services and space for bicycle traffic

4. Efforts toward "Zero Accidents"

In order to realize a safe and secure society, the national government aims at zero accidents in the future.

Therefore, the Road Traffic Department is engaged in research on effective traffic safety measures in order to create a road space where all users can utilize the space safely and securely.

Specifically, the development of tools is under way to help visualize problems by utilizing big data, AI image analysis and research in order to formulate an agreement which will enable proceeding with measures smoothly.

In addition, in order to enlarge and improve the space where automobiles, bicycles, and pedestrians are appropriately separated, research on structure and related concerns for effectively redistributing the limited space is under way, taking into account consideration of such research results on the "Guideline for the Creation of Safe and Comfortable Bicycle Use Environments."

5. Efforts toward the decarbonization of road traffic

Taking into consideration the global trends aimed at suppressing temperature rise, Japan has a policy of aiming at zero greenhouse gas emissions as a whole by 2050.

The road sector accounts for about 16% of CO_2 emissions in Japan. A decision in the "Road Sector Decarbonization Policy Book Ver. 1.0" was made to make efforts with the following as the basic pillars of the policy: (1) Creation of road space that supports the greening of road traffic; (2) Transformation into low-carbon human flow and distribution; (3) Optimization of road traffic; and (4) Low- carbonization of the entire road life cycle.

Specifically, the policy specifies that efforts will be made in the functional classification into high-standard roads and traffic management based on data, installation of EV charging facilities within roads and the improvement of guiding signs for such facilities, and others. In addition, it is required that various efforts be made efficiently and effectively, by building techniques that enable the following outcomes: estimation of CO_2 emissions due to automotive traffic as well as estimation and evaluation of the effects of CO_2 emissions reduction by means of road measures.

The Road Traffic Department is examining a CO_2 emissions coefficient corresponding to the dissemination of EVs, that substitute conventional gasoline vehicles. In the future, a technique for estimating CO_2 emissions will be created, thereby aiming at the development of techniques to evaluate the effectiveness of reduction in accordance with each of the policies.

6. Conclusion

Since the period of high economic growth, for many years in response to an increase in demand for automotive traffic and changes in social environments, the improvement of road networks has been pursued while changing the structure and operation. Even today new road policies are developed every year, on the basis of social problems. It is our intention to flexibly engage in the development of new technologies and research that contribute to the acquisition of knowledge, so as to be helpful in solving such social problems going forward.

☞For more detailed information, visit:

1) Website of the Road Traffic Department
https://www.nilim.go.jp/japanese/organization/koutsu/jkoutsu.htm

Development of Maintenance Engineers for Road Structures in Cooperation with Regional Development Bureaus, Etc.

HOSHIKUMA Junichi (Ph. D.), Director, Road Structures Department

(Key words) *human resources development, maintenance engineer for road structures, technical standard, training, technical support*

1. Introduction

The NILIM regards onsite support for the improvement of technical expertise of the Regional Development Bureaus, etc. (hereinafter called the "RDB") as one of the fundamental functions, together with research and development to support the planning, drafting, and propagation of technical policies of the Ministry of Land, Infrastructure, Transport and Tourism. In addition, an important role as an organization is developing regional core engineers by recruiting and training human resources who have both administrative knowledge and expertise, and transferring technical expertise through guidance and advice. This can only be accomplished by those who hold positions where they acquire knowledge about practical work and challenges faced at the site.

In this report, activities carried out by the Road Structures Department in cooperation with the RDB, and other related organizations will be presented, from the viewpoint of developing onsite technical expertise of maintenance engineers for road structures who play a core role in the regions.

2. Cooperation with the Regional Development Bureaus, etc. for the purpose of developing human resources

Figure-1 shows the efforts of the Road Structures Department in cooperation with the RDB in an effort to develop maintenance engineers for road structures who play a core role in the regions.

The 1st initiative is to accept technical staff of the RDB in the NILIM. This effort was started in FY2015, and 38 staffers of the RDB (hereinafter called the "staff on loan from the RDB") were accepted by FY2024. The staff on loan from the RDB are engaged in research work as the positions of staff of the NILIM, and are involved in research related to the revision, etc. of the technical standards for road structures. Furthermore, brush-up of technical expertise is pursued while accumulating experiences through OJT, concerning support for training to be provided by the RDB and technical support, etc. in the case of occurrence of damage caused to road structures due to a disaster or defect as well.

The 2nd initiative is to strengthen cooperation with the Road Maintenance Centers established in the Regional Development Bureaus. The Road Structures Department carries out investigations into defects in road structures, in each region, in an effort to ascertain the defect and cause of the damage. It works in cooperation with the Road Maintenance Center, while at the same time carrying out activities such as the investigation of problems related to the management of technical standards.

The Department is making progress, while developing engineers familiar with technical standards who play a core role in regions through these initiatives, resulting in technical knowledge about the maintenance of road structures that will be gathered in the RDB.

3. Development through research on the technical standards for regular inspection

With the occurrence in December 2012 of an accident of ceiling plate collapse in the Sasago Tunnel on the Chuo Expressway, relevant laws and regulations as well as cabinet and ministerial orders were amended in 2013, and in 2014 regular inspection of once every 5 years was obligated for road structures such as tunnels and bridges. After a period of 10 years, the "Regular Inspection Procedures" were reviewed in March 2024 at which time the results of two rounds of inspections were summarized.

At the time of this review, the data of the regular inspection until the present was analyzed objectively, and after having clarified the technical problems for achieving both the improvement of inspection/ diagnosis qualities and labor saving, a study of solutions of such problems was conducted. The staff on loan from the RDB have access to technical knowledge about the mechanisms of deterioration of and damage to road structures and the advancement of such deterioration or damage through data analysis, etc. in

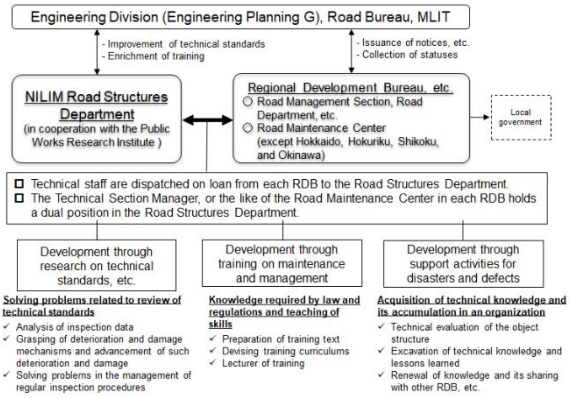


Figure-1 Cooperation with the RDB, for the development of engineers who play a core role

the process of engaging in the study work for this review, and put into practice the thought for the solution

of technical problems such as the improvement of diagnosis qualities. Moreover, the staff will also learn the true nature of technical measures through studying the review to ascertain what direction the inspection and diagnosis of road structures should be guided. These are important elements from the perspective of developing engineers who will play a core role in various regions.

4. Development through training on maintenance and management

With regard to road bridges, the results of regular inspection of management by the national government in all over Japan that have been accumulated until the present have been analyzed, and training text has been prepared consisting of examples of road bridge structure, design, construction, and damage as well as their mechanisms, methods of grasping the condition at the site and precautions, the concept of diagnosis considering progressiveness based on the roles and damage condition of members, etc. In addition, regarding the curriculum of training as well, contrivances have also been made to improve the quality of inspection, by incorporating practical training so that the assessment and findings of diagnosis can be learnt logically and systematically, and at the same time by performing site practical learning and by taking measures such as the introduction of an examination in which the findings of diagnosis of a bridge that has been checked visually in its vicinity.

In addition to what is listed above, training on the maintenance and management of road bridges includes the following training calibrated according to the number of years of experience.

- Training with the intent of acquiring basic knowledge that is necessary for the design of repair, and the implementation and supervision of construction
- Training intended to acquire knowledge about management including the planning, design and construction of repair on the basis of the technical standards regarding design and inspection
- Training intended to acquire knowledge about management including emergency response to recovery when damage occurs due to deterioration or a disaster.

Also, regarding tunnels as well, the RDB, etc. carries out training intended to acquire knowledge that is required when determining the classes of diagnosis of soundness in regular inspection, such as a study of technical evaluation based on the grasping of the conditions. In these types of training, staff on loan from the RDB prepare a curriculum plan and training text, or provide support for the RDB, as a lecturer, thereby making strategic efforts to develop human resources as engineers in charge of road management.

5. Development through support activities for disasters and defects

The Road Structures Department provides technical advice on various technical challenges faced at site by a road administrator, while utilizing thorough knowledge of technical standards and findings, that have been obtained through response to various conditions in the past. When damage has been caused to a road structure due to a disaster or defect, specialty staff are dispatched immediately upon request from the road administrator. Many things can be learned precisely in such a time. Because of that, on occasions when staff are dispatched to a site, staff on loan from the RDB are dispatched to accompany the specialty staff, and they are able to carry out an investigation jointly with the Road Maintenance Center in the region. That is one way that we are making efforts to provide technical advice for the requester regarding first-aid measures, as well as comprehensively based technical evaluation of such things as the performance of a road structure in the current situation and changes expected to occur hereafter, as well as location conditions and environmental conditions, and other unique conditions.

In addition, it is also important to summarize knowledge obtained through the findings of the technical support, and to share the knowledge with the Road Maintenance Centers all over Japan. The Road Structures Department shares the content of technical support provided to the road administrator through regular meetings with the RDB and Road Maintenance Centers, and at the same time exchanges opinions about points of further improvement regarding the content of technical advice. We also bring examples of damage to actual road bridges, and carry out technical evaluation on the performance of such bridges and as to how such performance may change hereafter, and engage in exchange of opinions as well, regarding the grounds related to the determination of soundness diagnosis classes, such as the policy of measures to be taken by the next time inspection as the road administrator.

6. Conclusion

Since the number of engineers involved in the maintenance and management of infrastructure facilities will decrease in the future, the importance of developing road structure maintenance engineers will further increase, who will be the motive power to efficiently turn the management cycles of road structures. We would like to make efforts in the support toward the improvement of technical expertise of the RDB, while continually seeking cooperation with the RDB.

☞For more detailed information, visit:

1) Civil Engineering Technical Material Vol.67, No.1 pp.46-49

Efforts of Building Research That Shapes the Future of Society

HASEGAWA Hiroshi (Ph. D.), Director, Building Department

(Key words) social needs and seeds, building, disaster management and mitigation, carbon neutral

1. Introduction

The Building Department is engaged in efforts to realize safer and more attractive buildings corresponding to the diversification and advancement of social needs and seeds. This paper introduces representative researches concerning disaster management and mitigation as well as carbon neutral (hereinafter called the "CN"), from the perspective of "building research that shapes the future of society."

2. Efforts related to disaster management and mitigation

(1) Efforts to respond to a large-scale earthquake

In the 2024 Noto Peninsula Earthquake (hereinafter called the "Noto Peninsula Earthquake"), damage due to the toppling of a reinforced concrete (hereinafter called "RC") building occurred. This was the first case in which a RC building with a pile foundation was toppled. The building was built before 1984 when the Guidelines for Short-term Load Design for Pile Foundations were enacted, and it is conjectured that the cause of the toppling damage is related to a decrease in support force due to damage or movement of the piles during the earthquake. However, at present the cause is unknown. Hereafter, we will elucidate the cause of the damage and will conduct studies to verify the suitability of the current standards and of the course of action to be taken for recurrence prevention.

In addition, not only the collapse and toppling of buildings, but also a wide range of damage due to inclination and subsidence was identified. To actualize prompt recovery and reconstruction of the damaged areas, it is necessary to grasp, at an early stage, the status of distribution of buildings where damage was great, including inclination and subsidence. Various techniques were used in the Noto Peninsula Earthquake, but the optimum technique taking into account the weather and time zone, the land conditions and location of the buildings has not been established. Therefore, in order to promptly make judgment on damage to the damaged buildings and provide support for the study of recovery and reconstruction measures at an early stage, we are engaged in the development of techniques for the advancement of evaluation of the status of damage to the damaged buildings (inclination angle, amount of subsidence, etc.) using airborne laser measurement and UAV laser (FY 2024 - 2025/Fig.-1).

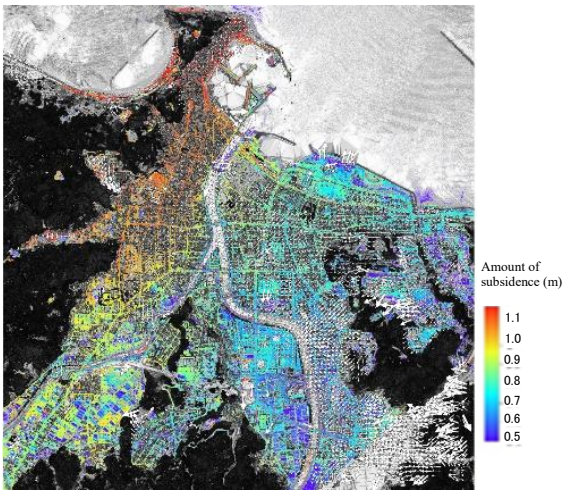
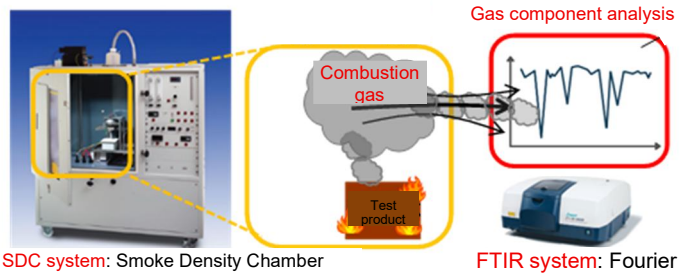


Fig.-1 Illustration of the grasping of distribution of damage to buildings using point cloud data obtained by airborne laser

Furthermore, 235 disaster-related deaths were recognized as part of the death toll of the Noto Peninsula Earthquake (as of November 22, 2024). In order to prevent a decline in the quality of life due to prolonged evacuation, the continued use of buildings is required even after a large-scale earthquake. Therefore, in an effort to increase the number of RC buildings having seismic resilience performance as "buildings that are unlikely to be damaged and easy to repair" in the event of a large-scale earthquake, we are engaged in the development of new techniques to evaluate such performance (FY 2022 - FY 2026).

(2) Efforts to respond to a large-scale fire

It is also a challenge to mitigate human damage caused by buildings during a large-scale fire associated with a large-scale earthquake. Therefore, we are engaged in the development of evacuation safety design methods based on the behavioral characteristics of people having difficulty in evacuation such as the aged, disabled, pregnant women, etc., considering buildings used by unspecified many (commercial facilities, etc.) (FY 2024 - FY 2026). While conventional evacuation safety design deems it a prerequisite that people with no disabilities evacuate to the ground by using stairways, we aim at developing new evacuation safety design presupposing the existence of people having difficulty in evacuation who cannot evacuate to the ground by using stairways.



Gas component analysis methods are to analyze the types, concentrations of gas components generated by combustion, which enable clean and quantitative evaluation to be performed, but they involve challenges such as improvement in analysis accuracy and the establishment of evaluation standards for toxicity.

Fig.-2 Illustration of the implementation of gas component analysis method

The primary cause of death in a building fire is by intoxication caused by toxic gases contained in smoke. Therefore, in order to ensure evacuation safety during a fire, building materials (interior materials) that generate toxic gases when combusted are restricted. The current mouse test method for evaluating the gas toxicity of building materials is an animal experiment that evaluates the gas toxicity qualitatively by measuring the stopping time of mice, and so it entails many problems in terms of animal protection and health risks of those engaging in experiments, as well as response to international standardization. Therefore, we plan to do research regarding the introduction of "gas component analysis method" (Fig.-2) that is clean, more advanced, and enables quantitative evaluation (FY 2025 to FY 2027).

3. Efforts toward the realization of CN

(1) Efforts to expand the utilization of wood

In order to realize CN in 2050, it is necessary to promote the utilization of wood that fixes carbon. The Building Department has heretofore been pursuing research for the promotion of the utilization of wood in medium- to high-rise buildings many of which are non-wooden buildings (such as the comprehensive project "Development of design and construction technologies for mixed structure buildings utilizing new wood-based materials (FY 2018 to FY 2022)". On the other hand, in order to realize a recycling society that contributes to CN, reuse of wood (reused wooden material) to which carbon is fixed is also indispensable. However, under the current building related laws and regulations, no method for evaluating reused materials is available, and it is difficult to make an evaluation of the performance durability of reused materials that is objective and reliable. Therefore, we will engage in new research to establish the evaluation methods for the durability, degree of deterioration, and soundness of reused wooden materials (FY 2025 to FY 2028).

(2) Efforts to expand the utilization of environmentally friendly concrete

Another indispensable factor in realizing CN to reduce CO_2 emissions during the manufacturing of cement and concrete which are the major materials in the building

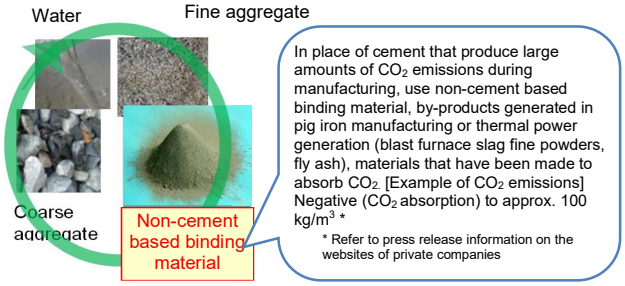


Fig.-3 Illustration of environmentally friendly concrete

field along with wood. It is necessary to promote utilization of various types of environmentally friendly concrete (Fig.-3) that is being developed by the private sector, etc. at present in major structures, etc., but the Building Standard Act stipulates that the materials that can be used for the major structures of buildings must conform to the Japanese Industrial Standards (JIS) or must be approved by the Minister of Land, Infrastructure, Transport and Tourism (Article 37 of the Building Standard Act). Since much of the environmentally friendly concrete that is being developed at present is not a JIS-compliant material, obtaining an individual approval from the Minister is required. However, the public notification standard related to the examination of approval by the Minister does not assume the materials used are greatly different from ordinary concrete in terms of the constituent materials and their ratios. Therefore, we are engaged in the developing items and standards for performance and quality that will be required for the approval examination by the Minister as specified in Article 37 of the Building Standard Act (FY 2023 to FY 2025). Moreover, starting in FY 2025, research will be advanced to develop an evaluation method for structural performance at the member and framework level as well as an evaluation method for durability (steel rod corrosion and volume change) as structural members (FY 2025 to FY 2028).

4. Conclusion

The Building Department will continually be engaged hereafter in the research of technical policies toward the propagation of buildings that realize disaster management and mitigation as well as CN, and social needs and seeds.

☞For more detailed information, refer to:

1) Technical Note of NILIM No. 1296 pp. 5.3-1 to 5.3-93
https://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1296pdf/ks1296_53.pdf
2) "Development of evaluation techniques concerning the performance of continued use of RC buildings after a large earthquake," P67 of this document
3) "Research on the technologies that increase the evacuation safety of people having difficulty in evacuation during a building fire," P100 of this document

Efforts to Respond to Social Needs through the Retrofitting and Utilization of Housing and Building Stock

FUJIMOTO Shuichi, Director, Housing Department

(Key words) energy saving, carbon neutral, stock management, retrofitting

1. Introduction

Based on the changes in socio-economic statuses surrounding housing, such as an increase in demand for environmental consideration on a global scale, the arrival of full-fledged population decline, low fertility rates and an aging society, the Housing Department has been engaged in research and development towards the goal of making safe and secure housing life a reality. This paper presents major researches concerning the promotion of energy saving and the building of a housing safety net through the stock management of housing and buildings.

2. Efforts toward the promotion of energy saving

In April 2025, the amended Building Energy Conservation Act was fully enforced, and compliance of all newly constructed houses and buildings with energy saving standards became mandatory. In addition to the strengthening of standards (for new buildings) to the ZEB and ZEH levels in 2030, in an effort to realize carbon neutrality (CN) in 2050, seeking still further improvement in energy saving performance has become a requirement, not only with newly constructed buildings but with existing buildings as well.

(1) Efforts with non-housing buildings

In existing office buildings (non-housing buildings), large energy-saving effects should be obtainable through reasonable additional investments, if the current condition diagnosis and redesign plans are carried out in line with an equipment renewal schedule that is implemented every 10 to 20 years. However, under the current circumstances, the practice is limited to easy replacement of facilities and equipment, thus missing energy saving opportunities. Based on these realities, we have been engaged in research on a retrofitting design method taking into account an assessment of the current condition of the structure with

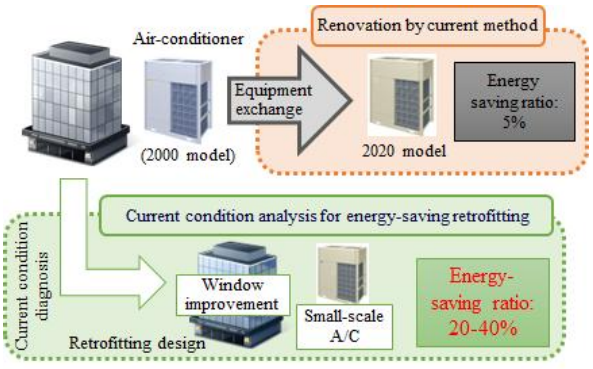


Fig.-1 Illustration of energy-saving retrofitting based on current condition diagnosis

the goal of energy saving of existing office buildings (FY 2022 to FY 2024). An additional goal is to provide guidance for more effective retrofitting. To that end we have developed technical guidelines and support tools concerning current condition diagnosis and retrofitting design.

On the other hand, in spaces use by large groups of people such as offices and schools, insufficient ventilation has been normalized and it has become a challenge to both secure a good indoor environment and achieve high energy saving performance. The nonconformity rates of offices and schools to the indoor CO_2 concentration standard in regular inspection pursuant to the Act for Maintenance of Sanitation in Buildings increased by about 3 times (38%) during the 20 years from 2000. During the coronavirus pandemic there were temporary improvements in nonconformity rates due to prioritizing "window opening" ventilation, but about 20% still continue to be nonconforming. At present after the pandemic, there remains a concern about the nonconformity rate worsening again. Based on the situation mentioned above, we have decided to engage in research concerning the securing of appropriate air environments and energy saving evaluation in office buildings and schools (FY 2025 to FY 2027). This research aims at creating technical guidelines for air conditioning ventilation equipment plans for securing appropriate indoor air environments, and at the same time developing an evaluation method for the energy saving effects of equipment having advanced ventilation air volume control that has not been evaluated under the current Building Energy Conservation Act.

(2) Efforts in housing complex (condominiums)

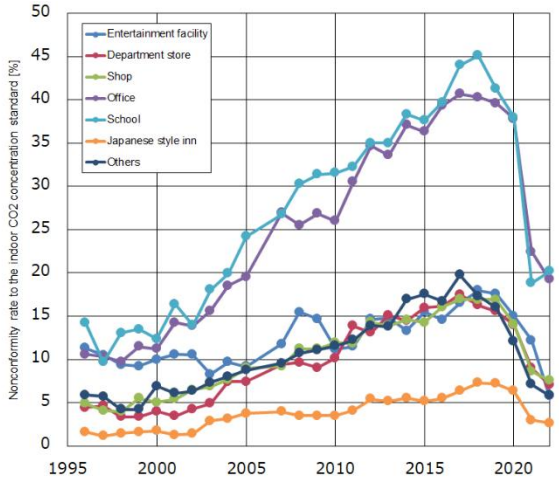


Fig.-2 Secular change in indoor CO_2 nonconformity rate by building use
(CO_2 concentration standard: 1,000 ppm or less)

Increasing energy efficiency in housing has mainly been done by focusing on newly constructed housing until the present. However, the stock of condominiums

was approximately 6.75 million housing units (as of the end of 2020), in which the stock of those before the current energy saving standard (1999 standard) accounted for 60% of the entire stock. Thus, in many condominiums the building frame has low thermal insulation performance. In order to realize carbon neutrality (CN) by 2050, it has become essential to promote retrofitting to improve the energy saving performance of existing condominiums mainly focused on thermal insulation retrofitting.

Condominiums are usually systematically repaired on a large scale after about 10 to 15 years, and it is effective and realistic to use this opportunity to perform energy saving retrofitting. However, according to the condominium comprehensive survey in 2018, of the condominiums recently subjected to large-scale repair works, those which underwent energy saving retrofitting were only 2.8% of the total, thus being in a situation in which the opportunities of energy saving performance improvement and CO_2 reduction were missed.

Photo Example of external thermal insulation retrofitting of a condominium

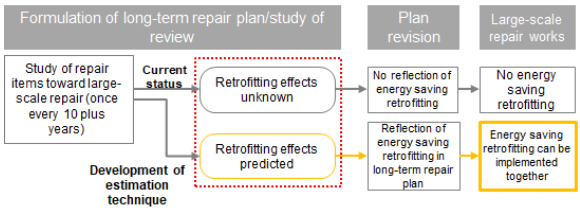


Fig.-3 Systematic implementation process of energy saving retrofitting (illustration)

Therefore, with a view to develop the quantification techniques for the effects of energy saving performance improvement retrofitting of existing condominiums, we are engaged in research concerning the quantification of retrofitting effects for the improvement of energy saving performance in existing condominiums (FY 2023 - FY 2025). At the same time that we develop a tool to estimate the cost-effectiveness by means of energy saving retrofitting, we are creating guides for positioning energy saving retrofitting in a long-term repair plan. We plan to reflect those tools and guides in the "Manual Concerning Condominium Revitalization Techniques by Retrofitting" issued by the Ministry of Land, Infrastructure, Transport and Tourism.

3. Efforts toward the strengthening a housing safety net

There is very large demand for public housing that plays a central role in the housing safety net, but partly due to financial restrictions of the national government and local governments, the number of the existing public housing units being managed has been decreasing. On the other hand, the number of vacant homes for rent in the private sector has been increasing, accounting for a majority of the total number of vacant homes. Also, there is some deviation in the demand for housing SN, depending on the municipality, but at present the demand is estimated just in the entire area of the prefecture.

In an effort to develop techniques to utilize the stock of private rental housing and to strategically set a target for the amount of public housing supply we are engaged in cooperative efforts with the housing sector and are developing techniques to estimate the demand for housing SN according to each living sphere and each municipality. We are proactively engaging in research on how to best set techniques for the target amount of supply of public housing while taking into consideration the utilization of the stock of private rental housing (FY 2024 to FY 2026).

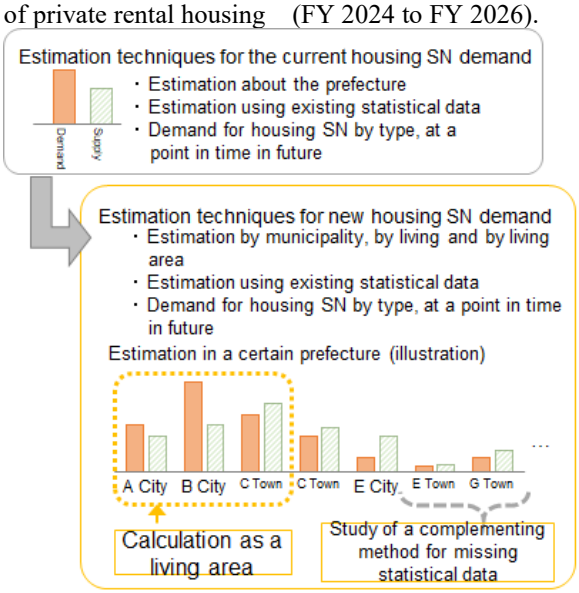


Fig.-4 Illustration of estimation techniques for housing SN demand by living area

4. Conclusion

The Housing Department would like to make efforts in the improvement of living comfort such as energy saving performance of housing/buildings and the strengthening of a housing safety net, through stock management of housing and buildings, in future as well.

Toward the Promotion of Comprehensive Earthquake Fire Measures in Both Hardware and Software Aspects in Densely Built-up Areas

KATSUMATA Wataru (Ph. D.), Director, Urban Planning Department

(Key words) densely built-up area, earthquake fire, evaluation index, hardware measures, software measures

1. Introduction

January 2025 marks the 30th anniversary of the Great Hanshin-Awaji Earthquake (1995 Southern Hyogo Prefecture Earthquake) and the first anniversary of the 2024 Noto Peninsula Earthquake. The Urban Planning Department has been continually engaged in the research and development of earthquake disaster management measures after the occurrence of the Great Hanshin-Awaji Earthquake, with a focus on city area fire safety measures for densely built-up areas. [1),2)]

2. Target areas of improvement of the national government for densely built-up areas

According to the Basic Housing Policy (National Plan) adopted by a Cabinet decision in March 2021, targets are set out to eliminate densely built-up areas that are significantly hazardous during an earthquake (hazardous densely built-up areas) (2020: about 2,200 ha in area → 2030: nearly eliminated) and the strengthening of software measures that contribute to the improvement of regional disaster management capabilities in line with such elimination (2020: implementation rate about 46% → 2025: 100%).

The hazardous densely built-up areas designation is based on the "assumed average burn loss rate" that is a fire spread hazard index and the "in-district blockage degree" that is an evacuation difficulty index. The areas are deemed to have been eliminated when the index values have decreased to below certain reference values as a result of development and improvements in terms of hardware in the district.

The improvements of roads and parks and rebuilding using non-combustible materials have been made by local governments, and steady progress has been made toward the elimination of hazardous densely built-up areas (area as of March 2023: 1,662 ha). However, there remain many hazardous densely built-up areas in the Kansai region particularly in historic city areas, and in Yokohama City, Nagasaki City where many buildings are built on slopes. Ensuring safety in these regions is a challenge.

3. Major efforts heretofore in the Urban Planning Department

The Urban Planning Department continues to be engaged in research and development concerning "fire safety evaluation techniques" and "improvement promotion measures" in densely built-up areas, to promote city area fire safety measures in densely built-up areas.

One example of the former is the development of the "city area fire simulation program"[3)]. In a three-dimensional city area model, the status of the spread of fire from any fire occurrence point can be estimated, while considering the fire protection performance, position, and opening performance in each building. By comparing multiple options, it is possible to conduct a study of effective measures for the district (Fig.-1).

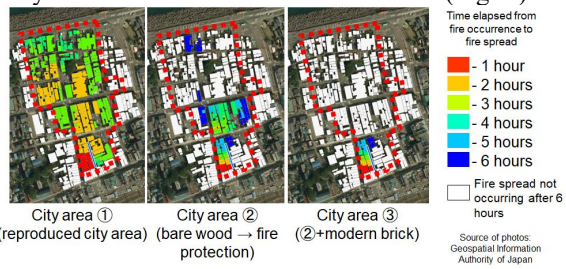


Fig.-1 Application of a city area fire simulation program to areas damaged by a large-scale fire in Itoigawa City

A representative example of the latter is the publication of the "Guidebook on Special Permissions in the Zoning Code under the Building Standards Law to Promote Rebuilding in Densely Built-Up Areas."[4)] In densely built-up areas, there are many cases in which it is difficult to comply with the Zoning Code under the Building Standards Law (setback provisions, height restrictions for buildings facing a road, restrictions on the building coverage ratio), and rebuilding is disabled. This is a guidebook for rebuilding that utilizes special permission techniques (town making guiding techniques) in which building regulations is replaced or mitigated, which is utilized by many local governments and town making consultants.

4. Challenges of the Wajima fire due to the 2024 Noto Peninsula Earthquake

In the 2024 Noto Peninsula Earthquake, more than 200 buildings were destroyed by the fire that spread in Kawai Town, Wajima City, becoming the first wide area fire following an earthquake since the Great Hanshin-Awaji Earthquake in which more than 7,000 buildings were destroyed by fire. The NILIM conducted an onsite survey jointly with the Building Research Institute (photo), and publicized preliminary reports[5)] of the results that analyzed the districts destroyed by fire, reasons the fire stopped, and the status of the spread of sparks in January and October 2024.

Photo Fire around the morning market street in Kawai Town, Wajima City

Staff from the Urban Planning Department also participated in the "Study meeting concerning how firefighting and disaster management measures ought to be based on the Wajima City large-scale fire" held by the Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications and the Housing Bureau of the Ministry of Land, Infrastructure, Transport and Tourism. In the report (July 2024), proposals were made about firefighting and disaster management measures in future. Regarding the firefighting systems, proposals were made about the possibility of introducing drones for early detection of fire, installing cameras for elevated photography, installing seismic water tanks, and enhancing firefighting brigades. Regarding fire safety measures, proposals were made about preventive measures to prevent furniture tip-over, the installation of fire alarms for housing and earthquake-sensing circuit breakers. Regarding town development, proposals were made about hardware measures such as the promotion of the development and improvement of densely built-up areas and seismic measures for buildings, as well as software measures that contribute to the improvement of regional disaster management capabilities of residents.

5. Technical development by the implementation of the "densely built-up area comprehensive project"

The Urban Planning Department is engaged in the MLIT comprehensive technical development project "Development of effective earthquake disaster management and mitigation technologies for existing city areas using new technologies" (densely built-up area comprehensive project, FY 2023 to FY 2026)[6], with the details that exactly match the proposals made in the aforesaid "Study meeting concerning how firefighting and disaster management measures ought to be based on the Wajima City large-scale fire."

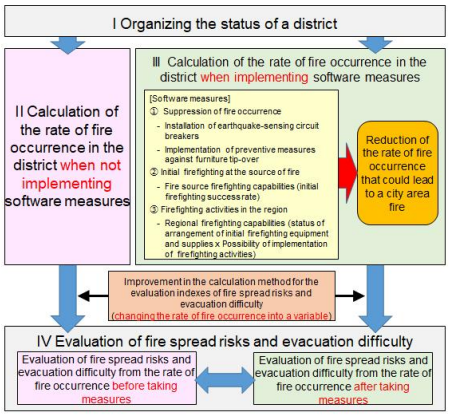


Fig.-2 Quantitative evaluation method for the effects of software measure currently being studied in the densely built-up area comprehensive project

The current evaluation indexes of hazardous densely built-up areas (assumed average burn loss rate, in-district blockage degree) only reflect the effects of hardware measures. The indexes fail to anticipate the effects of software measures such as the prevention of fire occurrence due to the installation of earthquake-sensing circuit breakers and initial firefighting with fire extinguishers and standpipes by local residents. Thus, they cannot evaluate the safety of densely built-up areas appropriately. Therefore, we are engaged in the development of evaluation techniques for comprehensive disaster management performance that reflect the effects of both hardware and software measures, by focusing on the effects of reduction of the fire occurrence rate of a district by the implementation of software measures, and by evaluating the effects of improvement in fire spread risks and evacuation difficulty from the rate of fire occurrence after taking the software measures (Fig.-2).

Furthermore, we are conducting studies of systems that early detect a fire or a place of building collapse, by utilizing new technologies such as drones, cameras for elevated photography, interlocking fire alarms, and SNS, and make such information widely known among local residents and the fire department, thereby facilitating early firefighting and early evaluation, and of evaluation techniques for the effects of safety improvement by means of such systems (Fig.-3).

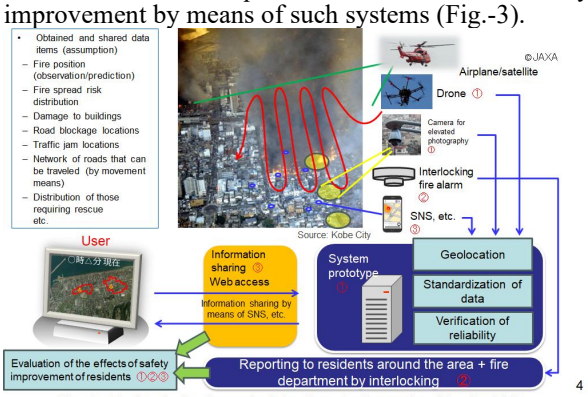


Fig.-3 Technologies for early detection of a fire and making it widely known by utilizing new technologies currently being studied in the densely built-up area comprehensive project

6. Conclusion

In a situation such as that in which the probability of a Nankai Trough mega earthquake occurring within the next 30 years is estimated to be "around 80%," earthquake disaster management measures are an urgent problem in Japan. The Urban Planning Department would like to continually be engaged in research and development in future, that contribute to earthquake disaster management measures as well as to the disaster management measures and targets of the national government.

☞For more detailed information, visit:

1) FY 2024 NILIM Lecture Meeting Panel Discussion I, "Efforts for Earthquake Disaster Management Measures for Housing and Communities" material
https://www.nilim.go.jp/lab/bbg/kouenkai/kouenkai2024/koen2024/pdf/2_2bu-panel_discussion.pdf
2) 20 Years of NILIM History "Improvement of safety in densely built-up areas"
https://www.nilim.go.jp/lab/bbg/20nenshi/pdf/109.pdf
3) City area fire simulation program
https://www.nilim.go.jp/lab/jdg/program.html
4) Technical Note of NILIM No. 1076 "Guidebook on Special Permissions in the Zoning Code under the Building Standards Law to Promote Rebuilding in Densely Built-Up Areas [Revised version, June 2019]"
https://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1076.htm
5) Technical Note of NILIM No. 1296 "Quick Report of the Field Survey on the Building Damage by The 2024 Noto Peninsula Earthquake"
https://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1296.htm
6) MLIT comprehensive technical development project "Development of effective earthquake disaster management and mitigation technologies for existing city areas using new technologies"
https://www.nilim.go.jp/lab/jbg/missyuu.html

Trend of the Times and Reform of Construction Production and Management Systems

YASUHARA Tatsushi, Director, Research Center for Infrastructure Management

(Key words) construction production management/management system, data-driven, green, decarbonization, green infrastructure

1. Introduction

I have had the opportunity to be engaged in management research again after twenty-plus years since the time when I worked for the Research Center for Construction Management Technology, and I feel that now is the critical time for achieving reform of construction production management systems without falling behind the trend of the times. We also face many challenges in order to carry out built-in efforts for green (G) such ad decarbonization, by overcoming the "2025 Digital Cliff" through work style reform by means of DX (D) such as i-Construction. This paper describes efforts toward reform of construction production/management systems.

2. Reform toward data-driven (D)

Regarding the efforts of i-Construction such as BIM/CIM or ICT construction, our Center visited a model office together with Committee Member Ozawa of the BIM/CIM Promotion Committee, and grasped the challenges. The efforts of BIM/CIM in the model office are roughly classified into efforts in which a digital twin called the project management tool is built and information on the project is visualized and shared by being tied to a three-dimensional model, and efforts in which information on structures that form the basis for asset management is built by means of a three-dimensional model. A great challenge at present would be the utilization of the three-dimensional model that is consistent from design through construction to maintenance and management in the latter efforts. Of these, regarding the delivery from design to construction under the condition of separation of design and construction, we consider that it is essential to thoroughly make design with little risks, while sufficiently examining the method of construction through investigation and consultation or by obtaining technical proposals by the ECI method at the design stage. After that, in the current situation, transmission of information such as that between the order receiver and the orderer, etc. concerning design, etc. is performed in two-dimensional forms such as drawings and discussion documents. Therefore, various types of data that are not conveyed by these forms are handled as additional work with the rules for handling the data remaining unclear, which has become the factor that will not lead to effective utilization of data or work improvement. Concerning these, it is necessary to make rules on the data creation, sharing, processing, approval, utilization, renewal, and discarding, and to review the work of both the order receiver and orderer so that the work will be based on data, including the review of document based contracts. In the "Discussion Meeting on How the Construction Production and Management System Ought to Be in Future to Fulfill the Responsibility of an Orderer" in December last year, a concept of data management is shown that refers to ISO 19650 concerning information modeling of a construction life cycle. Herein, it is stated to aim at achieving advanced project management by saving labor for data management and data-driven approaches and at speedup of decision making of the order receiver and orderer and relevant parties, by storing and sharing a three-dimensional model and QSCDE information (Quality, Cost, Delivery, Safety, and Environment) by means of a project CDE (Common Data

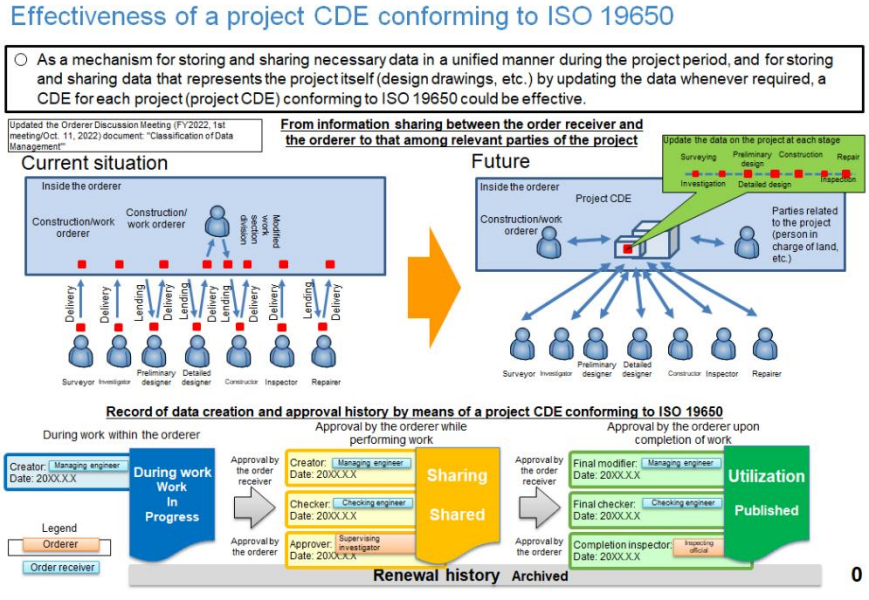


Figure-1 Illustration of data sharing by means of a project CDE

Environment). If this is realized, information on completed construction and its background, etc. that have been accumulated in the project CDE can be transferred to maintenance and management. Furthermore, by utilizing the data accumulated in the project CDE, supervision and inspection, completed construction management, design change and work unit survey, etc. that are performed via forms and human power may also be capable of being rationalized by data analysis.

Our Center plans to make efforts in research and development concerning data and information infrastructures, provision of consultative support for the site, human resource development, and others, toward the reform into the data-driven construction production and management systems such as those described above.

3. Response to green (G)

In COP28, "The Green Public Procurement Statement of Intent" was formulated, and the intention was expressed to require use of life cycle assessment in all the public construction projects. Also, in the international investment markets, GX-related investments are heating up, which realizes both greenhouse gas emissions reduction and economic growth. In realizing Japan's goal of reducing greenhouse gas emissions to zero as a whole by 2050, markets must be vitalized by Japan's GX products and services and they must be utilized appropriately in the construction production and management systems. To do so, an environment is necessary in which the greenhouse gas emissions reduction amounts by the GX products and services can be evaluated appropriately.

Our Center has formulated, as a (draft) manual in FY2023, methods for calculating the greenhouse gas emissions reduction amounts, using the construction cost estimation data for the activity amount of each of the construction supplies, materials and equipment that are required for calculation, and multiplying the data by the emission intensity. (See the featured article.)

Hereafter, in order to manage the calculation of greenhouse gas emissions reduction amounts based on the manual, the following will be necessary, and therefore their study is being conducted. (1) Improvement of the emission intensity of the standard supplies, materials and equipment, (2) Devising the rules to evaluate the emission intensity of GX products and services, (3) Organizing the handling of supplies, materials and equipment for which it is difficult to convert the estimation data to the activity amount, (4) Organizing systems for calculating emissions amounts by linking the estimation data with the activity amount and the emission intensity. In addition to this, in order to adopt GX products and services, evaluation criteria will be required for how to evaluate the greenhouse gas emissions reduction amounts as Value for Money, and so the criteria are also being studied.

As another trend concerning green (G), Nature Positive can be mentioned. The Ministry of Land, Infrastructure, Transport and Tourism has devised the Green Infrastructure Promotion Strategy 2023, stating that a "society living in harmony with nature" will be aimed at. In order to make good use of the effects of disaster preparedness and disaster mitigation as well as well-being, etc. of Green Infrastructure including natural environments, biodiversity, greening, and others, an information infrastructure will be required, in which the statuses of growth of a variety of animals and plants as well as biodiversity can be grasped and their effects can be evaluated.

Our Center would like to proceed with research and development, toward the establishment of biodiversity observation and evaluation techniques in which sensor and digital technologies, etc. that are significantly being advanced will be put into application.

4. Conclusion

In order to secure infrastructure investments in future as well, construction production and management systems must be reformed and maintained, in line with the trend of the times surrounding Japan. We would like to proceed with efforts toward the realization of such reform.

☞For more detailed information, visit:

1) Website of the Discussion Meeting on How the Construction Production and Management System Ought to Be in Future to Fulfill the Responsibility of an Orderer

https://www.nilim.go.jp/lab/peg/13yuusikisya.html

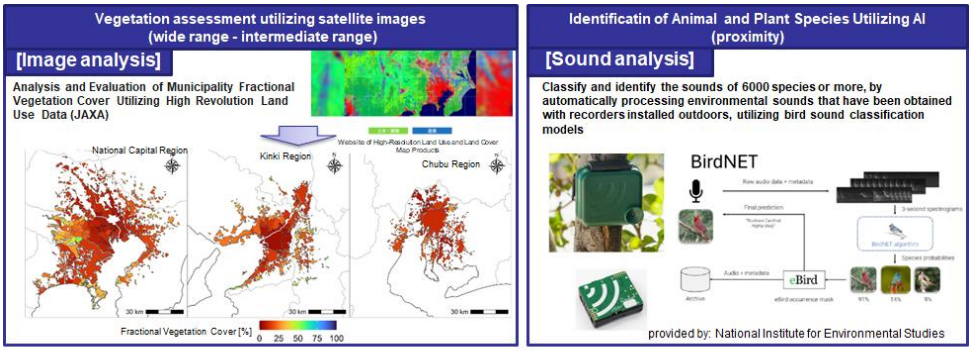


Figure-2 Illustration of the observation and evaluation techniques for biodiversity

Development of River Embankment Structure Highly Resistant to Overtopping under Public Private Partnership

(Research period: FY2023 ~ FY2025)

MIYOSHI Tomohiro, Senior Researcher　　FUKUOKA Chiaki, Researcher
KONO Tsutomu, Visiting Researcher　　MATSUO Takaki, Visiting Researcher
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(keywords) highly resistant river embankment, overtopping, reliability

1. Introduction

Most of the embankments have been made of earth due to the construction cost being relatively inexpensive as well as the fact that the construction material can be obtained easily. Also, it has a history of not deteriorating easily. However, embankments made of earth are vulnerable to overtopping.

Therefore, MLIT is developing a river embankment with a highly resistant structure (hereinafter referred to as “highly resistant river embankment”). It has damage mitigation qualities such as not easily collapsing or taking a longer time before collapsing even when it is overtopped. Considering the fact that it is technically difficult, at this this point in time , to keep embankments from not collapsing when it is overtopped (the 2008 report of Japan Society of Civil Engineers), our evaluation criteria for technical development is to extend the time to collapse as long as possible even when there is overtopping for 3 hours with an overflow water depth of 30cm.

In this article, I will introduce the history of technical developments until now and an overview of research for a method to efficiently ensure reliability for the highly resistant river embankment that NILIM is currently working on.

2. Development of river embankment structure highly resistant to overtopping

(1) Development of highly resistant river embankment by NILIM

So far, we have implemented “risk management type hardware measures” paving the top-end or placing blocks at the bottom of the city-side slope, to reinforce embankments against overtopping in vulnerable areas along rivers all over Japan. The purpose is to delay scouring of slope bottoms and collapsing of top-ends that could potentially accelerate the process from the start of overtopping to embankment collapse. This measure has strengthened existing embankments at a relatively low cost. I will show the situation after overtopping at the place where the risk management type hardware measures have been taken in Photo-1.

We can confirm that no scouring of the slope bottom occurred, and top-end pavement worked as an overhang reducing erosion of the embankment. On the other hand, the city-side slope, which is only covered with vegetation, may be eroded once overflow water depth becomes greater and the speed of the flow increases. It may eventually collapse if overtopping continues for a long time.

Taking this into account, we have devised a highly resistant river embankment (Photo-2) (hereinafter referred to as “block structure”) The structure consists of covering the city-side slope of the embankment with soil draw-out retaining material and concrete blocks used for protecting the slope. The structural details have gone through repeated waterway experiments. The results of this research and development were summarized in technical documents (draft) [1)] and publicly disclosed. We have already made pilot works of this structure at around 14 places all over Japan and we keep monitoring changes after the works.

(2) Technical development of highly resistant river embankment through open call

MLIT made an open call for “technology for highly resistant river embankment” to overtopping to promote technical development from March 2025 to September 2025, in addition to the block structure on which NILIM made research and development.

Photo-1 Erosion of inner slope at the area where the risk management type hardware measures have been taken

Among the proposals made, there were those made by companies that had not worked on embankment technologies before, so it helped to expand embankment technologies. The technologies applied (16 proposals in total) were evaluated as 4 in category B, 1 in Category C and 11 in category D (refer to Table-1. The technologies applied and evaluated as Category B or higher may be used on-site.) Among these proposals, there were a lot of technologies referring to the technical documents (draft) [1)] that NILIM publicly disclosed, and there were certain technologies for which experiments were made renting the large-scale experimental waterway that NILIM had, so NILIM's research results and facilities were effectively used. In addition, there were some approaches to aid applicants' technical development such as arranging discussions between those who requested to meet with members of evaluation committee.

3. Research on methods to improve reliability

In the development of highly resistant river embankment structures, we have made it mandatory to verify the proposal with experiments, using actual scale models. Technologies that received high evaluations can be said to possess "laboratory-level reliability," meaning they function effectively under ideal conditions. The highly evaluated technologies are, as the next stage, adopted in on-site pilot works, where they are tested to determine whether they can perform sufficiently under on-site circumstances having uncertainty —in other words, whether they possess "field-level reliability."

Photo-2 Example of highly resistant river embankment

Table-1 Evaluation category

Evaluation category	① Not to damage the function of existing embankments		② If having a function against overtopping or not
	Safety at planned water height level or lower	Items to be reflected and considered in design	
Category A	Equivalent to earth embankment or more	Equivalent to earth embankment or more	Yes, it has
Category B	Equivalent to earth embankment or more	Though not regarded as equivalent to earth embankment, continuous technical development is expected having a room for improvement	Confirmed at experiment results, etc. (on-site uncertainty, etc. is yet to be confirmed)
Category C	Though not regarded as equivalent to earth embankment, continuous technical development is expected having a room for improvement	Though not regarded as equivalent to earth embankment, continuous technical development is expected having a room for improvement	Confirmed at experiment results, etc. (on-site uncertainty, etc. is yet to be confirmed)
Category D	Having some issues in technology	Having some issues in technology	Having some issues in technology

The on-site uncertainty to which we are referring here can be minor work defects, material's deterioration over time due to carelessness at work, un-uniformity of earth quality for embankment, changes, land subsidence that has been affected or wind and rainfall over time. However, in case of the on-site pilot works, though it is considered efficient to improve the structure based on flood experience repeatedly occurred at an affected areas such as reinforcement of river-side slope, it takes time to verify a low probability of overtopping function of the embankment so it is not efficient.

Consequently, we make verification using a hydraulic experiment, systematically summarizing the causal relationship between on-site uncertainty and destruction of embankment in drawing, and selecting on-site uncertainty, from that which is assumed to lead to embankment collapse. For example, in block structure, we "dig down" destruction modes attributed to various on-site uncertainties by making experiments setting such status as making unevenness under the block assuming the occurrence of gully erosion, due to a long period of rainfalls for initial status of the experiment (refer to Photo-3). With this, we can confirm that the highly resistant river embankment would be vulnerable to some kind of uncertainty, the damage mechanism at such time and the structure to overcome such vulnerability and things to take note of for the maintenance and management. These verifications are also made for technologies highly evaluated in the open call previously mentioned, obtaining cooperation from the applicants themselves. From the research results, we would like to identify risks that are difficult to find under ideal circumstances, and to publicly propose a process to improve reliability in making countermeasures.

Photo-3 Experiment image having gully erosion at embankment slope

☞ Detailed information is as follows.

1) Technical documents (draft) to study structure for highly resistant river embankment https://www.nilim.go.jp/lab/fbg/download/gijutsusiryo.pdf

2) On technical development for highly resistant river embankment Japanese Geotechnical Society report, March 2025

Study to Implement Coastline Monitoring Using Satellite Images

(Research period: FY2023 ~)
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(keywords) coastal erosion, monitoring, satellite image, climate change

1. Importance of coastline monitoring

To convert coastal conservation into measures explicitly considering the impact of climate change while following the past data, Basic Policy on Coastal Conservation based on the Coast Act was revised in November 2020.

The Basic Policy on Coastal Conservation states that it is necessary to study and identify long-term changes, etc. in external forces affected by climate change and to secure appropriate protection standard against disasters fully taking them into account, and as for measures against erosion, it states that it is necessary to identify the entire fluvial system and the change trend for neighboring sandy beach through continuous monitoring and to implement "adaptive sandy beach management focusing on prediction", implementing measures based on prediction of future change.

Though there is a limited knowledge on the change in sandy beach affected by climate change, according to the Bruun Rule[1)], there are certain predictions that the coastline may retreat by tens of meters or the sandy beach may disappear depending on such conditions as land shape, following the sea-level rise by around 40cm predicted in 2℃ rise scenario (Figure-1). In studying the protection standard, it is important to identify the impact of climate change by monitoring the sandy beach, as the cross-sectional shape of sandy beach is an assumption to set external forces.

In this article, we introduce NILIM's approach to implement a method to monitor the coastline using satellite images.

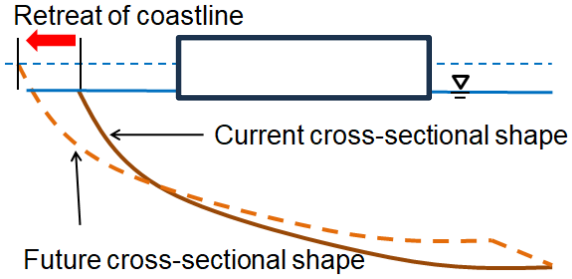


Figure-1 Image of coastline retreat affected by climate change based on the Bruun Rule[1)]

2. Coastline monitoring using satellite images

With the coastline monitoring using satellite images, it is difficult to identify the height or the shape of ocean floor, not like measurement. On the other hand, it has such benefits as being able to identify changes in coastline, going back to the past, as long as images are kept in the archive, and to confirm a wide range of coastline situation at one time, and being relatively inexpensive.

There are optical satellites (a satellite to observe natural synchrotron radiation and reflected light) having a resolution of 10m or more ~ around 50cm[2)], and it is possible to select them considering the objective and the cost, etc. (Figure-2). In addition, SAR satellites (a satellite to emit radio waves by itself and to observe its reflected waves) [2)] are effective to make observation at the time of disasters regardless of the time zone or the weather.

3. Trial of coastline monitoring

We created a tool to extract coastline from satellite images, and we made a verification whether we could capture changes of coastline over time selecting Shimizu Coast of Shizuoka Prefecture where a large-scale coastal erosion occurred when Typhoon No. 19 passed on October 12, 2019, as monitoring subject.

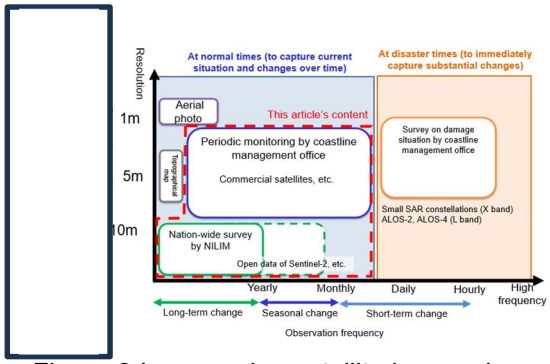


Figure-2 Image using satellite images in coastline monitoring. So far, the long-term change in coastline has been captured through topographical maps.

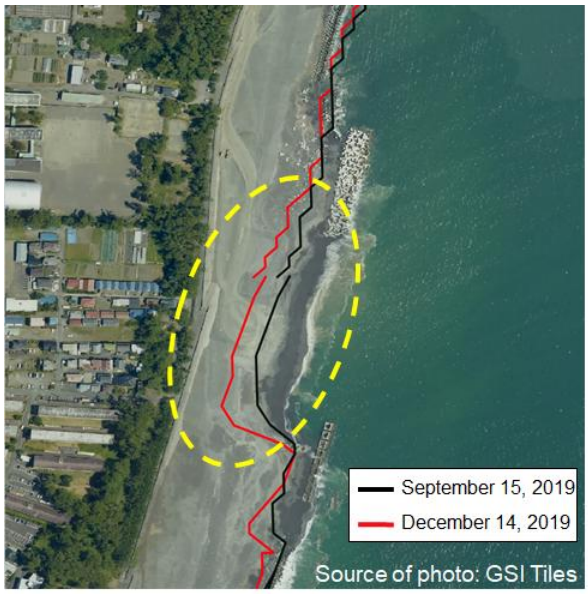
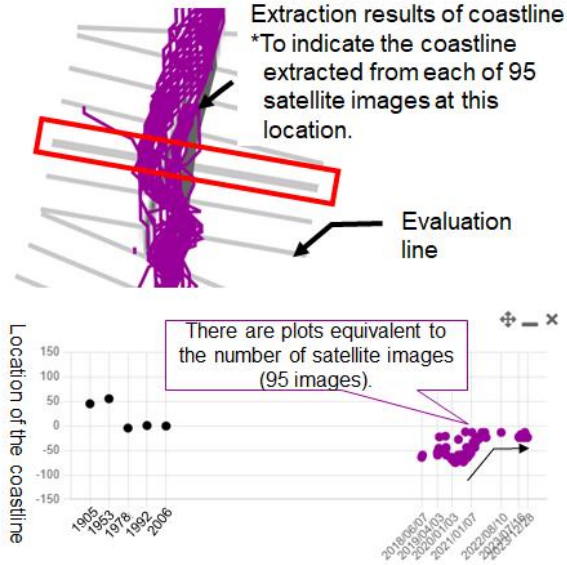


Figure-3 Extraction results of coastline from satellite images taken before and after large-scale coastline erosion caused by the typhoon having passed in October. The actual erosion was identified in the area circled in yellow after the typhoon.



Period (left) period to have prepared topographic map, (right) period to have taken satellite images)

Figure-4 Indication example of the website providing coastline monitoring results. The upper figure shows the extracted result of coastline (purple) and the evaluation lines (gray) to see changes in coastline and the lower figure shows changes over time in the location of coastline at a certain evaluation line (result of interpreting topographical map (black dots) and extracted results from satellite images (purple dots).

As a result of having tried to extract the coastline from the images from Sentinel (optical satellite having resolution of around 10m publicly disclosed) before and after the passing of the typhoon (September and December), we confirmed that the coastline extracted from the images in December after the damage retreated from the one in September (Figure-3) and that changes in coastline had been captured.

4. Website providing coastline monitoring results

We created a website for coastline management offices to verify changes in coastline by summarizing coastlines extracted from satellite images. In the website, we made it possible to indicate changes over time of the coastline extracted from the topographical map on evaluation lines vertically set along the coastline or from satellite images in addition to the coastline extracted from satellite images.

If we look at Shimizu Coast previously mentioned (Figure-4), we could largely identify the trend of changes in coastline, though we have not made such corrections as tide level and could confirm the fact that the coastline had been advancing since 2020.

5. Future issues

The current coastline extraction tool has such issues as misrecognizing offshore facilities, etc. with the coastline, so it is necessary to improve the accuracy to extract coastlines.

In addition, even if we convert satellite images into high resolution images, we still have such issues that the accuracy for coastline would not improve compared to the measurement results. We believe the reason is attributed to tide level and waves going upstream, etc. and we will study the analysis method for coastline monitoring results taking those factors into account.

Moreover, we will promote data accumulation to identify erosion history of coastlines, view exchanges with coastline management offices and study on the operating method for the website so that the tool can be practically used.

References

1) Bruun, P. (1962) “Sea-level rise as a cause of shore erosion,” J. Waterways Harbors Div. 88, 117–130
2) JAXA / MLIT (2018) “Guidebook for using artificial satellites at the time of disasters, water disaster version, basic volume for satellites”

☞ Detailed information is as follows.

1) To prevent loss of sandy beaches due to sea level rise keeping an eye on coasts from satellites (NILIM report 2023)
https://www.nilim.go.jp/lab/bcg/siryou/2023report/ar2023hp018.pdf

Study on Impact on Water Resources by Climate Change

(Research period: FY2020 ~)
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(keywords) climate change, water resources, drought, Honshu area d4PDF downscaling data, bias correction

1. Introduction

There are concerns over impact on water resources due to increase in no-raining days, increase in evapotranspiration and decrease in snow accumulation caused by climate change.

On the other hand, there are also concerns over uncertainty with the prediction of impact on water resources caused by climate change. In the proposal made by Research and Planning Working Group, Water Resources Development Subcommittee in National Land Council in October 2023, it is stated that there is still substantial uncertainty with the prediction, and it has not reached such level of accuracy as making a quantitative evaluation to be reflected in planning.

Taking such circumstances into account, we assumed that it would be important to provide society with objective evidence based on macro-analysis considering the importance of water resources, even if there is substantial uncertainty with the current accuracy in determining practical plans. Therefore, we calculated changes in occurrence frequency for low-rainfall years with non-exceedance probability of one tenth caused by climate change, for 96 first-class water systems covered by the Honshu area d4PDF downscaling data out of 109 first-class water systems in Japan. Moreover, we calculated changes in occurrence frequency for droughty water-discharges with non-exceedance probability of one tenth, creating flow analysis model for each water system and verifying its reproducibility.

2. Calculation method

We show the calculation flow in Figure-1 and the conceptual diagram of flow analysis model in Figure-2. As shown in Figure-1, we made bias corrections on the Honshu area d4PDF downscaling data using Dual-Window method and then inputted them in flow analysis model. As shown in Figure-2, the flow analysis model is created as tank type flow analysis model (4 layers) and is made into plane division per each flow observation location. In addition, we make the rainfall and the temperature as input values expressing snow accumulation / snow melting, water supply and evapotranspiration in the calculation process, and make the flow volume as output value.

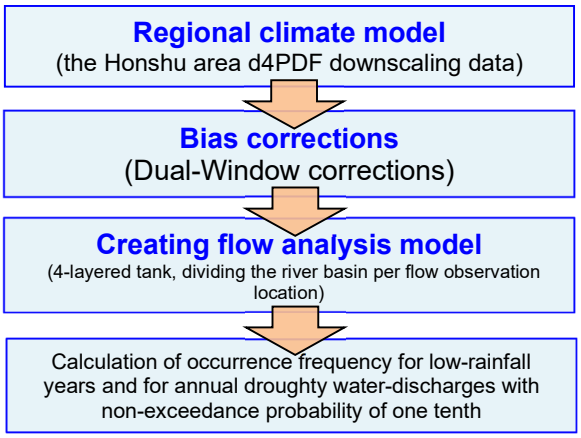

Figure-1 Calculation flow

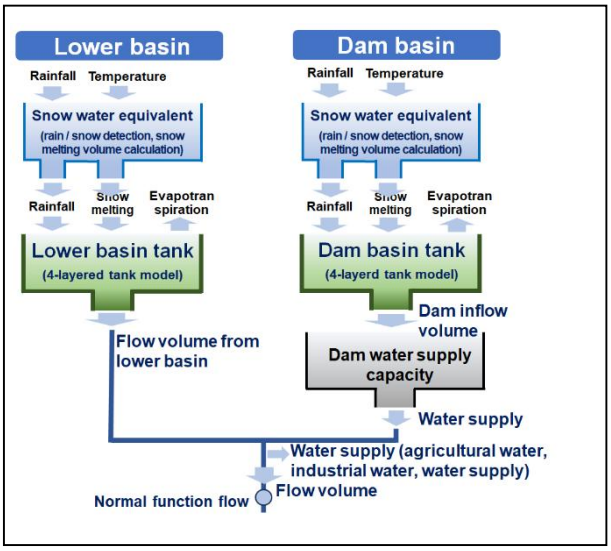

Figure-2 Conceptual diagram of flow analysis model [1)]

3. Calculation results and considerations

To evaluate the impact to water resources caused by climate change, we calculated to what extent the occurrence frequency for low-rainfall years and for droughty water-discharges having the probability level of once in 10 years would increase, which was the criteria for safety level of water use. We show the calculation results in Figure-3.

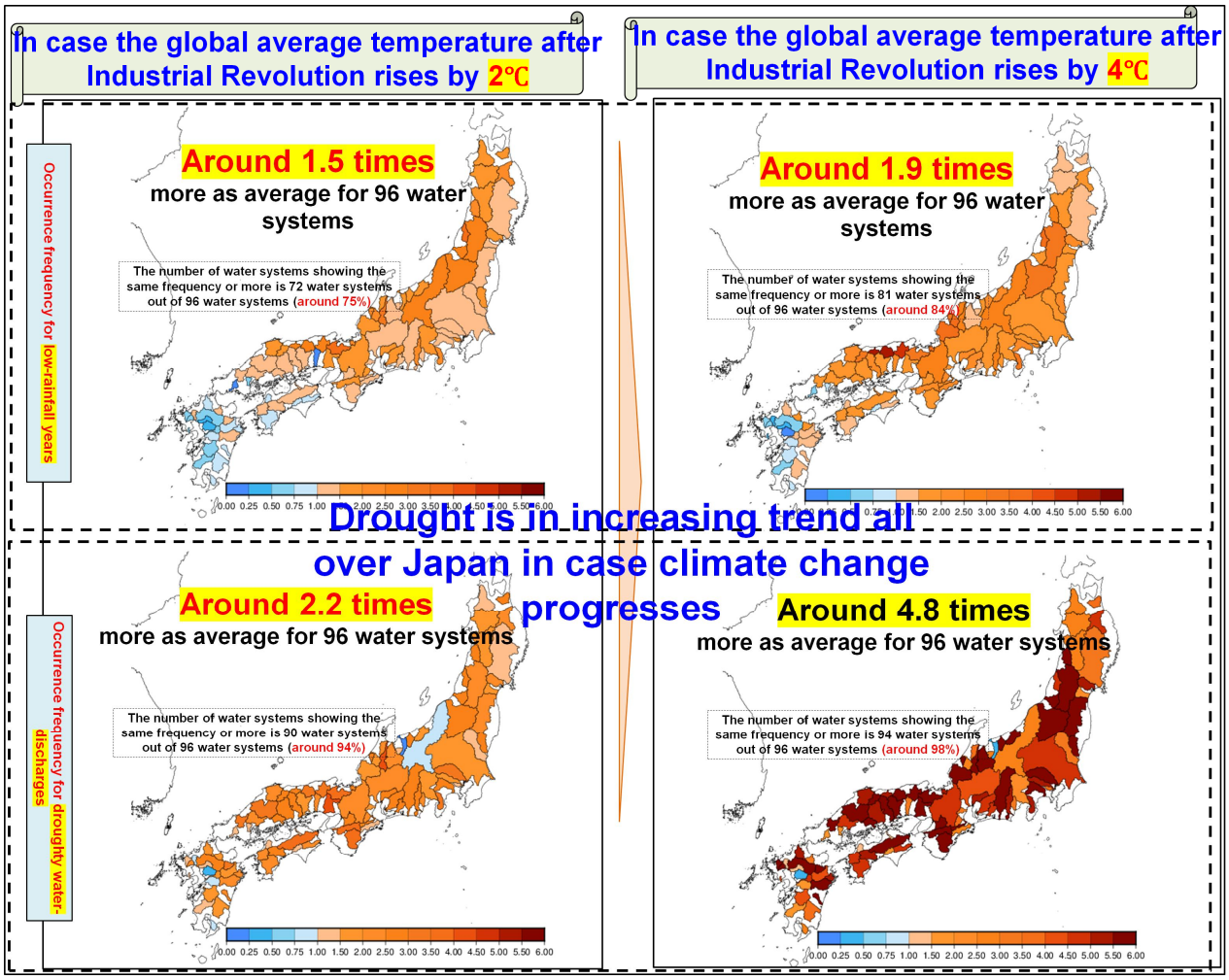

Figure-3 Changes in the occurrence frequency for low-rainfall years and for droughty water-discharges with non-exceedance probability of one tenth caused by climate change [1) 2)]

As a result, the occurrence frequency for low-rainfall years has risen by 1.5 times in case the temperature rises by 2℃ and by 1.9 times in case of 4℃, and the occurrence frequency for droughty water-discharges has risen by 2.2 time at 2℃, by 4.8 times at 4℃.

These results show that the occurrence frequency for low-rainfall years and droughty water-discharges increases in wide areas, having the probability scale for safety level of water use, caused by climate change, and that it is important evidence to indicate a necessity to reduce greenhouse gas emissions as mitigation measure.

On the other hand, even if we can reduce the temperature rise to 2℃, which is the goal of the Paris Agreement, the occurrence frequency will rise to some extent, therefore, we believe it is important evidence to indicate a necessity to promote adaptation measures, in parallel with mitigation measures.

3. Future prospects

In future, we believe it is important to present understandable indicators and goals including the reduction in water supply that may offset the impact of climate change as additional evaluation, and we would like to continuously evaluate the impact of climate change.

☞Detailed information is as follows.

1) NISHIMURA Sorin, TAKADA Nozomu, SAKAI Daisaku, MIZUGAKI Shigeru, TAKESHITA Tetsuya: Calculation of changes in the occurrence frequency for droughty water-discharges with non-exceedance probability of one tenth caused by climate change, collected papers of river technologies, Volume No. 30, pp. 363-368, 2024.

2) NISHIMURA Sorin, TAKADA Nozomu, SAKAMOTO Koji, KOIKE Katsuyuki, KOSHIDA Tomoki, TAKESHITA Tetsuya: Calculation of changes in the occurrence frequency for low-rainfall years with non-exceedance probability of one tenth caused by climate change, collected papers of river technologies, Volume No. 29, pp. 551-556, 2023.

Research on Hazard Characterization Analysis Contributing to Disaster Mitigation Measures Using Hazard Indicators Evident in Flood Scenario

(Research period: FY2021 ~ FY2023)

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TAKEUCHI Yoshinori, Head
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(keywords) hazard information by flood scenario, disaster mitigation measure, river basin water management

1. Research's background and objective

While water related disasters frequently occur all over Japan due to more frequent and heavier rainfalls affected by climate change, MLIT ensures that the river basin water management has been implemented at each location nationwide and that disaster mitigation measures are being taken. However, to accelerate progress in disaster prevention it is necessary to further study disaster mitigation measures based on the current water disaster hazard characteristics and to quantify its effects. We have hazard maps for floods[1)] that are sufficient for identifying the current hazard distribution of flood depth and flood range when maximum predicted scale as well as anticipated scale of rainfall occurs. However, as it is a summary of flood analysis results based on various flood averages, we cannot identify the worst case scenario for a given area, identifying the level of a flood's flow strength. Therefore, we believe it is necessary for on-site offices to manage rivers with accurate information and technologies that have been proven over time. Incorporating such knowledge, both quantitatively and logically, together with technologies and interpreting them in an understandable way is the key to initiating effective disaster mitigation measures in cooperation with regions and local governments.

To that end, this research's objective is to calculate hazard indicators by researching flood scenarios and to present ideas for disaster mitigation measures using such indicators.

2. Calculation method for hazard indicators by flood scenario

In this research, we established various flood scenarios for a certain model area (around 30km^2) and identified the maximum flood depth, the maximum flow speed and the flood level-up speed from the calculation results by flood scenario and analyzed hazard characteristics for inner water and flood water in the model area. In addition, for the flood scenario established, we selected a typical flood waveform for rainfalls experienced in the model area. For the collapse sections of embankment, we selected several places at the upstream side and the downstream side of the main river and the tributary, respectively in the model area so that we could cover various flood patterns likely to occur in the affected area. Also, we made a calculation using the method conforming to the flood analysis used to prepare flood hazard maps, etc.[1)] as detailed conditions for the calculation.

3. Comparing hazard indicator distribution among flood scenarios and identifying hazard characteristics by distributing them according to land use

1) Characteristics analysis using hazard indicators by flood scenario

We show an example of a series of calculation results in Figure-1.

From Figure-1 (a) ~ (d), based on the flood scenario with the main river, we have the range where the flood depth is 0.6m or more and the flow speed is 0.5m/s or more (conditions in which it is difficult for adults to have safe evacuation). If the collapse occurs on the upstream side, the impact is greater if it expands to the area that has essential regional functions such as the main station and the city hall. However, if the collapse occurs at the downstream side, the flood does not have substantial impact on the area having the main station and the city hall, etc. though some areas will have high flood depth and high flow speed.

On the other hand, from Figure-1 (e) ~ (h), in case of such scenarios where there is collapse in the tributary or overtopping only in the tributary, there is no area with flood depth of 0.6m or more and flow speed of 0.5m/s or more, as the flood damage is smaller compared to the case where collapse or overtopping occurs in the main river.

Also, we can see that the flood depth in the area surrounded by the main river and the tributary A is 1.0m or more in all the scenarios assumed.

2) Hazard characteristics analysis based on hazard indicator distribution by flood scenario and land use distribution

By overlapping the hazard distribution characteristics studied in 1) with the land use situation, we can divide the model area into sub-divided small areas as shown in Figure-2.

・Area A: An area where there are a lot of buildings including residential lands. In all the scenarios assumed,

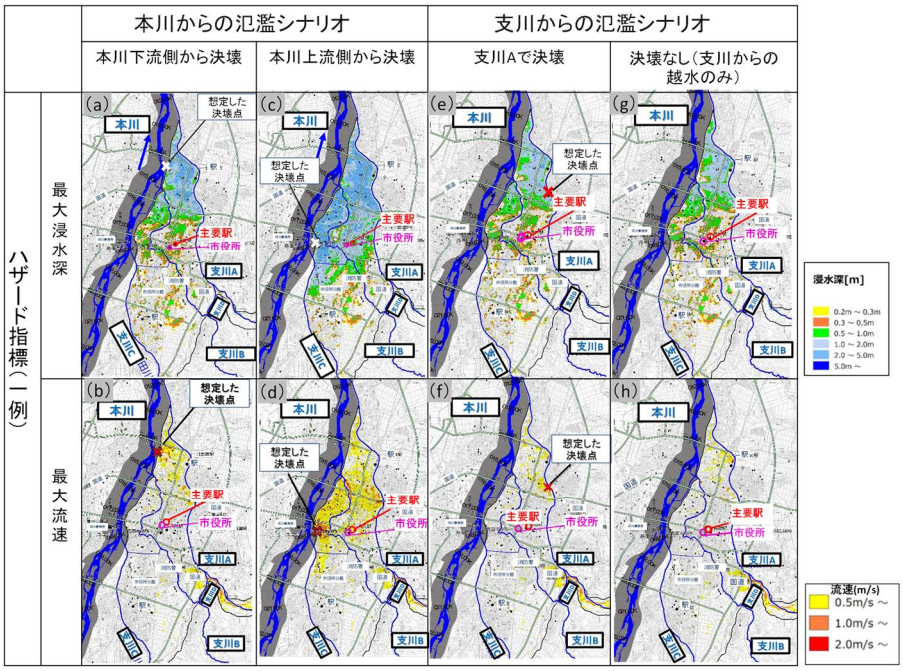

Figure-1 Hazard distribution by flood scenario

the flood depth would reach 1.0m or more and in case the main river collapses, it would be difficult to ensure safe evacuation no matter where the collapse occurs.

・Area B: An area having such essential regional functions as the main station and the city hall. In case the collapse occurs at the upstream side of the main river, the flood depth would be high, and it is difficult to ensure safe evacuation.

・Area C: An area where there are a lot of buildings including residential lands. In case the collapse occurs at the upstream side of the main river, it is difficult to ensure safe evacuation.

・Area D: The upstream area has a lot of agricultural lands and forests. There is no noticeable impact in all the projected scenarios.

From the above analysis, for the model area, we can study disaster mitigation measures to reduce high flood depth and high flow speed which may occur in areas A ~ C in case the collapse occurs at the upstream side of the main river, and disaster mitigation measures to prevent flood in Area A which would occur in all the scenarios.

In this way, by overlapping various hazard distribution and land use distribution, it is possible to identify in which area, under which flood scenario, what kind of vulnerabilities there are , and we believe we can obtain base information to study disaster mitigation measures.

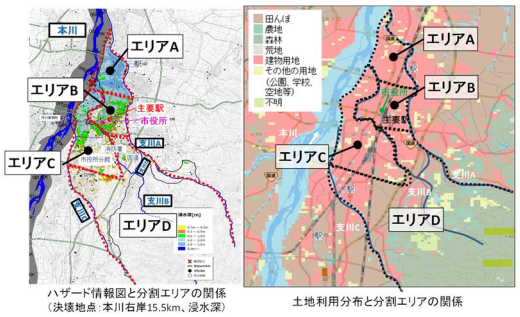

Figure-2 The land use distribution in the model area and sub-divided areas

4. Future prospects

In the future, we will study a method to establish reasonable flood scenarios that would merit nation-wide deployment of this research.

☞Detailed information is as follows.

1) Guidelines on study and preparation of multi-layered flood assumption map and water damage risk map (January 2023)
https://www.mlit.go.jp/river/shishin_guideline/pdf/guideline_kouzuishinsui_2301.pdf

Community Living Together with a River: Collaboration Between Residents of Osato-cho, Miyagi Prefecture and Our Regional Office.
A Story of Evacuation from Water Damage due to East Japan Typhoon and Reconstruction

(Research period: FY2024 ~ FY2025)
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TAKEUCHI Yoshinori, Head
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(keywords) river basin water management, East Japan Typhoon, dialogue and collaboration

1. Undulating embankment

> Was it on Saturday? At that time, many young guys, I was also still in my 30's. Well, a bunch of people. Fire fighters and senior people, in short everyone, all men were putting up sandbags to prevent the embankment from collapsing in our area. The same as everyone, I still remember, the embankment was undulating! There was massive pressure. That was so scary! We all put up sandbags, saying that it would be OK if there is no overtopping, we needed to stop water leakage, never letting water pass through. (Mr. A, Osato-cho)

The above is a story of a resident of Nakakasukawa district, Osato-cho, Kurokawa gun, Miyagi Prefecture on the water damage in August 1986. The Nakakasukawa district is adjacent to Yoshida River, in Naruse River water system, flowing in the middle of Miyagi Prefecture. Typhoon No. 10 that approached East Japan in the beginning of August 1986 caused substantial damage to various regions including Miyagi Prefecture.

From those few lines of narration, we can get a picture of many things other than the undulating embankment. For example, around 40 years ago, many residents joined flood prevention activities. Mr. B, Osato-cho, mentioned that it was difficult to join the fire department at that time even though he wanted to. Currently, this district faces a shortage in fire department members. This narration sheds light on the changes of the times. Also, flood prevention activities were an event that all men in the district joined, led by the fire department, and as shown in the expression "in our area", it was an opportunity to remind them of their commitment to the area they called home. It was, at the same time, an opportunity for young residents to learn from senior residents' local knowledge, that is, "it would be OK if there is no overtopping".

Photo-1 Nakakasukawa district just after the collapse (provided by Geospatial Information Authority of Japan)

2. Looking for key points on collaboration for river basin water management

The embankment of that Yoshida River collapsed in Nakakasukawa district due to the water damage caused by Typhoon No. 19 in 2019 (East Japan Typhoon). The overlapping was observed in the early morning of October 13, and the collapse occurred around 7:50 A.M.

I, the writer, have continuously conducted interviews with residents of this district and of Kashimadai district of Osaki city since the summer of 2024. In this article, I will make an interim report based on the survey results. I have 2 objectives for this research. The 1st one is to look for key points of collaboration for river basin water management by carefully interpreting water disaster and the reconstruction experience of residents along the river basin. Yoshida River (and Naruse River, undividable in disaster management history) is an advanced area in river basin water management and the death toll due to the water disaster by Typhoon No. 19 was zero in Nakakasukawa district. Also, the district residents created a reconstruction committee by themselves and had a leading role in paving a path for regional reconstruction, collaborating with the town, the prefecture and MLIT (River Office for Kitakamigawa River Downstream).

Why was Nakakasukawa district successful in evacuation, restoration and reconstruction? I would like to take a deeper look into the key values of the region's residents that made it possible. By digging into the

history, culture and the nature of the community the meaning of the work done by the local office becomes apparent. By analyzing this case, I will find a base for deployment of river basin water management. The objective is to look for key points to achieve comprehensive dialogue and collaboration between the region and the personnel in charge of river management.

The 2nd objective is to propose a method based on humanities and social sciences to identify key points of dialogue and collaboration derived from regional residents' voices and their history. There can be many varied examples on how to ensure dialogue and collaboration for each river basin. I assume we cannot currently identify all such key points through a general questionnaire or surveys and hearings. However, I believe it will lead to appropriate and sincere dialogue and collaboration at each river basin. I propose a practical, actionable and simple method to be carried out by Regional Development Bureaus and river offices based on concepts of humanities and social sciences.

In this research, I continue interviews mainly with disaster affected residents. In cooperation with the River Office for Kitakamigawa River Downstream, I interviewed 13 residents. The average interview time per person was around 1.5 hours, recorded upon their approval and the transcription was returned to the individual to reconfirm the details. Then, I identify the meaning of damage and reconstruction experience, studying the transcription details by KJ method and phenomenological analysis.

KJ method is a simple interpretation method for data in cultural anthropology. The method digs into the meaning of survey data through sorting out and summarizing findings, obtained by surveys by writing down each of them on paper. In this research, I wrote down the details told in the interview one by one on sticky notes on an online whiteboard, and repeated the process to add any new findings, sorting out those notes. By using this method, it became apparent how the disaster survivors are responding to this evacuation and reconstruction as they look at the past and the future of their region.

3. Why are the evacuation and restoration / reconstruction successful?

Why have the residents of Nakakasukawa district accomplished complete evacuation and restoration / reconstruction? In this article, firstly I will explain the reasons.

1) To have regular simple disaster prevention drills and evacuation drills with a high attendance rate, after having established their own self disaster prevention organization in 2006.

2) Most of the residents, responding to the call by leaders of the regional association and fire department, evacuated in advance. Also, the local fire department and the official fire department rescued those who were delayed in evacuation.

3) Nakakasukawa district is a compact district having around 100 houses and the residents have kept very close relations with one another. The executives of the regional association fully understood residents' evacuation situation and the necessity for help.

4) There were trust relations and coordination with the leaders of the regional association led by the chairman of the association. The leaders of the regional association played a leading role in evacuation, rescue and restoration / reconstruction. They have a custom of fostering leaders in the long run through multi-dimensional locally connected organizations and of establishing a relationship of trust.

5) The residents themselves engage in the maintenance of the regional environment including mowing the grass of the embankment and cleaning irrigation canals so they know the situation of the river and the natural environment very well. "The regional residents' voices are well heard through water disaster management. (omission) I hope that the opinions of such residents are seriously heard.", a resident Mr. C emphasized.

Photo-2 "Cheers at waterfront" event (Nakakasukawa district, July 2024)

4. The meaning of collaboration with our regional office

In the survey, I received a positive evaluation from many residents on the restoration / reconstruction projects made by our local office. The reasons included the fact that the manager in charge ensured making periodical reports on the work progress to the region's reconstruction committee to implement plans without delay, and that the office head gave explanations and opportunity for discussion at each critical moment. In particular, it seems that the steady progress of the project gave the damage affected residents a reconstruction perspective and sense of recovery timetable. In addition, we believe the most important thing was that our local office reinforced safety above all else and respected damage affected residents' serious choice, which is to stay and reconstruct at the "bottom of the embankment". They fully understood the regional dynamics such as an aging population and the deterioration of regional maintenance and water damage risk. It is this collaboration with the shared value and commitment that "we shall live here nevertheless".

☞Detailed information is as follows.

1) The River Office for Kitakamigawa River Downstream "Yoshida River water management report, No. 6"
https://www.thr.mlit.go.jp/karyuu/_upload/doc/08_construction/tokkinn/chisuidayori/yoshida06_211025.pdf

Development of Calculation Model to Accurately Predict Sediment Deposition at the Occurrence of Flooding of Debris and Inundation

(Research period: FY2021 ~ FY2023)
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(keywords) flooding of debris and inundation, fine-grained soil, becoming liquid phase

1. Introduction

In recent years, there has been a phenomenon called flooding of debris and inundation causing substantial damage due to flooding and deposition of large volume of sediment in addition to inundation (Photo). As characteristics of flooding of debris and inundation, we can point out that the damage is caused by deposition of large volume of minute soil in a wide area.

The current calculation model has been structured assuming that the particle size of sediment that flows along with erosion and deposition processes of debris flow ~ sediment flow. can be covered by a single representative value and such a phenomenon in which minute sediment such as flooding of debris and inundation reaches gentle slope areas more widely.

Therefore, we developed a model having high versatility in analyzing a flow including sediment with a wide variety of particle sizes by considering erosion and deposition processes of such sediment.

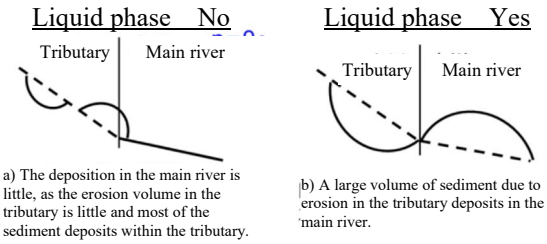
2. Method

In recent years, the importance to consider the effect that fine-grained soil inside of a flow moves as liquid phase such as clear water is pointed out. To represent such effect of fine-grained soil being made into liquid phase, we improved and established a calculation model considering such effect of fine-grained soil being made into liquid phase such as water, not as sediment (solid) when such fine-grained soil is integrated into the flow. We made calculations for Akayagawa River of Chikugogawa River water system using the developed model and verified its appropriateness.

3. Results and considerations

In the existing model, there was such issue that sediment deposited in the upstream and that it did not deposit to the downstream compared with the actual phenomenon, however, with the model established in this research, taking the phenomenon of fine-grained soil being made in to liquid phase into account, we can express sediment flow and deposition to the downstream more accurately (Figure). On the other hand, we noticed such new issue as identification of particle size of sediment being made into liquid phase.

Photo Flooding of debris and inundation at Akayagawa River due to Northern Kyushu heavy rain in July 2017 (source: Geospatial Information Authority of Japan)



a) The deposition in the main river is little, as the erosion volume in the tributary is little and most of the sediment deposits within the tributary.

b) A large volume of sediment due to erosion in the tributary deposits in the main river.

Figure Effect considering the phenomenon of fine-grained soil being made into liquid phase (Simulation figure prepared based on the calculation results)

4. Conclusion

By using the model considering the phenomenon of fine-grained soil being made into liquid phase, we can express sediment flow and deposition caused by past disasters more accurately. In future, we expect that it will be possible to ensure more appropriate positioning of facilities by studying such issues as the method to determine particle size, etc. of fine-grained soil being made into liquid phase.

Reduction of Non-visible Areas Using Plural SAR Satellites in Landslide Disaster Survey

(Research period: FY2024)
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(keywords) SAR, landslide disaster survey, non-visible area

1. Introduction

It is very important to promptly and accurately identify areas that have landslides during the initial stage of disasters. As SAR (Synthetic Aperture Radar) can make observations for wide areas at night or under bad weather, it is utilized as soon as disasters occur.

If it is likely that a disaster will occur, currently we conduct a survey for areas that have landslides using one-time, Daiichi 2 (ALOS-2) emergency observation technology. However, SAR observation can detect non-visible areas using layover and radar shadow technology from the principle of observation. As non-visible areas tend to be in areas having steep land shapes, mountain areas which are the subject of surveys for landslides frequently have non-visible areas. If we do not detect the non-visible areas, we may overlook landslides. Therefore, in order to promptly and accurately identify areas that have landslides, it is necessary to expediate the reduction of non-visible areas. In recent years, as various SAR satellites have been launched in Japan and overseas, it is becoming possible to utilize them to reduce non-visible areas.

In this research, we studied to what extent we would have been able to reduce non-visible areas by using plural SAR satellites for past disaster cases to verify the effect using plural SAR satellites on non-visible areas.

2. Method

We selected the Northern Kyushu heavy rain in July 2017 (hereinafter referred to as “Disaster A”) that caused a lot of landslide disasters and the heavy rain in July 2018 (hereinafter referred to as “Disaster B”) as subject disasters and selected the range where many landslides occurred in both disasters as subject range for our research. For these two disasters, we prepared and estimated non-visible areas from actual observation results using plural satellites and verified to what extent the non-visible areas occurred within the range were reduced after the emergency observation. We used 3 satellites, ALOS-2 each having observation mode of resolution of 5m or less, COSMO-SkyMed (CSK) and TerraSAR-X (TSX). The time period we surveyed was 96 hours after the emergency observation (4 days). Also, we verified the proportion of the number of landslide polygons identifiable against the total number of polygons, using the polygon data of landslides identified through aerial photos and airborne laser scanning after the disasters. As for the polygon data of landslides, we used the identification results of Kyushu Regional Development Bureau for Disaster A, and of the study group of Hiroshima University (geography group) for the heavy rain disaster in July 2018 for Disaster B. In addition, for both disasters, as a lot of landslide polygons were distributed in the area where the inclination (θ) of slopes was 20 ~ 40°, we divided the subject range we surveyed into 3 sections as the slope inclination of less than 20°, of 20 ~ 40° and of 40° or more and verified the reduction of non-visible areas in each section.

3. Results and considerations

We have shown the observation history after the emergency observation for Disaster A and Disaster B in the Table. For Disaster A, there were 3 observations with ALOS-2 and one observation with TSX within the 96-hour time frame after the emergency observation. In the same manner, for Disaster B, there were 2 observations with CSK, and it was only around 275 hours after the emergency observation that the 2nd observation was conducted. We believe the reason would be that the observation requirements for ALOS-2 were widely distributed, as many landslides and flood disasters occurred in various areas in Western Japan, mainly in Chugoku and Shikoku regions. From this, we believe that it is possible to conduct multiple observations at the early stage by using plural satellites even if we cannot immediately use ALOS-2.

Table Observation history after emergency observation

Disaster	No.	Satellite name	Observation date	Time lapsed from emergency observation
Disaster A	1 (emergency observation)	ALOS-2	2017/7/7 12:52	0
	2	ALOS-2	2017/7/7 23:43	10 h 51 min
	3	TSX	2017/7/8 18:10	29 h 18 min
	4	ALOS-2	2017/7/9 11:57	47 h 05 min
	5	ALOS-2	2017/7/10 12:18	71 h 26 min
Disaster B	1 (emergency observation)	ALOS-2	2018/7/8 11:56	0
	2	CSK	2018/7/9 17:58	30 h 02 min
	3	CSK	2018/7/11 17:46	77 h 50 min

In the Figure, we show changes in the proportion of non-visible areas and the number of landslide polygons identifiable with the time lapsed from emergency observation. The proportion of non-visible areas at the time of emergency observation was 10.2% in the entire area for Disaster A and when we divided the data by slope inclination, it was 2.7% for less than 20°, 18.2% for 20 ~ 40°and 30.2% for 40°or more. In the same manner, for Disaster B, it was 3.7% for the entire area, and 0.7% for less than 20°, 6.7% for 20 ~ 40°and 16.7% for 40°or more. In this way, the non-visible areas may reach over 30% in the highly inclined areas where landslides occurred , so it may not be possible to make a conclusive survey based on only one emergency observation. On the other hand, the proportion of the non-visible areas at the 2nd observation after emergency observation for Disaster A was, 1.4% for the entire area, 0.3% for less than 20°of inclination, 2.3% for 20 ~ 40°and 5.9% for 40°or more. For Disaster B, it was 0.6% for the entire area, 0.2% for less than 20°, 1.0% for 20 ~ 40°and 3.4% for 40°or more. We found out that the proportion of non-visible areas for both disasters was gradually reduced from the 3rd observation onward. On the basis of these results, we recognized that we could substantially reduce the non-visible areas by making the 2nd observation and could gradually reduce such areas furthermore by making further observations. As the 2nd observation substantially contributed to reducing the non-visible areas, we believe it is important how quickly we make the 2nd observation. In addition, for such areas that have steep inclines and a propensity towards landslides that are likely to have non-visible areas, we acknowledged that it would be possible to sufficiently reduce the non-visible areas by continuing to make ongoing observations.

Also, though the proportion of the number of landslide polygons identifiable was 69.4% for Disaster A at the time of emergency observation, and 82.5% for Disaster B, it increased to 93.1% for Disaster A and 98.7% for Disaster B at the 2nd observation after emergency observation. From this, we recognize that it would be possible to conduct effective surveys for areas that have landslides by making observations more than twice to reduce non-visible areas.

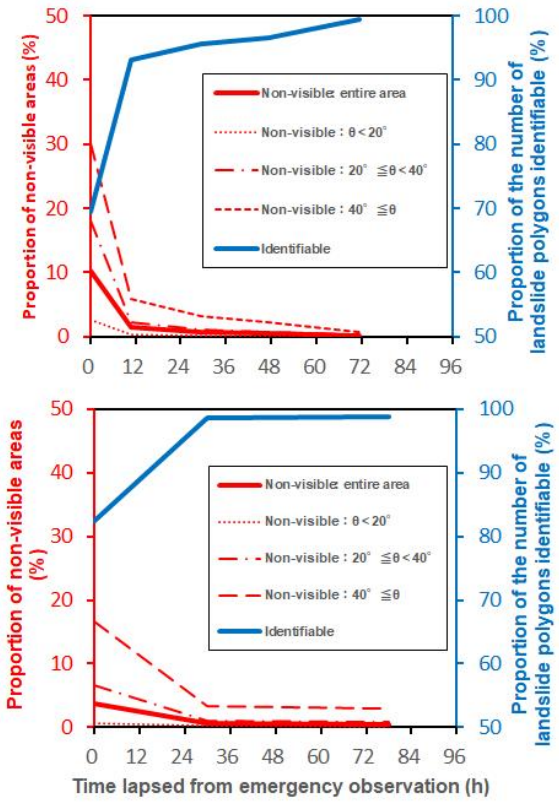

Figure Changes in the proportion of the non-visible areas and the number of landslide polygons identifiable
(upper figure: Disaster A, lower figure: Disaster B)

4. Conclusion

Based on the results of this research, we recognized that it would be possible to conduct an effective survey for areas that have landslides by making multiple observations after emergency observation utilizing multiple satellites, for areas that have steep inclines and a propensity for landslides and in so doing substantially reduce non-visible areas. In addition, we acknowledge that it is important how quickly we can make the 2nd observation to reduce non-visible areas. From these findings, we believe that it is important to effectively utilize various satellites to promptly and accurately identify areas that have landslides during the initial stage of disasters.

☞Detailed information is as follows.

1) Muraki and others: Reduction of non-visible areas using plural SAR satellites for landslide disaster survey, The Remote Sensing Society of Japan, collected papers of Academic Lecture, pp. 121-124, 2024

Research into the revision of the "Guidelines for Facilitating Smooth Transportation on Roads"
-Experiments to evaluate the Method of Installing Guidance Indicators for the Visually Impaired on Road Crossings-

(Research period: FY 2023 - FY 2025)
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(Key words) *facilitation of smooth transportation, visually impaired, guidance indication*

1. Introduction

The "Guidelines for Facilitating Smooth Transportation on Roads (Road Bureau, Ministry of Land, Infrastructure, Transport and Tourism)[1)]" (hereinafter called the "Guidelines"), which show that according to universal design a road space should allow all people including the aged, people with disabilities, and others to utilize the space easily. The Guidelines are intended to be used when road administrators formulate a plan and implement or evaluate a project. They help the administrators understand the structure of a road in order to form the appropriate road space.

The NILIM is engaged in researching the method of installation of guidance indicators so that the visually impaired can walk on roads safety and smoothly. In 2023 - 2024, we conducted research on the method of installation of guidance indicators with dents and projections on the surface of a crosswalks, and in 2024 - 2025, we have been conducting research on the method of installation of guidance indicators on the boundary using a corner cut between a sidewalk and a vehicle lane (tactile paving for guidance for the visually impaired). This paper presents the research, focusing on the former topic.

2. Experiments to evaluate the method of installation of guidance indicators for the visually impaired on road crossings.

In April 2022, on a road crossing in Yamato Koriyama City, Nara Prefecture, a crossing accident occurred in which a visually impaired person came into contact with a train without being able to recognize that the they were within the crossing. Following this accident, we conducted evaluation experiments with visually impaired persons in order to examine the method of installation of guidance indicators for the visually impaired on road crossings.

(1) Viewpoints and procedure of the evaluation experiments

The evaluation experiments were performed according to the procedure in Fig.-1, based on A - C within the parameters of the viewpoints required for the prevention of accidents in crossings shown in Table-1.

Table-1 Viewpoints required for the prevention of accidents in crossings

A) Recognizability	Entry into/exit from an crossing shall be capable of being recognized.
B) Distinguishability	Presence in a crossing shall be capable of being recognized. (Distinction from a pedestrian crosswalk / distinction from a sidewalk)
C) Straight passing performance	The crossing shall be capable of being passed without deviation toward the railroad or vehicle lane.
D) Situation handling performance	When a person has been left in a crossing, the situation shall be capable of being handled correctly.

Preliminary experiment	Experiment for separately experiencing passage through guidance indications: 4 patterns in the area before entering a crossing and 5 patterns in the crossing	

↓ Based on the evaluation, select the patterns to be used in the main experiment

Main experiment	An experiment for experiencing, in a series, passage through a combination of guidance indications : 1 pattern in the area before entering a crossing and 4 patterns in the crossing	

↓ Based on the evaluation and problems, select the patterns for final confirmation

Final confirmation	・An experiment for experiencing, in a series, passage through 2 patterns of combination of guidance indications in the area before entering a crossing and in the crossing, in response to problems, etc. that have been grasped in the main experiment ・Organizing precautions for installation

/* It was assumed that vibrations due to the dents and projections of guidance indications might cause hindrance to the passage for wheelchair users. Therefore, in the main experiment and final confirmation, we checked with wheelchair users as well for their opinions.

Fig.-1 Procedure of the evaluation experiments

(2) Results of the evaluation experiments

We present the major results below, that have been obtained through the evaluation experiments with visually impaired persons before entering a crossing area and while in the crossing.

The area before entering a crossing was mainly evaluated from the viewpoints of A (Recognizability) and B (Distinguishability), and the structure with a clearance between the blister tactile paving and the crossing barrier as shown in Fig.-2 left was highly evaluated, and it was considered that the visually impaired person recognized the entry into/exit from the crossing by means of the clearance. Also, the most highly evaluated structure was the structure pasted with a rubber chip sheet, as shown in Fig.-2 right.

The area within the crossing was mainly evaluated from the viewpoints of B (Distinguishability) and C (Straight passing performance), and the two structures shown in Fig.-3 were thoroughly evaluated, and a tendency was found for the evaluation of a guidance indicator with a greater width to be more highly evaluated than a guidance indicator with a smaller width. Also, the structure equipped with an escort zone that is installed in a pedestrian crosswalk was evaluated to be inferior from the viewpoint of distinguishability from a pedestrian crosswalk, resulting in a risk that the visually impaired person could not distinguish the situation where they were within the crossing.

(3) Reflection in the Guidelines

Based on the results of the evaluation experiments, discussions were held and working groups established by the Road Bureau of the MLIT, and the Guidelines [1)] were revised in January 2024. In the Guidelines, as the structures for guidance indicators on road crossings, the standard method of installation and the standard method of installation when the width is small took wheelchair users into consideration as shown. (Fig.-4). In addition, as an improvement, rubber chip paving for the clearance in the area before entering a crossing was also shown.

3. Future schedule

The Guidelines show the method of installation of tactile paving for guidance for the visually impaired in the boundary with a corner cut between a sidewalk and a vehicle lane in an intersection with tactile paving. However, one concern that has been expressed is the potential difficulty to grasp the walking direction due to the adjacent tactile paving tiles used for guidance for the visually impaired before entering a pedestrian crosswalk being connected to each other, or being installed in the form of a stairway.

In the future, the NILIM plans to make efforts in developing the method of installation of tactile paving for guidance for the visually impaired in a corner cut, taking into account the opinions of the visually impaired as well as knowledgeable persons in order to contribute to a the study made by the discussion meetings of the Road Bureau of the MLIT regarding the method for appropriately showing the walking direction in a corner cut of an intersection.

Through these efforts, we would like to be able to show how to improve road spaces that can be utilized safely and with confidence by the aged, people with disabilities, and all others in keeping with the actual situation of each locality.

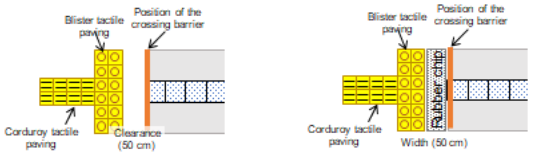


Fig.-2 Structures of the [illegible] crossing that were highly evaluated

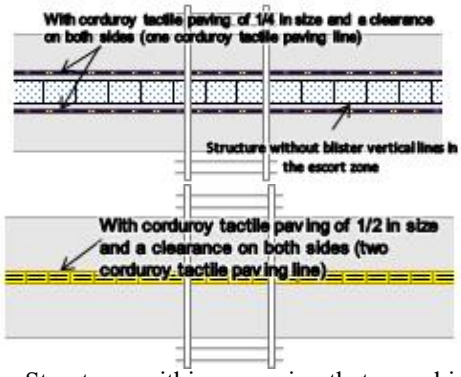
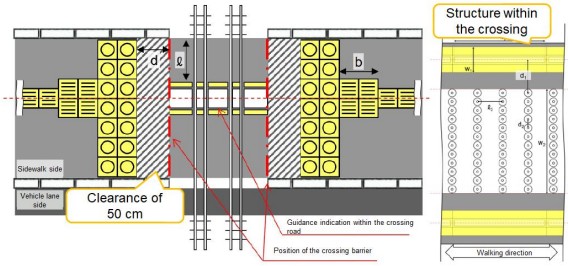


Fig.-3 Structures within a crossing that were highly evaluated

Standard method of installation



Standard method of installation when the width of the waling space is small

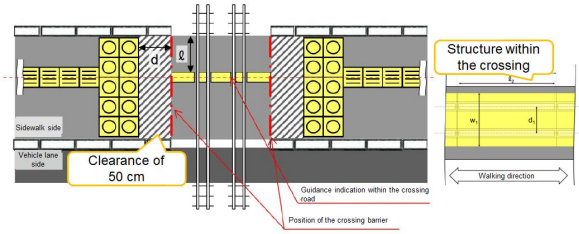
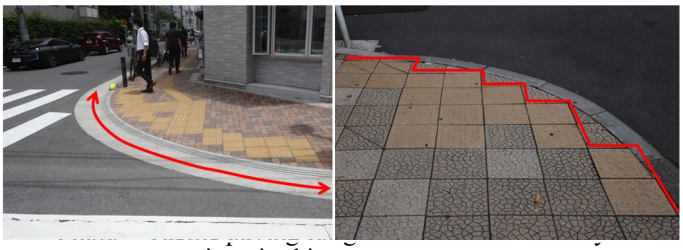


Fig.-4 Methods of installation of guidance indications shown in the Guidelines



impaired in a corner cut

☞For more detailed information, refer to the following:

1) Road Bureau of the MLIT: Guidelines for Facilitating Smooth Transportation on Roads (January 2024) pp. 7-45-7-68
https://www.mlit.go.jp/road/road/traffic/bf/kijun/pdf/all.pdf

Research on the Applicability of the Understanding Road Damage Status Utilizing SAR Satellite Images - Verification in the 2024 Noto Peninsula Earthquake -

(Research period: FY 2023 -)
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(Key words) road damage status survey, remote sensing technology, small SAR satellite

1. Introduction

The NILIM conducts research on the method of effective utilization of remote sensing technology that can be applied right after the occurrence of a disaster, for the purposes of early detection of the statuses of damaged road facilities due to an earthquake or torrential rain damage and of the prevention of the damage spreading as well as secondary disasters.

Satellites are expected to be utilized to help understand the breadth of road damage in recent years, with the expansion of satellite constellation projects in Japan and the higher resolution quality of small SAR satellites. On the other hand, there is a limit to the reading of the statuses of road damage utilizing SAR images, due to the principle and conditions of observation of Synthetic Aperture Radars (SARs) and restrictions on the resolution. However, specific studies are not being carried out regarding the extent and accuracy that can be grasped about the type of road structure and cause of damage.

Therefore, for the purpose of clarifying disaster events that can be read from small and high resolution X band SAR satellite images (hereinafter called the "small SAR satellite images") and the size of such events, verification was carried out concerning the statuses of road damage due to the 2024 Noto Peninsula Earthquake, and the results are reported below.

2. Understanding of the statuses of road damage utilizing the small SAR satellite images

Considering the road disaster events in the 2024 Noto Peninsula Earthquake, verification is carried out on the possibility of understanding such disasters from the small SAR satellite images. This paper presents the results of verification of slope failures in 6 locations that occurred in the following. Local roads which are the areas around the tip of the Noto Peninsula that is considered to take much time for road patrol during a large-scale disaster (No. 1 - No. 3 in Fig.-1); important urban trunk roads that connect cities (No. 4 and No. 5 in Fig.-1); and a trunk road expected to cause difficulty in recovery if a disaster occurs on a coast line (No. 6 in Fig.-1). Note that in this verification, the satellite images of the Institute for Q-shu Pioneers of Space, Inc. were used, which provide the highest resolution as a small SAR satellite in Japan.

Fig.-2 shows aerial photos and the small SAR

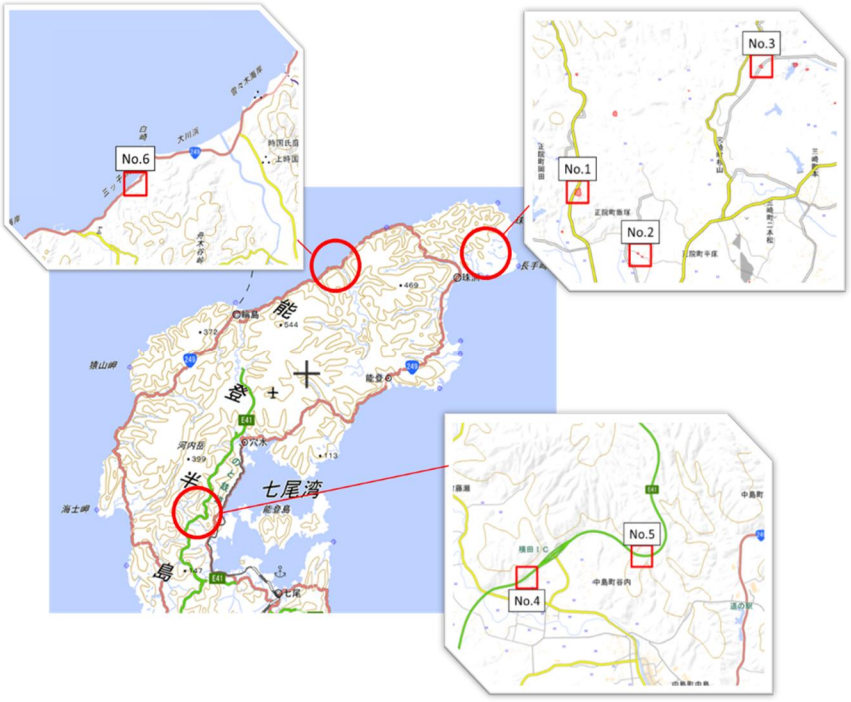

Fig.-1 Locations of slope failure in the 2024 Noto Peninsula Earthquake (partial excerpt)

satellite images of the locations of road damage due to slope failures that occurred in the 2024 Noto Peninsula Earthquake. Note that the examples of local roads are shown for comparison because observation was implemented before the occurrence of the earthquake as well.

From Fig.-2, it can be seen by checking the satellite images of Examples No. 1 and No. 3 that the locations of failure are photographed in white (areas in red circle in the figure). It is considered from these that clear reflections could be confirmed because they were the locations of failure that occurred on slopes roughly placed face-to-face with the direction of irradiation of satellite radio waves. On the other hand, in Example No. 2, the reading was difficult because the location of failure was localized, the slope was a location placed not face-to-face with the direction of irradiation of satellite radio waves, and it is also considered that there was an influence of the foreshortening of vegetation in the surrounding area (a phenomenon in which, if the target of observation has a height, the target is projected toward the side of the observer, corresponding to the shortening of the transmission and receiving time of radio waves). Example No. 4 was a slope failure on the side opposite to the direction of irradiation of radio waves, and it was a location under the conditions close to those of radar shadow, the reading was difficult. Lastly, Examples No. 5 and No. 6 were locations where the slope before the disaster was not located face-to-face with the direction of irradiation of radio waves, but as a result of occurrence of a surface located face-to-face due to the influence of the slope failure, the location of the slope failure was photographed in white, and the reading was possible.

3. Conclusion

As a result of trying whether a reading of the statuses of road damage was possible by using the small SAR satellite images, it has been clarified that thorough understanding of the statuses is possible if the location of failure is around 25 m x 25 m in size and occurred on a slope and was roughly face-to-face with the direction of irradiation of satellite radio waves. On the other hand, as a precaution when utilizing SAR satellite images, since the images are greatly affected by the surrounding trees and houses on actual roads, it is necessary to factor in certain principles of observation, such as prior verification of areas where the reading will be impossible, and the organization of documents for the improvement of reading accuracy so that the road line data can be put onto the SAR satellite images during analysis.

In future, we will verify whether it is possible to grasp the actual disaster events as well, such as slope failures and road surface failures, level differences that are smaller in size, and at the same time will summarize utilization guides (draft) that make the utilization at site possible.

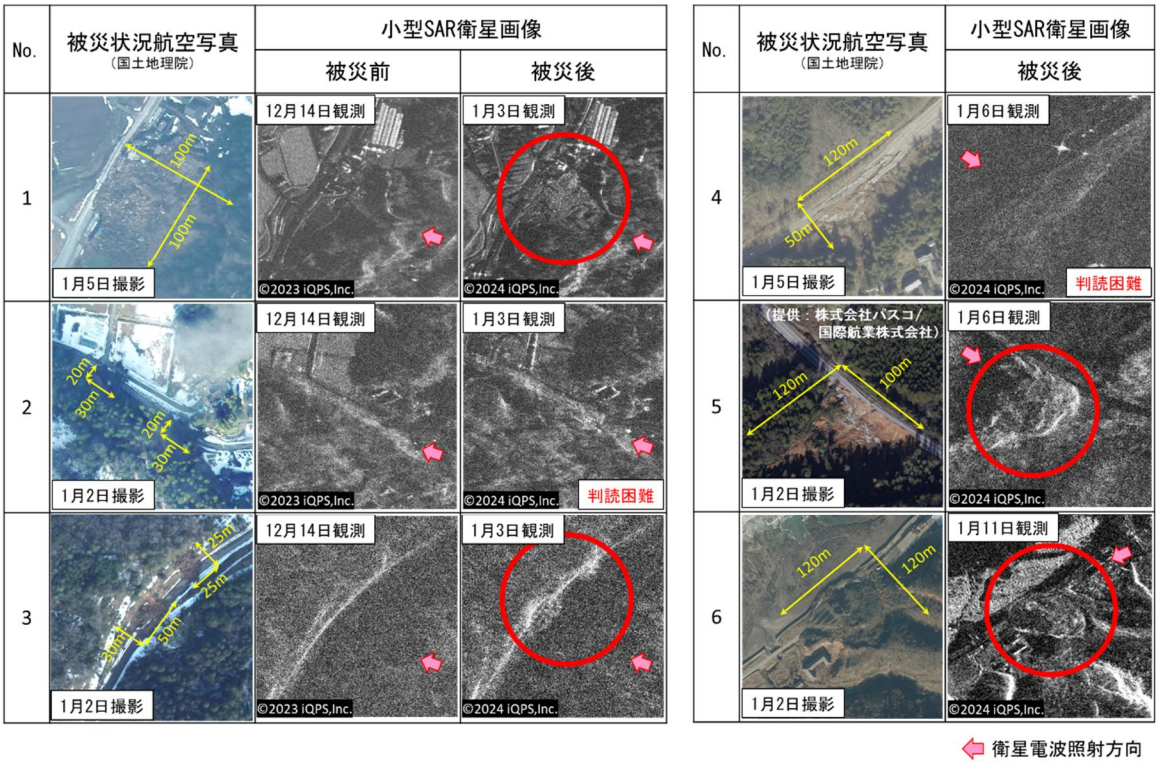

Fig.-2 Example of reading in the 2024 Noto Peninsula Earthquake (locations of slope failure)

Observation of Combustion Status for Reed Burning in the Watarase Wetland

(Research period: FY 2023 - FY 2024)

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HIMOTO Keisuke (Ph. D.), Head, Urban Development Division, Urban Planning Department

(Key words) drone, artificial satellite, combustion characteristics

1. Introduction

In the Watarase wetland, reed burning in reed beds (hereinafter called "reed burning") is performed in early March every year. The reed burning in FY 2023 (ignition) started at 8:30 on March 3, 2024, and reed beds of about 1,200 ha were burnt.

As part of a study into early detection of a fire and understanding combustion properties during a large-scale fire, we tried to perform the following evaluation concerning the reed burning: measurement of the temperature on the ground and the wind velocity, confirmation of the status of combustion using a drone, and the grasping of the areas of combustion by means of artificial satellites, and others.

2. Details of the measurement

Using the area shown in the black frame in Fig.-1 (about 1 km^2) as the area subject to measurement, we performed drone filming, measurement and observation using measuring devices and cameras installed in the area and surrounding vicinity, and detection of the combustion areas by means of artificial satellites. In addition to these, we performed the measurement of the reed heights and weights, sampling for the measurement of the heat release rate, the measurement of the soil moisture content, etc. in the area subject to measurement.

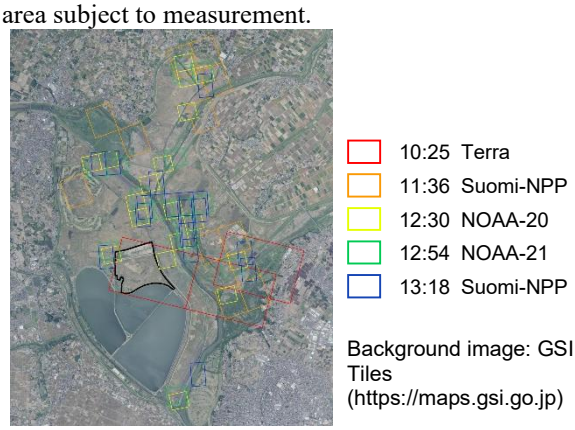

Fig.-1 Area subject to measurement and results of measurement with satellites

3. Overview of the measurement results

The distribution of temperatures in the direction of height was measured at 3 spots within the area subject to measurement, and the combustion characteristics were confirmed, including the time of fire spread, the maximum temperature (753°C) and the duration of continuation of high-temperatures (around 1 - 2 minutes), etc. Fig.-2 shows the results of measurement of the temperatures after 60 - 70 minutes from the start of the ignition, when a rapid temperature rise was observed.

Fig.-3 is a drone image taken from right overhead after around 60 minutes and 34 seconds, which captures a scene in which the spread of fire came closer to the spot at the center of the red circle in Fig.-3 (Spot A) from the southwest direction. At Spot A, the temperature rose rapidly 130 seconds after this point in time, and the rate of spread of fire during this period was estimated to be about 2,000 m/h.

In the observation by means of artificial satellites, fires (significantly high temperatures) were detected a total of 5 times with the 4 satellites, and changes in the positions of the fire in the time series were confirmed (Fig.-1).

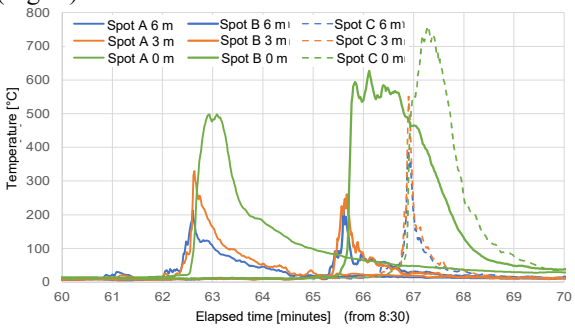

Fig.-2 Results of measurement of temperatures within the reed beds

4. Conclusion

We plan to proceed with analysis in future to carry out verification, etc. of the possibility of estimation of the combustion properties by means of drones and artificial satellites.

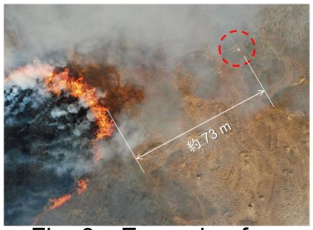

Fig.-3 Example of an observation image with a drone

☞For more detailed information, refer to:

1) Summaries of Technical Papers of Annual Meeting, Architectural Institute of Japan (Kanto)
2024.8, pp.149-150

Research on Prediction of the Heat Release Rate of a City Fire Utilizing Image Analysis Technology

(Research period: FY 2023 - FY 2026)

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(Key words) deep layer neutral network, city fire, heat release rate

1. Introduction

In order to promptly grasp the hazard of a large-scale fire that occurs in a densely populated city area during an earthquake or other natural disaster, it is necessary to be able to predict the heat release rate (a typical index of the scale of a fire) of the fire, based on the information collected from overhead using drones. For that purpose, research, into the development of a heat release rate prediction model is underway utilizing image analysis technology based on a deep layer neutral network, as part of the comprehensive technical development project "Development of Effective Earthquake Disaster Management and Mitigation Technologies for Existing City Areas Using New Technologies, Etc." (FY 2023 - FY 2026). This paper presents an overview of the development of research.

2. Overview of the heat release rate prediction model

In this research, we are engaged in the building of a model for predicting, from the data of images of a fire taken, the heat release rate when the images were taken. Although various frameworks are available for the analysis of image data, this research utilizes a deep layer neutral network. This is to enable the global features of an entire image to be interpreted, by going through multiple layers of computation processing, extracting local features as feature maps in a step-by-step process and integrating the feature maps. The prediction of parameters in a deep layer neutral network generally requires a large-scale dataset for learning, but it is not easy to initially prepare such a dataset. Therefore, we decided to utilize the parameters of an existing pre-trained model called ResNet by modifying them.

The figure shows the results of comparison, regarding a fire created by burning alcohol fuel, between the heat release rate of the fire measured from the analysis of components of the combustion gas generated (measured value) and the heat release rate predicted from the image data (predicted value). Although the conditions are relatively simple in which a single source of fire is installed at the center of the screen, the changes in the heat release rate over time could roughly be grasped in good condition, in which the fire gradually became larger, reaching around 40 - 50 kW at the maximum.

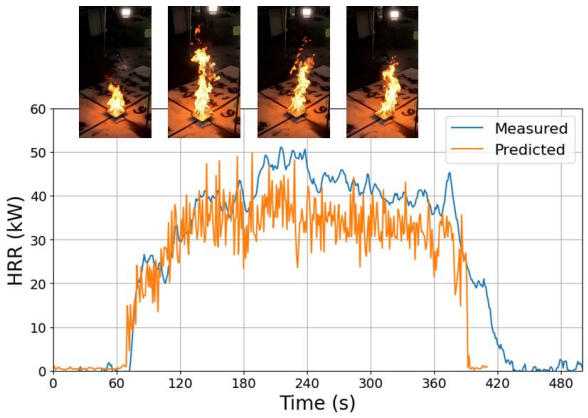

Figure Comparison between the measured value and the predicted value of the heat release rate

3. Conclusion

In the models that have built until the present, images that enable the entire image of a fire to be visible were used as data for learning. However, in actual fires, there may also be a case where combustion continues inside of a building, and such a case does not necessarily match such conditions. In future, while seeking the improvement of the accuracy of the present model, at the same time it is required to expand the target, so that the model will be capable of being applied to even cases where the entire image of a fire is invisible.

☞For more detailed information, visit:
https://www.nilim.go.jp/lab/jbg/missyuu.html

Effects of Measures to Secure Road Traffic During Heavy Snowfall on Motor Vehicle Traffic

(Research period: FY 2022 -)

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(Key words) heavy snowfall disaster, measures to secure road traffic, calling for refraining from going out, behavior change

1. Introduction

In recent years, unusually heavy snowfall caused a large-scale standstill of vehicles, which not only greatly affects socioeconomic activities, but also threatens the lives of drivers. Therefore, the Ministry of Land, Infrastructure, Transport and Tourism has enhanced efforts toward the securing of road traffic during heavy snowfall, according to the basic concept of "thoroughly avoiding a large-scale standstill of vehicles on trunk roads, giving top priority to human lives." The NILIM conducts research on the effects of measures to be taken, among varied measures to secure road traffic, focusing on a "calling for refraining from nonessential and non-urgent going out" to be performed by the road administrator, the Japan Meteorological Agency, and others in the joint names, and "preventive traffic control" to perform concentrated and efficient snow removal work.

In this paper, the traffic volume when it was called for on December 18, 2023 to refrain from nonessential and non-urgent going out starting on December 21 in the Hokuriku Region has been compared with the average traffic volume (hereinafter called the "average traffic volume" in December 2022, which was the same month in the preceding year, and the results of analysis of the effects of the calling for refraining from going out on the traffic volume are presented. Note that when calculating the average traffic volume, the traffic volumes on the date of implementation of traffic control in December 2022 and in the year-end period are different from those during ordinary periods, and therefore they are excluded from the calculation.

2. Effects on the traffic volume in city areas

As for the traffic volume in city areas, the traffic volume on National Route 8 in Niigata City was analyzed, and the traffic volume per day in these areas is shown in Fig.-1. The average traffic volumes are prepared and shown in 6 types in total: on the day without accumulation of snow and on the day with accumulation of snow and snowfall, for each of weekdays, Saturdays and Sundays.

The traffic volume of compact vehicles decreased from 21st to 24th as compared with the average traffic volume. The traffic volume of large vehicles was of the same level as the average traffic volume on 21st, and decreased on 22nd. Also, for both compact vehicles and large vehicles, the traffic volumes before and after the date when the traffic volume decreased were of the same level as the average traffic volume, and rushing traffic before refraining from going out or traffic that increases as compared to normal after refraining from going out cannot be identified. From these, it can be assumed that compact vehicles act in response to the calling for refraining from going out and large vehicles determine refraining from going out, observing the status of snowfall, and that there are tendencies in the action of refraining from going out to cancel the action on the day instead of postponing such action.

Fig.-2 shows the traffic volume organized by time

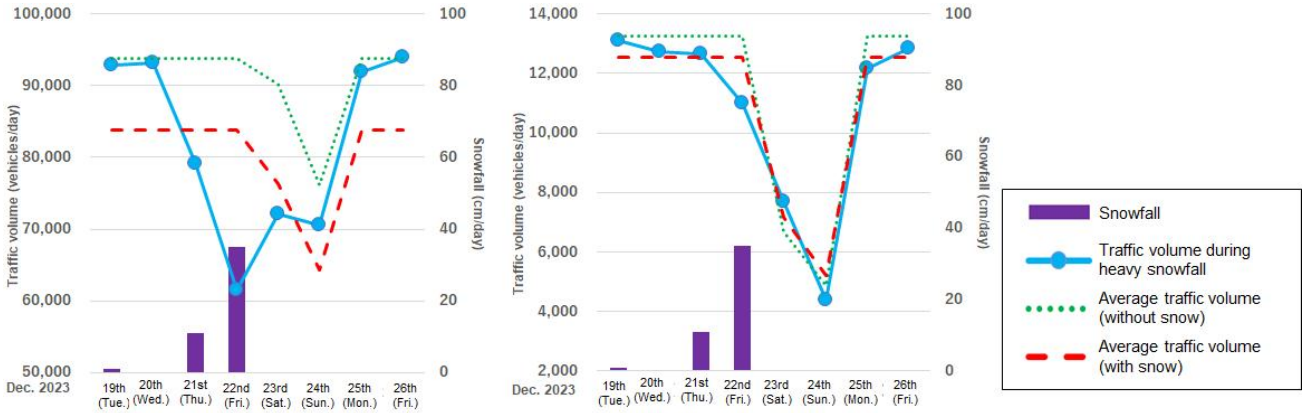

Fig.-1　Traffic volume per day on an ordinary road (National Route 8) in city areas (in Niigata City) [Left: compact vehicles, right: large vehicles]

based on the traffic volume per day of compact vehicles in Fig.-1. Until 20th, the peaks of the traffic volume were identified in the commuting hours to/from work in the morning and in the evening. On the other hand, on 21st when refraining from going out occurred, the peaks in the morning and in the evening disappeared. In addition, there was no great change in the traffic volume during the daytime when compared with that in the preceding day. From these, it is assumed that the details of refraining from going out on 21st were that commutation to/from work or school in the morning and in the evening decreased. On 22nd when the snowfall increased, the traffic volume during the daytime also decreased in addition to that in the morning and in the evening. From this, it is assumed that the details of refraining from going out on 22nd were that, in addition to the cancelling of commutation to work, business activities during the daytime and daily activities such as shopping were restrained.

3. Effects on the traffic volume in the suburbs

As for the traffic volume in the suburbs, the traffic volume on National Route 18 in Myoko City was analyzed. The traffic volume of compact vehicles decreased on 21st and 22nd, which has a tendency similar to that in city areas, but the traffic volume increased on 23rd when snowfall subsided. This could have been caused by leisure demand for ski resorts in the suburbs due to improvement of the weather on 23rd.

The traffic volume of large vehicles organized by time is shown in Fig.-3. In city areas, the traffic volume became less than the average traffic volume after the snowfall increased, whereas in the suburbs the traffic volume decreased before the snowfall increased. The decrease could have been caused in the suburbs by the announcement of the possibility of traffic closure and a planned guidance for the installation of tire chains, in addition to the calling for refraining from going out. In addition, the traffic volume increased during the period of 12 hours from the time right after the change at around 23:00 on 22nd from the heavy snowfall warning to the heavy snowfall caution. From this, there is a possibility that vehicles that had cancelled moving on Friday and had been prepared for departure started moving as soon as the heavy snowfall warning was lifted.

4. Conclusion

In future, we plan to carry out traffic simulation by referring to the effects on the traffic volume by means of the measures to secure road traffic during heavy snowfall that have been obtained in this paper, and to calculate the effects of suppression of temporal loss and economic loss by means of the measures to secure road traffic. We would like to utilize the effects to be calculated for the nourishment of opportunities in which the entire society including general drivers, businesses, schools will actively engage in behavior change.

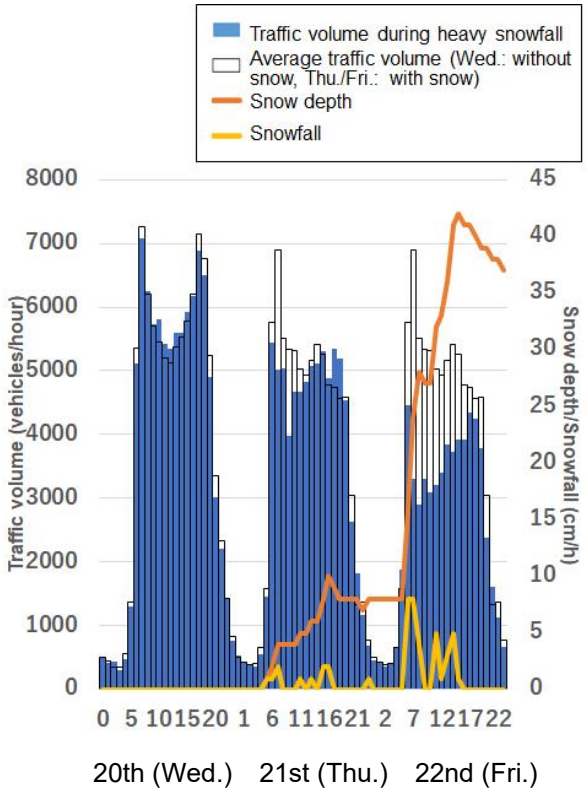

Fig.-2 Traffic volume by time on an ordinary road (National Route 8) in city areas (in Niigata City) [Compact vehicles]

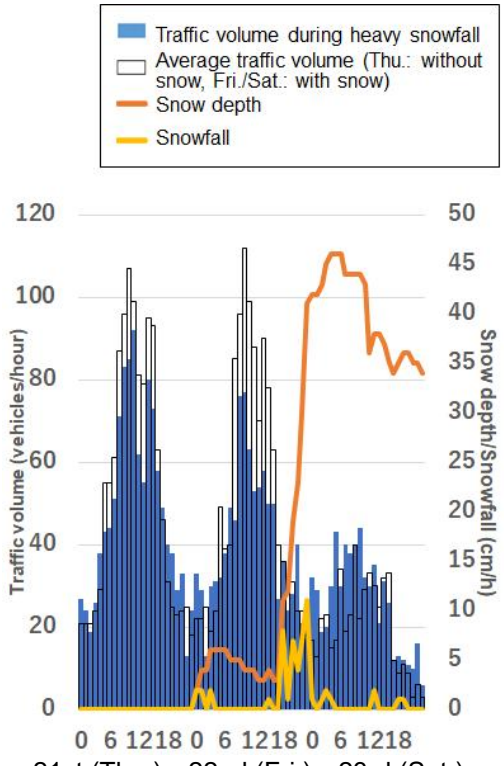

Fig.-3 Traffic volume by time on an ordinary road (National Route 18) in the suburbs (in Myoko City) [Large vehicles]

Research on Grasping and Evaluating Road Traffic Conditions to Improve Road Performance

(Research Period: FY 2024 - FY 2026)

Road Traffic Department, Road Division

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(Key words) K-factor, basic capacity, maximum traffic volume

1. Introduction

In the "Policies for WISENET 2050" that were compiled by the Road Bureau of the Ministry of Land, Infrastructure, Transport and Tourism in October 2023, it is shown that improvement of services for the entire high-standard road network will be realized by implementing measures for bottleneck efficiently and effectively, by means of data-driven performance management of traffic demand and congestion that are unevenly distributed temporally and spatially. In order to improve the performance of a road, it is necessary to utilize its potential to the fullest (Fig.-1).

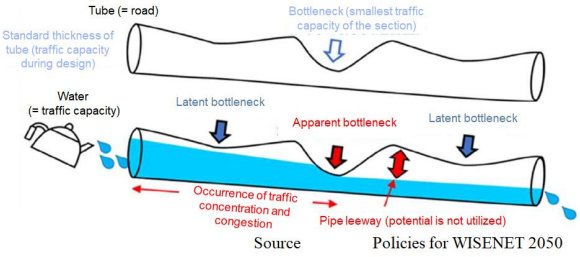

Fig.-1 Conceptual diagram of road performance

An existing research of the NILIM shows, when identifying bottlenecks, the effectiveness of bottleneck points obtained from the frequency of occurrence of congestion for each of the road sections divided equidistantly.

In the planning and design of roads including measures for bottleneck, based on the situations that require response to problems caused by localized insufficient capacity or by traffic volume fluctuations, and in response to autonomous driving and new mobility, as well as new findings such as a decrease in capacity in recent years, it is necessary to consider a review of the conventional methods (including the method for determining the number of lanes).

In this study, in order to contribute to the above consideration, analysis was carried out on the traffic volume fluctuation characteristics and the trends of maximum traffic volume (observed value related to the capacity) in recent years.

2. Analysis of traffic volume fluctuation characteristics

Conventionally, regarding the determination of the number of lanes on a road, a method is used to compare the designed traffic volume (traffic volume expected to pass through the road) with the standard design volume (traffic volume allowed by the road). In Japan, it is specified that the design shall be made based on the 30th highest hourly volume among the 8,760 hours in a year, and in the calculation of the standard design volume, the K-factor (ratio of the 30th highest hourly volume to the annual average daily traffic) is used as the index to represent peak traffic characteristics. This K-factor is set uniformly all over Japan, for each area where roads exist (rural areas, urban areas) or landform (level, mountainous).

In order to analyze the trends of K-factor in recent years and the difference at each spot, we have organized the distribution of the K-factors at the spots according to each situation of areas along the road, by using the constantly observed traffic volume data obtained at 1,046 spots on the national highways under the jurisdiction of the MLIT all over Japan in one single year of FY 2021. Fig.-2 shows the distribution of the K-factors at 182 spots in densely inhabited districts and 253 spots in mountainous areas. Focusing on the average of the K-factors, we can see that the values in mountainous areas are greater than those in the densely inhabited districts, and the differences due to the situation of areas along the road can be identified.

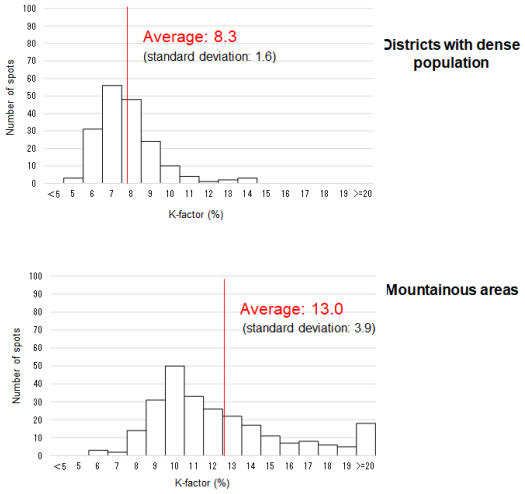

Fig.-2 K-factor distribution

Focusing on the shape of distribution of the K-factors, we can see that the standard deviation is greater in mountainous areas than in densely inhabited districts, and the values at the spots are distributed in a wide range. Therefore, when designing a road in a section in mountainous areas, if the K-factor can be set appropriately from the traffic volume data in the route and in surrounding areas, a design would be possible that is fit for the peak characteristics in the section.

3. Analysis of maximum traffic volume

The basic capacity is used as the capacity that forms the basics when calculating the capacity of a road, and in the publication of the Japan Road Association, "Highway Capacity" (1984), the basic capacity is defined as the maximum number of passenger cars that can be expected to pass through the road when the road conditions and traffic conditions meet basic conditions. In the publication, the basic capacity is defined to be 2,200 pcu/h per lane in the case of multilane roads, which is defined based on the results of observation of the maximum traffic volume in Japan. Note that pcu is the passenger car unit that is used to convert traffic volume into the number of passenger cars.

Table 1 shows values converted into pcu, by using the constantly observed traffic volume data in FY 2023 and extracting the top 5 spots with the maximum traffic volume (actual number of vehicles) on expressways and national highways under the jurisdiction of the MLIT with 2 lanes per direction, and by making corrections by means of the percentage of heavy vehicles , lane width, lateral clearance, and the situation of areas along the road to that the basic conditions will be met in order to make comparison with the basic capacity. The basic capacity in the sections with 2 lanes per direction is 2,200×2＝4,400 pcu/h, and the average at the 5 spots on expressways is about the same level as that of this value, but the values on highways under the jurisdiction of the MLIT are lower than this value. On ordinary roads, there may also be the influence of signalized intersections, but it is considered that a calculation method for capacity will be required that could appropriately consider the site situations including other factors.

Table-2 is an example of year-over-year comparison of maximum traffic volume at the same observation spot, which shows that the volume in FY 2023 is smaller by about 700 vehicles/h. The conditions of roads have improved since 1981 and it is inferred that the mode of utilization of road networks in a wide area is also different, so simple comparison may not be made from the viewpoint of capacity. However, when referring to the values of capacity in the past, it is recommended that attention should be paid to such comparisons. On that basis the values of capacity are required to be reviewed based on the trends in recent years.

Table-1 Maximum traffic volume in sections with 2 lanes per direction

Number of lanes	Observation spot	Direction	Maximum traffic volume generated (pcu/h)	Average maximum traffic volume generated (pcu/h)
2 lanes per direction (expressway)	Ikaw adani - Tamatsu	Upbound	4,841	4,450
	Ebina JCT - Ebina	Upbound	4,784	
	Ichinomiya - Ichinomiya JCT	Downbound	4,283	
	Fushiko - Kariki	Downbound	4,199	
	Funabashi - Hanaw a	Downbound	4,142	
2 lanes per direction (national highways under the jurisdiction of the MLIT)	Kuchi	Upbound	3,894	3,329
	Chikushino	Downbound	3,560	
	Yui	Upbound	3,359	
	Yui	Downbound	3,203	
	Miyamaru	Downbound	2,629	

Table-2 Year-over-year comparison of maximum traffic volume

Route name		E4 Tohoku Expressw ay	E4 Tohoku Expressw ay
Observation spot		Yaita - Nishi-nasuno	Yaita - Yaita-kita
Number of lanes		2 lanes per direction	2 lanes per direction
Observation period		January 1981 - December 1981	April 2023 - March 2024
Realized maximum traffic volume (vehicles/h)	Upbound	3,457	2,794
	Downbound	3,597	2,851
Source		"Traffic Capacity of Rods" (1984)	FY 2023 constantly observed traffic volume data

4. Conclusion

In this paper, the shape of distribution of K-factors has been analyzed, and it has been shown that the peak characteristics of the traffic volume are varied with each spot. Also, in the analysis of maximum traffic volume, the necessity to consider the site situation appropriately has been mentioned in the calculation of capacity using the current basic capacity. In the measures for bottleneck and planning and design of a new road, it is considered that the improvement of road performance can be realized efficiently and effectively, by using the values of traffic demand (peak characteristics, etc.) and capacity that appropriately reflect the situation of the applicable section. We understand that a review of the standard design volume and basic capacity is highly required, based on the differences in traffic characteristics according to the spot and year-over-year changes, and it is necessary to perform data analysis continually.

☞For more detailed information, refer to:
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https://www.nilim.go.jp/lab/bcg/siryou/2018report/ar2018hp083.pdf
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Efforts Toward the Realization of Autonomous Driving Trucks Supported by Road Infrastructure

(Research period: FY 2023 -)
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(Key words) autonomous driving, cooperative road-vehicle system, demonstration experiment

1. Introduction

In recent years, with an increase in the number of cases of distribution and the growing seriousness of driver shortages in the cargo vehicle transportation business, there is a concern about shortages in transportation capacity. Under the circumstances, autonomous driving contributes to labor saving / unmanned operation of transportation, and is expected to greatly contribute to the solving of these social problems. On the other hand, the current autonomous driving technology has not reached a level where the driving operation by a driver on an actual road can be substituted by the vehicle alone. Therefore, the NILIM is conducting various types of research on support provided by the road infrastructure side (road-vehicle cooperation) for the realization of safe and smooth autonomous driving on expressways.

This paper presents an overview of the demonstration experiments and research of the NILIM toward the realization of autonomous driving trucks on expressways.

2. Demonstration experiment with an autonomous driving truck in the Shin-Tomei

Toward the early realization of autonomous driving distribution services on expressways, autonomous driving vehicle priority lanes were set on the Shin-Tomei Expressway in FY2024 (between Surugawan-Numazu SA/SIC and Hamamatsu SA/SIC) (in the midnight zone only), and the NILIM started a Level 4 autonomous driving truck demonstration experiment by means of road-vehicle cooperation (Fig.-1). The autonomous driving truck used in this experiment was prepared by experiment vehicle cooperators (vehicle manufacturer) (Fig.-2).

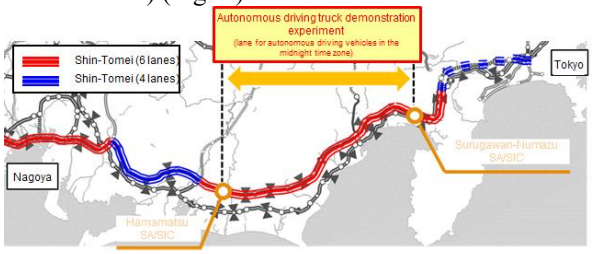

Fig.-1 Autonomous driving truck demonstration experiment section

Source: Prepared based on the 1st Autonomous Driving Infrastructure Study Meeting material[1)]

Fig.-2 Appearance of the autonomous driving truck

Large vehicles including autonomous driving trucks have greater necessity to provide information from road infrastructure than ordinary vehicles, because they require a long driving distance for acceleration and lane change due to reasons for vehicle performance, and there is limitation to the detection of surrounding traffic due to restrictions on vehicle dimensions. Therefore, in this demonstration experiment, information (merging support information, information on dropped objects, information on traffic management during construction) is provided to the autonomous driving truck by means of a road-vehicle cooperation system, based on requests from the vehicle manufacturer, and its effectiveness is verified (Fig.-3).

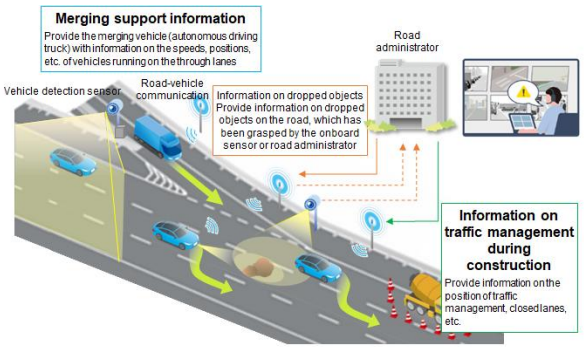

Fig.-3 Provision of information by means of a road-vehicle cooperation system

Source: Prepared based on 82nd Basic Policy Subcommittee material[2)]

3. Details of research conducted by the NILIM

The NILIM has been conducting public-private joint research on road-vehicle cooperative ITS intended for autonomous driving vehicles (ordinary vehicles) until the present, and has created the technical specifications of a road-vehicle cooperation system that provides merging support information and look-ahead

information (information on the status of the road ahead of the vehicle that cannot be detected by the vehicle alone)[3]. Based on the results of this research, the "installation of an experiment facility" and "verification of the effectiveness of the provision of information" will be implemented in this demonstration experiment.

Firstly, regarding the installation of experimental facilities, the following has been installed in cooperation with the Central Nippon Expressway Company Limited (Fig.-4). Vehicle detection sensors and information provision facilities that will be required for the provision of merging support information; sites for switching between autonomous driving and manual driving in the SA/PA (parking space); road information plate that displays the priority lanes for autonomous driving vehicles; and others

(a) Vehicle detection sensor (b) Information provision facility

Fig.-4 Experimental devices for the provision of merging support information
(near the Hamamatsu SA on the Shin-Tomei Expressway)

Secondly, regarding verification of the effectiveness of the provision of information, after having created an experimental plan, vehicle behavior will be analyzed and evaluated from the viewpoints of safety and smoothness of the running of an autonomous driving truck. Specifically, after checking the accuracy of the provision of information in the demonstration experiment, several evaluation indexes will be set, and evaluation value will be calculated according to whether there is the provision of information or not (see Table). Also, in order to grasp the effects of a difference in the flow of through traffic on the merging support information, we plan to verify the effectiveness of the merging support information provision system, by performing traffic simulations based on the measured values that have been obtained in the demonstration experiment. Based on the results of these, we plan to create the technical specifications of the merging support information provision system for autonomous driving trucks within FY 2025.

Note that in FY 2025 and thereafter, it is planned that similar demonstration experiments in other routes (Tohoku Expressway, etc.) will be conducted by the NILIM, and we plan to enhance the technical specifications of the road-vehicle cooperation system for autonomous driving trucks through the accumulation of findings obtained in the experiments.

Table Evaluation criteria and indexes for the effectiveness of the provision of merging support information

Evaluation criteria	Evaluation index	Description
Comfort	Speed	Speed of the autonomous driving truck
	Acceleration	Acceleration of the autonomous driving truck
	Angular velocity	Angular velocity when the autonomous driving truck turns
Safety	TTC	The time until the following vehicle catches up with the vehicle ahead, when the autonomous driving truck and a vehicle on a through lane are maintaining the speed and the running direction
	PICUD	The relative position of the following vehicle that has decelerated suddenly with a delay after the autonomous driving truck has decelerated suddenly
Smoothness	Avoidance operation	Vehicle lane change that has been performed by a through traffic vehicle before and after merging of the autonomous driving truck to through traffic
	Deceleration	Deceleration of a through traffic vehicle before and after merging of the autonomous driving truck to through traffic
	Disturbances in through traffic	Disturbances that occur in through traffic lanes before and after merging of the autonomous driving truck to through traffic

* "Comfort" is evaluation on the amount of change in the vehicle behavior of the autonomous driving truck, "safety" is evaluation on the latent possibility of collision between the autonomous driving truck and a through traffic vehicle, and "smoothness" is evaluation on the effects of merging of the autonomous driving truck to through traffic on through traffic.

4. Conclusion

This paper has presented an overview of the demonstration experiments and research conducted by the NILIM toward the realization of autonomous driving supported by road infrastructure. The NILIM would like to continually contribute to the early realization of autonomous driving that will be of help to the securing of distribution and human flow that are sustainable, in cooperation with those in charge of policies, researchers, and business operators in Japan and overseas.

☞References

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Development of Evaluation Techniques for Energy Saving Retrofitting of Existing Office Buildings

(Research period: FY 2022 to FY 2024)

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(Key words) existing building, decarbonization, energy saving, retrofitting, ZEB, simulation

1. Background and purpose of research

In order to realize decarbonization in Japan, further energy saving of not only newly built buildings but also existing buildings is indispensable. In office buildings, etc. (non-residential buildings), re-design based on the diagnosis of the current condition at the time of equipment renewal (air conditioning and lighting, etc.) to be performed every 10 to 20 years enables great energy saving effects to be obtained by reasonable additional investments (Fig.-1). However, such retrofitting (energy saving retrofitting) is not well recognized at present, and it is very seldom performed. Therefore, in this research, techniques are developed that evaluate quantitatively to what extent energy consumption can be reduced by retrofitting, for the purpose of providing guidance for retrofitting with greater effects. Here, when formulating a retrofitting plan, it is the general practice to determine whether retrofitting should be performed by simplified evaluation, and for a prospective building, to carry out detailed studies by conducting a survey, taking time. Therefore, 2 types of methods are developed: "simplified evaluation method" in which energy saving effects are roughly estimated in a simplified manner by conducting a current condition survey of about 1 hour; and "detailed evaluation method" in which energy saving effects are estimated precisely by considering the actual operating conditions of the building based on a more detailed survey. Note that both of the evaluation methods are based on the program used for determining conforming to building energy codes when constructing a new building (web program), and the settings of default values and expansion of functions are made so the program is more suitable for the evaluation of existing buildings.

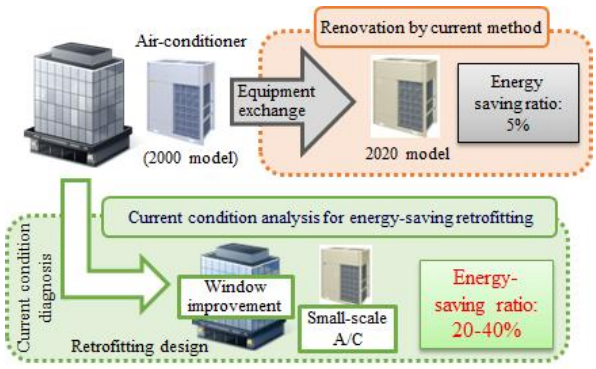


Fig.-1 Energy saving retrofitting work based on diagnosis of the current condition

2. Overview of the developed evaluation methods

(1) Simplified evaluation method

The simplified evaluation method has been designed to be a method that enables evaluation to be performed without taking time as much as possible by performing simplification shown below, based on the "model building method (for small buildings)."

- The range of entry of the building envelope and equipment specifications is limited to that of a "representative room."
- Regarding thermal insulation specifications (thermal insulation material type, thickness) and opening area specifications (performance of window frame and glass), default values are set that are used when the specifications are unknown.
- Ventilation equipment is excluded from the target of entry, and the target of entry of the hot water supply equipment is limited (only kitchen and bathroom uses in part of the building uses).

Information required for evaluation by the simplified evaluation method is shown in the table. If these 13 items can be grasped by the current condition survey, the current energy performance (BEI; a value obtained by dividing the estimated value of energy consumption of the building by the reference energy consumption specified by the national government) can be calculated. Also, by changing the value of each item, it can be grasped quantitatively to what extent the energy saving performance will be improved by retrofitting.

(2) Detailed evaluation method

The detailed evaluation method has been designed to be a method that enables energy saving performance more precisely, on the basis of the results of the current condition survey, by adding the functions shown below based on the "standard input method."

Table Information required for evaluation by the simplified evaluation method

	Entry item	Current condition survey method
1	Regional category (select)	To be selected from location
2	Building use (select)	To be determined by interviewing
3	Floor area of the portion subject to calculation [m^2]	To be calculated from drawings
4	Floor area of the portion subject to calculation to be air-conditioned [m^2]	
5	Type of opening area/fitting (select)	To be checked visually at site (Use existing values, if unknown)
6	Type of opening area/glass (select)	
7	With or without of blind (select)	
8	Type of exterior wall/thermal insulation material (select)	
9	Type of roof/thermal insulation material (select)	
10	Type of air conditioner heat source (select)	
11	Rated capacity of air conditioner heat source (cooling, warming) [kW]	
12	Type of main lighting equipment (select)	
13	Type of main hot water supply equipment (select)	

- The weather conditions (temperature, solar irradiance etc.) on the construction site can be entered.
- The room use conditions of each building (usage time of each room, air conditioning period, air conditioning setting temperature, lighting usage time, occupant density) can be entered.
- The actual performance of each piece of equipment/control (energy performance curve of air conditioning heat source and energy saving effects by means of automatic control) can be entered.

Although much information is required to perform evaluation by the detailed evaluation method, such information is required definitely when designing retrofitting. By proceeding with retrofitting design while performing quantitative evaluation by this evaluation method, retrofitting proposals with greater effects can be derived.

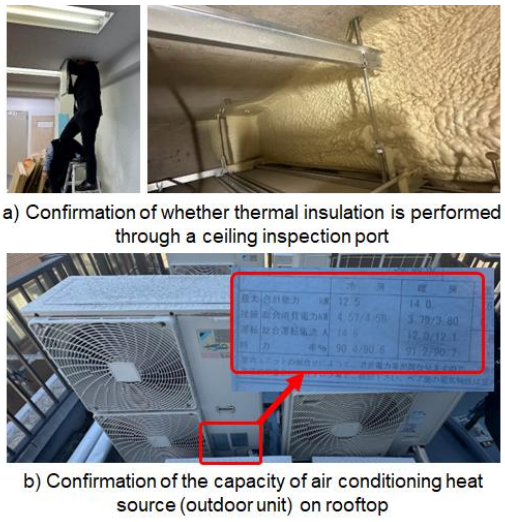
3. Trial of evaluation

(1) Simplified evaluation method

As an example of trial, Fig.-2 shows the scenes when applying the simplified evaluation method to an office building located in Tokyo (10-story, about 900m^2). The current condition survey was conducted by 4 persons, and was completed in about 1 hour. The current BEI is 1.17, and it has been found that, by renewal of the air conditioning units and lighting equipment, energy saving of about 30% can be achieved.

(2) Detailed evaluation method

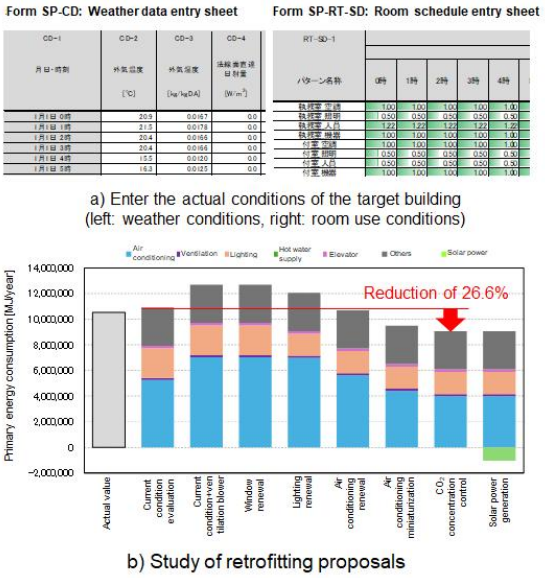
As an example of trial, Fig.-3 shows the results of applying the detailed evaluation method to an office building located in the Philippines (4-story, about 7,000m^2). The current condition survey was conducted by 3 persons for 2 days. Based on the results of the current condition survey, evaluation was carried out by entering the weather conditions and room use conditions of the building. It has been found that, by retrofitting the windows (introduction of vacuum glass), air conditioning (efficiency improvement, miniaturization), and lighting (introduction of high



a) Confirmation of whether thermal insulation is performed through a ceiling inspection port

b) Confirmation of the capacity of air conditioning heat source (outdoor unit) on rooftop

Fig.-2 Trial of the simplified evaluation method (scenes of the current condition survey)



a) Enter the actual conditions of the target building (left: weather conditions, right: room use conditions)

b) Study of retrofitting proposals

Fig.-3 Trial of the detailed evaluation method (studies of retrofitting proposals)

efficiency LEDs), there is an energy saving effect of 26.6% even when considering an increase in energy consumption by the introduction of ventilation fans that are not installed at present, and energy saving of 36.6% can be achieved by additionally installing solar power generation (117 kW).

4. Conclusion

For the purpose of further promotion of energy saving retrofitting of existing office buildings, etc., techniques for evaluating energy saving retrofitting effects (simplified evaluation method, detailed evaluation method) have been developed. In future, we would like to create easy-to-use interface, and at the same time to attempt to add retrofitting proposal support functions by utilizing AI.

Publicizing of "Smart City Case-Study Collection [Introduction] - Toward the Matching between Urban Challenges and New Technologies -" Ver2.0

(Research period: FY 2023 to FY 2024)
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(Key words) smart city, urban challenge, new technology, case-study collection

1. Introduction

For the purpose of providing support for local public entities when they examine the direction of solving major urban challenges by utilizing new technologies such as IoT (transformation into a smart city), the NILIM is engaged in a systematic organizing of new technologies that can be used for the solution of various challenges of cities, and research and development concerning planning evaluation techniques related to the effects of the solution of major urban challenges by utilizing new technologies.

This paper presents the latest version, Ver2.0, with the recent addition of case studies, of the "Smart City Case-Study Collection [Introduction]"[2)] that takes up smart city case studies in various parts of Japan as the subject, and presents new technologies that may possibly be introduced for major urban challenges in one-to-one correspondence, by focusing on the problems and solutions when introducing such technologies and the evaluation methods for the effects of introduction.

2. Overview of the Smart City Case-Study Collection

(1) Background

In the questionnaire survey conducted by the NILIM in FY 2020, many local public entities stated that "we do not know what kinds of technologies can be utilized for the urban challenges we are facing,". Many businesses expressed their opinion that "we do not know what kinds of urban challenges can be solved by utilizing the new technologies we possess," however we realized once again the necessity of sharing information on the matching between urban challenges and new technologies.

In light of that, we have decided to create a case-study collection that systematically presents new technologies that may be introduced to solve major urban challenges, on the condition that the collection of this data will be utilized by local public entities and businesses that intend to engage in a smart city from now on.

(2) Features of the Case-Study Collection

This Case-Study Collection is not simply a presentation of each project, but it also has features that include how new technologies may be introduced for major urban challenges in one-to-one correspondence. It focuses on the problems and solutions when introducing such technologies and the evaluation methods for the effects of introduction. Also, a table of contents includes each of the items: "urban challenges," "new technologies" and "local public entities," enabling case studies to be searched in a multifaceted manner.

(3) Combinations of urban challenges and new technologies

In this Case-Study Collection, "new technologies" that are introduced in model projects, etc. of the national government are extracted, and they are associated with "urban problems" that are expected to be solved by the introduction of the new technologies, and case studies are narrowed down from the viewpoints of extraction that, among such associations, case studies in which the "urban challenge" and "new technology" are likely to be placed in one-to-one correspondence or case studies that have actually been introduced in the stage of implementation or in the stage of demonstration and experiment should be extracted (Fig.-1).

Urban challenge \ New technology		h Automobile	f Data utilization	c Analysis /forecasting	b Observation	a Communication	i Drone/robot	d Data foundation	e Big data	g Energy	Total
A	Transportation	14		3		2	1	1			21
C	Bustle	2	5	4				2	1		14
D	Health and healthcare	2	3	1	1	1		2	1		11
G	Disaster management		2		2	3	1	1	2		11
F	Environment		2	1	2		1			2	8
B	Industry	2	1				4				7
E	Infrastructure	1		1	2		1	1			6
H	Security				2	3					5
I	Common to all fields		2								2
Total		21	15	10	9	9	8	7	4	2	85

Fig.-1 Combinations of urban challenges and new technologies (number of case studies)

3. Overview of the case studies presented in the Case-Study Collection Ver2.0

In the "Smart City Case-Study Collection [Introduction]," 9 case studies mainly covering urban challenges such as the environment and disaster management were newly added to the 76 case studies presented in Ver1.0 (Table).

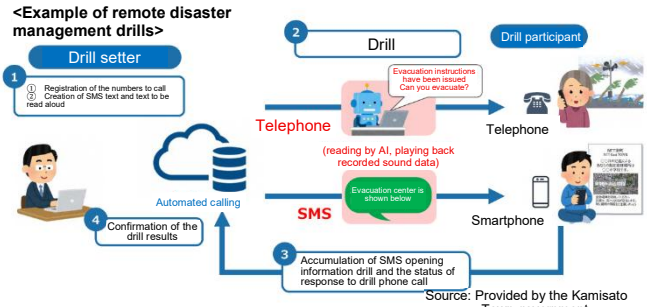
Table 9 case studies added to the Case-Study Collection Ver2.0

	[Urban challenge] x [New technology]	Local public entity
①	Sharing/joint utilization of disaster information x Drone for monitoring	Jinsekikogen Town, Hiroshima Prefecture
②	Evacuation guidance x Push-type information transmission by concurrent calling	Kamisato Town, Saitama Prefecture
③	Evacuation guidance x Push-type information transmission by apps	Minato Ward, Tokyo Metropolis
④	Support for moving the elderly x Autonomous vehicle	Kasugai City, Aichi Prefecture
⑤	Measures to mitigate heat in city centers x 3D urban environment simulation	Kumagaya City, Saitama Prefecture
⑥	CO2 emissions control by citizens x Visualization tools	Kanagawa Prefecture
⑦	Increasing efficiency in garbage collection/processing x Smart garbage bins	Hiroshima Prefecture/Kobe City
⑧	Increasing efficiency in garbage collection/processing x Resident participation support tools	Kameoka City, Kyoto Prefecture
⑨	Promotion of rambling at city center x Integrated apps	Kumagaya City, Saitama Prefecture

Some of the case studies added in Ver2.0 are presented below.

(1) Evacuation guidance x Push-type information transmission by concurrent calling

In Kamisato Town, Saitama Prefecture, efforts are being made that take into consideration, the digital divide when it comes to delivering necessary information promptly to the elderly households and residents who do not have smartphones. Evacuation guidance, etc. when a disaster has occurred is implemented using a mechanism in which information by means of sound guidance is sent to pre-registered landline telephones by concurrent calling, for the purpose of increasing efficiency in information transmission among staff in the disaster management operations such as transmission of information for residents when a disaster has occurred and the management of evacuation centers (Fig.-2).

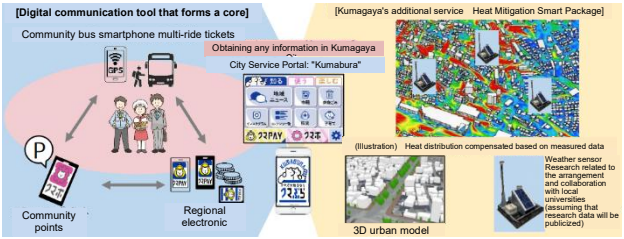


Source: Provided by the Kamisato Town government

Fig.-2 Push-type information transmission by concurrent calling (Kamisato Town)

(2) Measures to mitigate heat in city centers x 3D urban environment simulation

In Kumagaya City, Saitama Prefecture, visualization of temperature changes in each area of the city on representative days in summer and in winter and the selection of areas suited to smart towns are implemented by utilizing the 3D urban model data and the weather data in 31 locations in the city where equipment is installed to transmit heat illness information. Also, by calculating the amount of heat radiated when walking, trial calculations are made to evaluate the risks of heat related illness when living in such residential areas (Fig.-3).



Source: Cool City Smart Package, Kumagaya City Implementation Plan, Updated in December 2023

Fig.-3 Measures to mitigate heat in city centers (Kumagaya City)

(3) Increasing efficiency in garbage collection/processing x Resident participation support tools

In Kameoka City, Kyoto Prefecture, efforts are being made in a project aimed at building an environment where littering is unlikely to occur. Services have been provided since April 2022 in which the status of littering can be reported through the SNS account of the City. Analyzing the littering report data thus obtained, IoT garbage bins "SmaGo" have been installed at the North and South Exits of JR Kameoka Station that are crowded with people, where the number of littering reports was numerous, and are utilized for the processing of littered garbage that has been collected by cleaning activities (Fig.-4).

Illustration of littering report mapping

Illustration of installation at JR Kameoka Station North Exit (top) and South Exit (bottom)

Source: Kameoka City website page ID: 0032708

Fig.-4 Increasing efficiency in garbage collection/processing (Kameoka City)

4. Conclusion

At present the NILIM is making efforts in the creation of an evaluation model (draft) by which forecasting and evaluation are carried out quantitatively at the planning stage and the stage of progress, as to whether the effects of solution of urban challenges could be obtained that match the cost of introduction and operation of new technologies in a smart city. Regarding the "Smart City Case-Study Collection [Introduction]," we would like to revise it whenever necessary by continually engaging in the addition of case studies of efforts and the updating of the content in line with technological reform.

☞For more detailed information, visit:

1) Website of the Urban Planning Division
https://www.nilim.go.jp/lab/jbg/smart.html
2) "Smart City Case-Study Collection [Introduction]" Ver2.0
https://www.nilim.go.jp/lab/jbg/pdf/smart/SC_CASES_V2_0.pdf

Study Toward the Enlargement of Application of Technical Proposals and Negotiation Method

(Research period: FY 2022 -)
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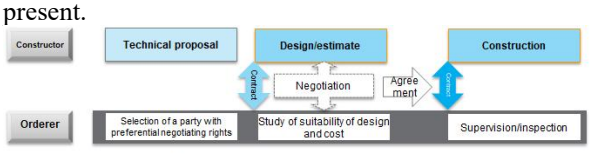
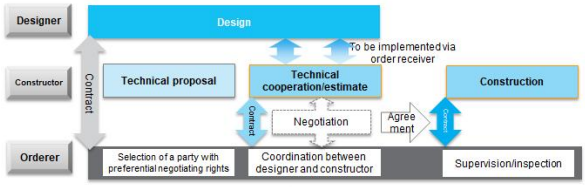
(Key words)　tender contract system, technical proposal/negotiation method, ECI, guideline revision

1. Introduction

With the enactment of the "Act on Promoting Quality Assurance in Public Works (Quality Assurance Act)" in 2005, the expansion of applications for the general competitive bidding/comprehensive evaluation method has been advanced, and the general competitive bidding/comprehensive evaluation method is being applied to most of the projects under the jurisdiction of the Ministry of Land, Infrastructure, Transport and Tourism. On the other hand, the amendment of the Quality Assurance Act in 2014 newly specified a "method by means of examination of technical proposals and negotiation on prices" (hereinafter called the "technical proposal/negotiation method") by which, in the case of works that involve difficulty in the finalization of specifications, it is possible to finalize the specifications and specify a target price through examination of technical proposals and negotiations on prices. With this method, process improvements and the effects of the utilization of technologies proposed by the contractor can be expected by incorporating the findings of the construction company from the design stage, and the 2 types shown in Fig.-1 are applied at present.



(a) Design negotiation/construction type



(b) Technical cooperation/construction type

Fig.-1 Contract type of the technical proposal/negotiation method

Using the comprehensive evaluation method, it is difficult to make a proposal accompanied by object changes and discussions, but by applying the technical proposal/negotiation method, it is possible to make a proposal by utilizing the original technology and know-how of the contractor. In addition, a detailed and optimum construction plan can be devised that takes into consideration the social conditions and site restrictions, thus enabling a design with high realizability and certainty. Additionally, selection of the optimum construction method can be made after having examined the cost-effectiveness and length of the construction period. It has been confirmed that this results in shortening the construction period and risk reduction during construction.

As of December 2024, a total of 42 cases of the technical proposal/negotiation method have been applied to the projects under the jurisdiction of the MLIT, but further grasping of problems and improvements are required in order to further expand this application.

In this paper, examples of the effects of specific application cases using the technical proposal/negotiation method will be presented, and then the problems that became evident in the process of interviewing, etc. and a policy for addressing such problems will be reported.

2. Grasping the problems encountered in the technical proposal/negotiation method and a policy for addressing those problems

As described above, various effects can be seen when applying the technical proposal/negotiation method, but there are also problems with the application and operation of the current system. Our Division has grasped problems through interviewing and questionnaires with customers who place an order as well as contractors. Fig.-2 shows the results the details. In response to these problems, it has been determined that the Operation Guidelines for the Technical Proposal/Negotiation Method in Projects under the Jurisdiction of the MLIT (hereinafter called the "Guidelines") shall be revised in 2 stages: short term and mid- to long-term. We have conducted a study of the following 3 points, which are mentioned to be short-term problems that can be addressed urgently. "① The effectiveness of the technical proposal/negotiation method may not be utilized in some cases," "② A large load before receiving an order," and "③ Response to change in the construction type that is not set in the requirements for engineers planned to be deployed."

① Study of response to GL revision (this time), ② Study of GL revision (mid- to long-term), ③ Response other than by GL, ④ Response is difficult

Classification	Minor classification	Main opinions	Response policy
Construction period/construction cost	Short technical cooperation period (design period)	- If the period of technical cooperation work is short, even in cases where it is assumed that an essential solution is possible when discussions with relevant persons are in order, there are cases in which the proposal must be withdrawn.	③ Response other than by GL
	Deviation between order receiving and placement parties on the technical cooperation work cost	- Although the contract amount of technical cooperation work is 5 million, the actual amount required is 10 times such contract amount.	② Study of GL revision (long-term)
	Judgment on the suitability of estimate prices is difficult	- A concept of the suitability of an estimate by one company is desired. (orderer) - There was a great deviation between the reference amount and the estimate amount of the constructor. (orderer) - There is a possibility that the proposed specifications have been adopted as they are, without performing a screening of the technical proposal. (orderer)	② Study of GL revision (long-term)
	About the width of the arrangement of estimated construction cost in the tender explanation document	- Due to the possibility of the construction contract amount being changed greatly through investigation and studies, and in order to urge better proposals by participants, the description of the estimated construction cost in the tender explanation documents should have a certain range of width.	④ Response is difficult
How to proceed with work sharing, etc.	Appropriate response to change	- In the contract document, matters to be changed are specified in Articles 18, 19, and 20, but it is difficult to change the matters due to the standpoint of the party with preferential negotiating rights.	③ Response other than by GL
	Risk sharing (concept of change in contract amount)	- Risk sharing (orderer, designer, and the party with preferential negotiating rights) should clearly be defined.	② Study of GL revision (long-term)
Revision of Guidelines (this time) / Load, etc. of order receiving and placement procedures	The effectiveness of the technical proposal/negotiation method may not be utilized in some cases.	- Toward the enlargement of utilization of the technical proposal/negotiation method, the details of the applicable works suited to ECI should be indicated. - Discussions among relevant organizations are not sufficiently in order, and the advances of the technical proposal/negotiation method are not fully utilized.	① Study of response to GL revision (this time)
	Large load before order receiving	- The range of the subjects of technical proposal evaluation should be narrowed. - The setting of the subjects of technical proposal that require both a shortening of the construction period and a reduction of the construction cost should be discontinued.	① Study of response to GL revision (this time)
	Response to change in construction type not set in the requirements for engineers planned to be deployed	- The handling of cases should be clearly defined, in which the requirements for engineers planned to be deployed are not met that were set at the time of public announcement, due to a change in the construction method, etc. during the design period.	① Study of response to GL revision (this time)
	Large load in order placement procedure	- There is a burden of the procedures for starting specialty subcommittees and various deliberations and preparations.	② Study of GL revision (long-term)
	Technical proposal submittal period	- Regarding a proposal in which structural change can be made, structural calculation is required, and so the period from public announcement to the submittal of a technical proposal should be 2 months or more. - Regarding the volume of a technical proposal document, a guide should be shown as an example, and the number of proposals per subject and the number of sheets of the document should be reduced.	② Study of GL revision (long-term)
	Burden regarding reference amount	- Re-submittal of a technical proposal and an estimate based on the reference amount should be deleted, because it puts a great burden in terms of both aspects of work and period. - The reference amount was calculated based on the construction cost of the downbound line, but the reference amount was small, without a correction of two days off per week and a rebate of the successful bid rate . (orderer) - The basis for the setting of the reference amount was unknown. (constructor)	② Study of GL revision (long-term)
	About duplication of evaluation items	- The details described in individual problems are likely to be duplicated with the description of the degree of understanding, and if the required details are different, it should be clearly stated to that effect.	② Study of GL revision (long-term)
	Period until notification of the creation of design documents for technical cooperation work	It appears that the period from the notification of the selection of preferential negotiating rights to the creation of design documents for technical cooperation work differs with the works, but the rough period should be clearly indicated as a guide. In the properties we worked on, the work started with the design conditions remaining unfinalized, the period of around one month was insufficient.	② Study of GL revision (long-term)
	Publicizing of material required for the creation of a technical proposal document	The material required for the creation of a technical proposal document should be publicized at an early stage. (Clear indication of the publicizing period)	③ Response other than by GL
	About the improvement of a technical proposal	- An improvement proposal document should be capable of being submitted without fail after interviewing. (A better proposal can be made by checking the difference in concept between the order receiver and the orderer.)	③ Response other than by GL
	Clarification of the public announcement period	The period for public announcement should be clearly indicated.	③ Response other than by GL

Fig.-2 Policy for addressing the major problems of the technical proposal/negotiation method

As the background of the opinion that "① The effectiveness of the technical proposal/negotiation method may not be utilized in some cases," there may be cases where there will be an influence of the projects in surrounding areas and various types of insufficient coordination resulting in suspension of project, a delay in the construction period, and re-examination of the construction method. In that case, the advantages of the technical proposal/negotiation method cannot be utilized. Therefore, when applying the technical proposal/negotiation method to the Guidelines, precautions have been clearly stated, and cases of applicable projects such as bridge repair which in recent years the application of the method has been expanded. We anticipate that this will lead to support for the person in charge of the practical work of order placement, and aid the expansion of application of the technical proposal/negotiation method.

As for the background concerning "② A large load before receiving an order," there also was an opinion such that the load on the participants in competition was great, due to the setting of contradicting technical proposal subjects of a shortening of the construction period and a reduction of the construction cost as well as the setting of technical proposal subjects that have a wide range of the matters to be examined, as the proposal subjects required by the orderer during the section of technical cooperation work. Therefore, precautions so that the range of technical proposals required will not be too wide, not requiring a shortening of the construction period and a reduction of the construction cost simultaneously, and others have been clearly stated.

As for the background concerning "③ Response to change in the construction type that is not set in the requirements for engineers planned to be deployed," in the works to which the technical proposal/negotiation method is applied, there were cases in which the details of construction were changed to those of a construction method that was different from the experiences of construction required for the engineers that were planned to be deployed at first, as a result of a study of design during the design work period. Therefore, as response to be taken hereafter, the experiences required for the engineers that are planned to be deployed shall be set based on the possibility of change after the technical cooperation work, and it has been determined that the Guidelines shall clearly state that, if a construction method has been adopted, which is different from that involving the experiences required for the engineers that are planned to be deployed in the stage of technical cooperation work, and the engineers that have been deployed do not have experiences in such construction method, it shall be described in the public announcement material, requiring that engineers having the experiences in such construction method should be deployed as substitutes, or such engineers should be deployed separately.

These details as mentioned above had been reflected in the revision of the Guidelines in February 2025.

3. Conclusion

The technical proposal/negotiation method is an effective technique in construction in which the findings of the constructor should be utilized, but there also are problems stated above, and we are seeking improvements as appropriate, in cooperation with the MLIT, etc.

A follow-up for the system of the technical proposal/negotiation method will be implemented continually, in order to make improvements in the problems that have been determined to be studied continually, and at the same time support, etc. for each of the order placing organizations will also be provided continually.

☞For more detailed information, refer to:はこちら

1) FY 2024 Discussion meeting concerning how the construction production and management system ought to be in future in order to fulfill the responsibility of an orderer (FY 2024 Construction Production and Management System Subcommittee 1st meeting (June 25, 2024))

Disclosing Catalog for Sewerage Pipeline Survey Devices

(Research period: FY2022 ~)
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(keywords) stock management, sewerage pipeline survey, survey devices

1. Introduction

For the management of sewerage pipeline facilities, we have a lot of needs for technical development of survey devices including improvement of survey speed and introduction at places difficult to survey. NILIM created "sewerage pipeline simulation facilities" in FY2021, reproducing a life-size pipeline and started experiments in FY2022 to clarify the function of sewerage pipeline survey devices and to promote further technological development by private companies, and also to enable local governments to select survey devices suitable for usage when conducting a sewerage pipeline survey.

In July 2024, we summarized survey devices for sewerage pipeline facilities used for two-years' experiments in "catalog for sewerage pipeline survey devices" (hereinafter referred to as "Catalog") and disclosed the Catalog in NILIM's homepage, so we will explain its overview.

2. Sewerage pipeline simulation facilities

The sewerage pipeline simulation facilities are mainly composed of pressure pipes (rigid polyvinyl chloride pipe), small diameter pipelines and large diameter pipelines (reinforced concrete pipe) (Figure-1). The small diameter pipelines and large diameter pipelines can reproduce such various abnormalities that occur within the sewerage pipeline facilities as cracks and corrosion by setting abnormality simulation steel plate at the opening (Figure-2), and also can reproduce water flow and wind inside the pipeline by using water storage tank and ventilator, therefore, it is possible to make quantitative evaluation of survey devices under conditions similar to the actual situation.

Figure-1 Bird's eye view of sewerage pipeline simulation facilities

3. "Catalog for Sewerage Pipeline Survey Devices"

(1) Selection criteria for devices subject to publication

As the selection criteria for devices which are subject to publication, we basically select survey devices used in experiments on performance verification at the sewerage pipeline simulation facilities started in FY2022. In addition, the survey devices used in experiments do not fully cover all the survey devices put into practical use.

(2) Devices subject to publication and the details

There are 17 devices in total published in Catalog and they are classified into self-running, flying and floating, etc. depending on their characteristics.

For these survey devices, we published the data considered to be referenced when selecting survey devices (applicable conditions, camera performance and daily survey length, etc.) after verifying the details with each survey device manufacturer.

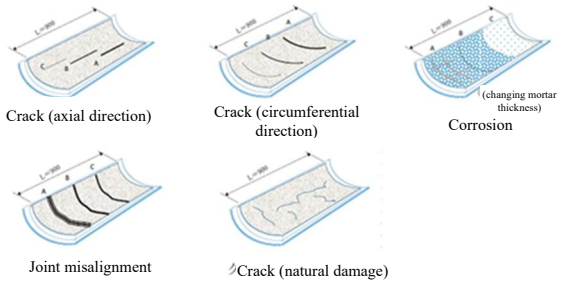


Figure-2 Abnormality simulation steel plate (for φ200 and 250)

(3) Overview of experiments

We publish the overview of experiments done at the sewerage pipeline simulation facilities and the experiment results for various survey devices at the end of Catalog as reference. In addition, as for the experiment results for various survey devices, they are the results obtained under predetermined conditions at the sewerage pipeline simulation facilities, therefore they do not necessarily guarantee the performance of each survey device.

We show the overview of the experiments done in ① ~ ⑤.

① Survey performance experiment for abnormality inside the pipeline for small diameter pipelines and large diameter pipelines

We inserted the survey device from the starting point (entrance hole), surveyed the abnormality inside the pipeline reproduced using the abnormality simulation steel plate and the intruding water, etc. reproduced at the opening, and summarized the survey performance for abnormality in the pipeline from the survey results, and calculated the daily survey length.

As the result of the experiment, we found that it was possible to identify the extent of abnormality in addition to the type of abnormality with survey devices having high resolution.

② Roadability experiment at cross-sectional obstruction part for small diameter pipelines and large diameter pipelines

We reproduced a cross-sectional obstruction part by inserting / throwing in an obstruction object from the opening and then threw in the survey device from the starting point (entrance hole) and let it move forward up to the roadable place and summarized its roadability at the cross-sectional obstruction part.

We found out such tendencies that as for the self-running type, it was substantially affected by protrusion of branch pipes, and as for floating type and flying type, they were substantially affected by the intrusion of tree roots.

③ Long-range flying quality experiment by drone for large diameter pipelines

We inserted drone type survey device from the starting point (entrance hole) and made a continuous flying experiment making the straight-line part as flying section. When it reached the end of the straight-line part, we continued the experiment repeatedly and we measured the total moving distance and the flying speed when continuously flying with one-time charged battery. When we acknowledged that the flying was difficult due to the impact of water height in the pipeline, we suspended the flying even if the battery remained.

④ Flying quality experiment by drone under windy condition inside the pipeline for large diameter pipelines

We reproduced the wind in the pipeline using a ventilator and studied the impact to the flying quality of the drone type survey device.

Among the survey devices we did experiments with this time, there were some devices whose flying speed decreased, compared to the time having no wind.

⑤ Insertion performance experiment for pressure pipes

We verified the insertion performance (whether it is possible to insert or not, insertion length) by pushing in the survey device from the flange for air valve and observing the movement of camera and cables when passing through the curve toward horizontal and vertical directions and at full insertion.

We show a part of actual experiments on NILIM's YouTube channel (Figure-3).

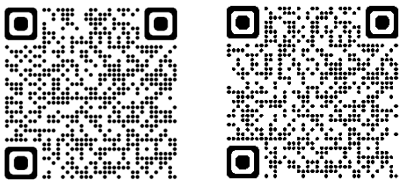
4. Future prospects

As for Catalog we have disclosed this time, we expect that local governments, in particular, would utilize it as study documents to use new technologies when they bid for such projects as maintenance and management of sewerage pipelines and have discussions with the successful bidders. Therefore, we plan to update it in line with the future technological development in a timely manner.

As we have an inquiry counter on publication in catalog in Wastewater System Division of Water Supply and Sewerage Department, we would like anyone to use this counter for consultation on publishing new survey devices, etc.

In addition, from May 2024, we started offering to let our sewerage pipeline simulation facilities be used on charged basis to such external institutions as private businesses, universities and local governments. They can be used as experimental fields for private businesses' technical development in addition to performance test of survey devices for publication in Catalog.

We hope that the disclosure of Catalog and the start of lending out our sewerage pipeline simulation facilities will contribute to further technical development of survey devices and promotion of new technology utilization, and thereafter to efficient stock management of sewerage pipelines.



Left: Survey performance experiment for abnormality inside the pipeline by drone using the sewerage pipeline simulation facilities
Right: To conduct performance verification and comparative experiment for inspection and survey devices of sewerage pipelines

Figure-3 NILIM's YouTube channel

☞Detailed information is as follows.

1) Wastewater System Division Homepage, Catalog for Sewerage Pipeline Survey Devices
https://www.nilim.go.jp/lab/ebg/catalog.html

Rationalization of Sound Isolation and Lighting Performance Evaluation in the Housing Performance Indication System

(Research period: FY 2022 to FY 2026)
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(Key words) Housing Performance Indication System, sound isolation, lighting

1. Introduction

The indoor living environment required for housing has become varied in recent years due to the advancement of working from home, and a method for appropriate evaluation is needed according to each varied level required. Also, as part of the measures to counter sub-replacement fertility, homes are needed where children can be raised securely. One aspect of this is the necessity of expanding housing complexes with high quality sound isolation.

One of the metrics for evaluating the quality of housing is the Housing Performance Indication System pursuant to the "Act on the Promotion of Housing Quality Assurance." The Equipment Standards Division is engaged in research and development that contribute to the establishment of evaluation techniques corresponding to changes in the needs in recent years, regarding the matters related to the light and visual environments and sound environment, among the matters related to the indoor living environment. This paper presents the details of studies toward the rational improvements in the evaluation methods for sound isolation performance and lighting performance.

2. Survey on the sound isolation performance of non-RC housing complex

Regarding non-RC housing complex, there are two methods for obtaining sound isolation performance data. One is shown by the housing supplier side: cases where measurements are made in an actual building; and the other is cases where it is made in a laboratory. But no methodology re-reading the difference in the method of measurement has yet been established, and it has been pointed out by consumers in general that a comparison between these two types of data is difficult to understand.

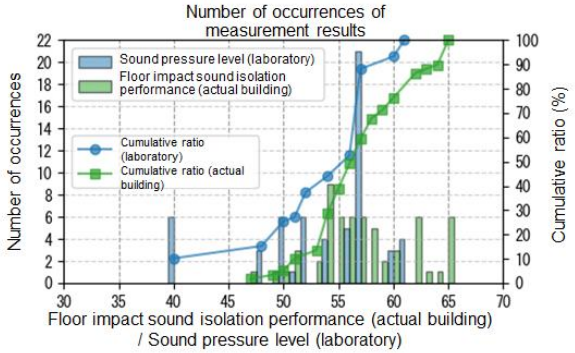

Fig.-1 Comparison of sound isolation performance between an actual building and a laboratory building

The NILIM collected and compared the data of sound isolation performance against heavy floor impact sound in an actual building and a laboratory having the same floor structure, as obtained by measurements performed by multiple suppliers. A tendency was found in which the data measured in the laboratory was distributed more toward the side of higher performance around several dB than the data measured in the actual building (Fig.-1).

3. Survey on the effects of adjacent environments on lighting performance

The amount of lighting from a window is greatly affected by the area of the window as well as adjacent environments such as the distance from the window to the adjacent building. A study of the relationship between the adjacent environments of an individual building and lighting has been made possible by using daylight simulation, but it involves a high working load and is not suitable for simplified evaluation.

In order to grasp the relationship between the difference in adjacent environments and lighting performance, we carried out a web questionnaire survey, and conducted a study of the effects of the building density neighboring the living area of the replier on lighting performance. A tendency was apparent in which, in a detached house in a low density area, the satisfaction of lighting is likely to be more assured even if the area of the window is small, as compared with that in the high density area (Fig.-2).

4. Future developments

In the Housing Performance Indication System, we plan to continually implement studies that will contribute to the development of evaluation and indication methods that are reasonable and easy to understand, from the viewpoints of both consumers and suppliers.

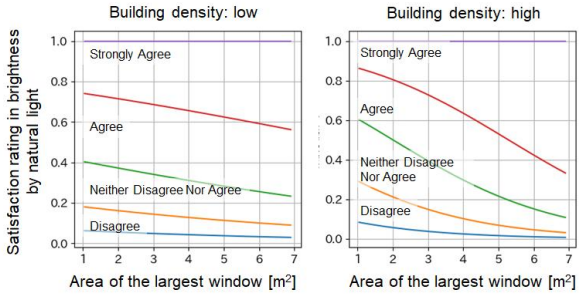

Fig.-2 Relationship between window area and lighting satisfaction

Research on More Effective Management of Public Housing Based on Actual Status of Regions

(Research period: FY 2024 to FY 2026)

UTSUMI Koya (Ph. D.), Senior Researcher
SAKATA Shohei, Head
Housing Planning Division, Housing Department

(Key words) housing safety net, public housing supply target volume, collaboration among regions, private rental housing

1. Introduction

Amid the advance of population decline and an ageing population, in the field of housing safety nets (hereinafter called the housing SN), even more effective management of public housing is required than before. Therefore, the NILIM is engaged in the development of a technique for setting a target volume for the supply of public housing more effectively, based on the studies of ① collaboration among regions and ② the possibility of utilizing private rental housing. This paper presents the basic concept of this technique and the findings acquired until the present.

2. Basic concept

① As for collaboration among regions, collaboration among municipalities is studied. For example, even when demand exceeds supply in A City, if there is a C Village where supply is in shortage in the living sphere including A City, it is considered that demand in the region can be responded to efficiently without excess or shortage through collaboration among regions. (Fig.-1)

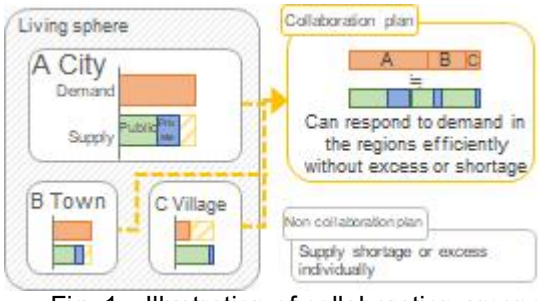

Fig.-1 Illustration of collaboration among regions

② As for the possibility of utilizing private rental housing, the number of houses is estimated by region, that meets the registration standards (seismic performance, floor area) of the SN housing registration system that is a representative utilization method in the housing SN from hardware aspects, and that considers the percentage of owners who intend utilization in the housing SN from software aspects.

By combining these with the results of estimation of the number of households requiring support according to the attribute of the households living in the housing, an optimum matching of supply and demand is studied. For example, if there are many single households living in public housing with a large floor area, it is considered that more appropriate management can be done by matching private rental housing with a smaller size with the households living in the public housing with such attribute. A technique will shall be developed to achieve such management in the form incorporating ① and ② (Fig.-2).

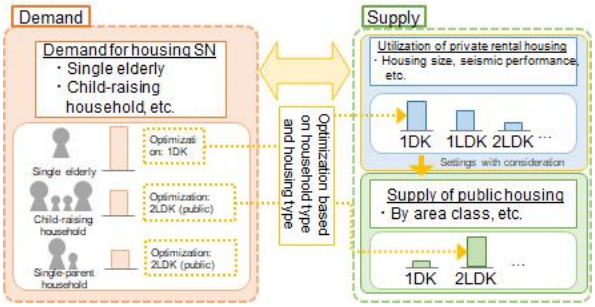

Fig.-2 Illustration of effective settings

3. Future developments

In FY 2024, we created a plan for setting living spheres for each prefecture, and at the same time estimated the number of private rental housing stocks that meet both of the hardware and software conditions for each prefecture. In addition, based on these, we built a basic framework for the effective setting technique for the supply target volume of public housing.

In FY 2025 and thereafter, we will conduct case studies using the technique that has been built, and after making improvements, will organize the technique and prepare for its publicizing.

☞For more detailed information, visit:

1) NILIM website Support program for estimation of the number of households that require consideration in securing housing https://www.nilim.go.jp/lab/ibg/contents/SPG/stockProgram.html

Resident's Assessment of the Effects of External Thermal Insulation Retrofitting in Condominiums

(Research period: FY 2023 to FY 2025)
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FUJIMOTO Hidekazu, Director, Housing Department

(Key words) condominium, external thermal insulation retrofitting, retrofitting effect, questionnaire survey

1. Introduction

As of the end of fiscal year 2022, the total stock of condominium units in Japan has reached about 6.943 million. Many aging condominium buildings exhibit insufficient thermal insulation in their primary structural components. To enhance long-term durability and advance national carbon-neutral goals, promoting energy-efficiency retrofitting has become essential.

This paper reports the findings of a questionnaire survey conducted among condominium residents to assess the effects of external thermal insulation retrofitting.

2. Survey Overview

The survey targeted three condominiums in the suburbs in Kanto that had undertaken external wall thermal retrofitting – specially, external thermal insulation systems - in recent years. Only dwelling units for which at least one year had passed since completion of the works were included. Key building characteristics are summarized in Table-1 (upper section). In all cases, the retrofitting was accompanied by additional improvements to window openings and rooftop insulation..

A structured questionnaire comprising 16 questions (35 sub-questions) was administered, covering respondent demographics, household lifestyle patterns, and residents' assessments of indoor environmental conditions before and after external thermal insulation retrofitting. Survey implementation details for each complex are presented in Table-1 (lower section).

Table-1. Building and Survey Overview

		Condo A	Condo B	Condo C
Building Overview	Location	Chiba City, Chiba	Tama City, Tokyo	Inagi City, Tokyo
	Completed	Sept. 1968	Mar. 1983	Mar. 1993
	Buildings/Units	40 /1,530*1	14/293	7/160
	Floors	5F	3 - 5F	5 - 6F
	Type / Elevator	Staircase w/o E	Staircase w/o E	Single-corridor w/ E
	Structure	RC wall	RC wall (PC)	RC frame / wall
	Major Energy-Efficiency Retrofit Record	2006: Doors 2012: Roof and rooftop 2020: Windows 2021-23: Exterior walls	2021-22: Exterior walls, doors, windows Roof and rooftop	2015: windows 2018: Roof and rooftop 2020: Exterior walls, doors
Survey Overview	Period	Jan. 11 - 26, 2024	Jan. 12 - 26, 2024	Jan. 12 - 26, 2024
	Vaild / Distributed*2	270/879	176/288	108/160
	Response Rate	30.7%	61.1%	67.5%

*1 980 units surveyed, retrofit completed >1 year ago
*2 Excludes vacant units and similar cases.

3. Results

(1) Respondent Characteristics

The average age of the respondents was 70.6 years, the average length of residence was 28.6 years, and the average household size was 2.06 persons. Disaggregated data for each condominium complex are shown in Table-2.

Table-2. Respondent Characteristics

	Overall	Condo A	Condo B	Condo C
Average Age [years]	70.6	72.6	63.8	68.3
Average Years of Residence [years]	28.6	30.1	28.4	25.2
Average Household Size [persons]	2.06	1.76	2.36	2.31

(2) Summer Indoor Environmental Before and After Insulation Retrofitting

① Evaluation of Living-room Temperature

Overall, residents reported predominantly positive evaluations of indoor temperature conditions after retrofitting (Fig.-1). In Condo A, the most frequent response was "No change," whereas in Condo B and C, "Somewhat less hot" was most common, accounting for slightly below 40% of responses.

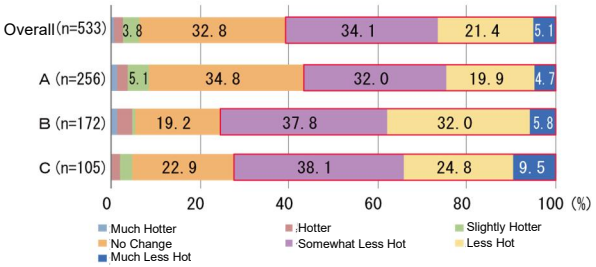

Fig.-1.Summer Living Room Temperature Evaluation After Retrofit

② Changes in Summer Housing and Lifestyle

Across all the three condominiums, residents consistently reported improvements in their summer living conditions, including "Less mold on windows and doors", "Less heat near windows", and "Less heat when entering the house" (Fig.-2). Condo A exhibited a particularly strong trend toward " Less mold on windows and doors", whereas Condo B and C, "Less heat when entering the house " was most prominently reported.

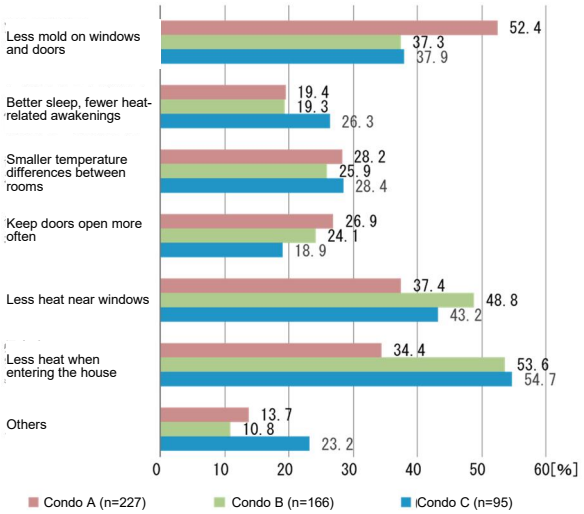

Fig.-2. Changes in Summer Housing and Lifestyle (multiple responses)

③ Summer Electricity Cost and Consumption Before and After Retrofitting

Average summer electricity expenditures in all three condominiums following external thermal insulation retrofitting (Table-3).

Table-3. Electricity Cost and Consumptions in Peak Month (July-September)

	Average Electricity Cost		Average Electricity Consumption	
	Pre-Retrofit / Post-Retrofit	Difference from Pre-Retrofitting	Pre-Retrofit / Post-Retrofit	Difference from Pre-Retrofitting
A	7,916 yen / 7,712 yen	-204 yen (n=111)	255kWh / 255kWh	0 kWh (n=36)
B	10,655 yen / 8,844 yen	-1,812 yen (n=90)	313kWh / 293kWh	-20 kWh (n=46)
C	11,416 yen / 10,686 yen	-731 yen (n=45)	378kWh / 344kWh	-35 kWh (n=24)

(3) Winter Indoor Environmental Before and After Insulation Retrofitting

① Evaluation of Living-room Temperature

Residents reported overwhelmingly positive evaluations—such as “Somewhat warmer,” “Warmer,” and “Much warmer”—across all complexes (Fig.-3). Notably, the degree of positive response was higher in winter than in summer.

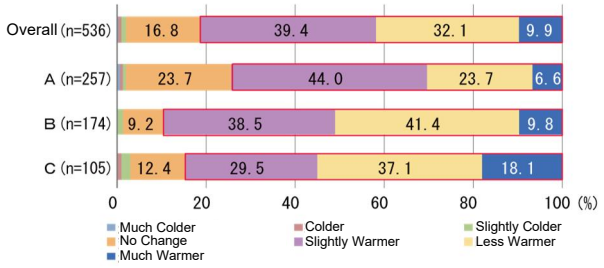

Fig.-3. Winter Living Room Temperature Evaluation After Retrofit

② Changes in Winter Summer Housing and Lifestyle

In all condominiums, “Less mold on windows and doors” was the most frequently reported improvement (Fig.-4). In condo B, where windows improvements preceded external thermal insulation retrofitting in 2021-22, over 60% of residents reported " Less cold near windows" . In Condo B and C, many also cited " Less cold when entering the house".

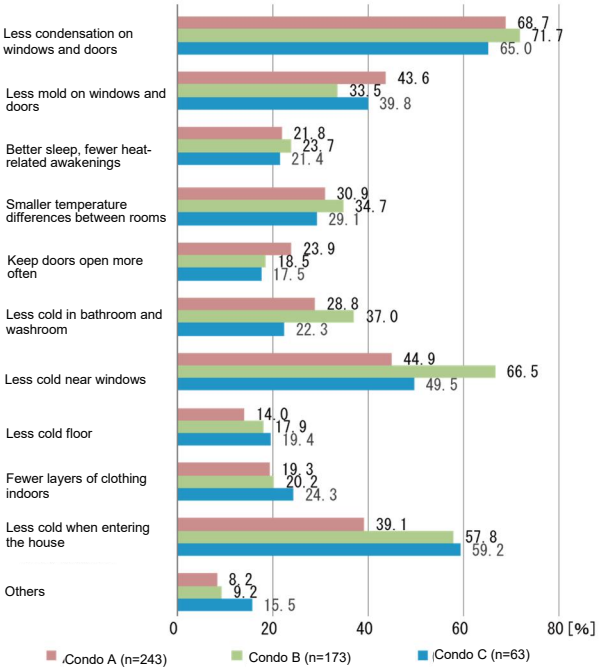

Fig.-4. Changes in Winter Housing and Lifestyle (multiple responses)

③ Winter Electricity Cost and Consumption Before and After Retrofitting

As in summer, average winter electricity expenditures and consumption decreased after retrofitting across all condominiums (Table-4). Gas and kerosene consumption also declined, except for gas expenditures in condo C.

Table-4. Electricity Cost and Consumptions in Peak Month (December – February)

	Average Electricity Cost		Average Electricity Consumption	
	Pre-Retrofit / Post-Retrofit	Difference from Pre-Retrofitting	Pre-Retrofit / Post-Retrofit	Difference from Pre-Retrofitting
A	8,703 yen / 8,204 yen	-499 yen (n=93)	296kWh / 250kWh	-46 kWh (n=37)
B	10,903 yen / 9,778 yen	-1,125 yen (n=81)	337kWh / 286kWh	-50 kWh (n=49)
C	11,992 yen / 11,717 yen	-275 yen (n=43)	411kWh / 344kWh	-66kWh (n=23)

4. Future Work

The survey results confirm both quantitative and qualitative benefits of external thermal insulation retrofitting. Building on the collected data on retrofitting outcomes and associated costs, future work will focus on developing methodologies to quantitatively assess the cost-effectiveness of energy-efficiency retrofitting measures in condominium buildings.

Development of Standard Activity-based Simulator (ABS) Utilizing the Nationwide Urban Transportation Characteristics Survey Data

(Research period: FY 2021 -)

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Urban Facilities Division, Urban Planning Department

(Key words) disaggregate behavioral model, microsimulation, nationwide PT survey, future estimation, urban transportation planning

1. Activity and mobility of a diversifying population

Urban transportation measures are now required that involve not only quantitative response but also that cover the qualitative aspects for improving the well-being of each individual in urban life, against the background of low fertility and population aging, new ways of life such as telework and diversification of activities in public space, propagation of readily available mobility such as GSM (Green Slow Mobility), and the advancement of new technologies such as big data and remote technologies.

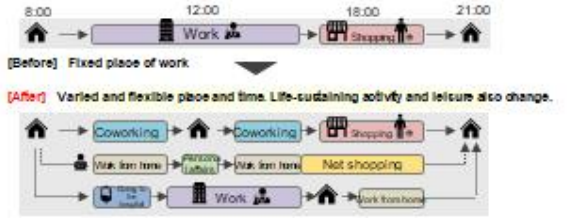

Fig.-1 Post-Covid urban activities have become diversified

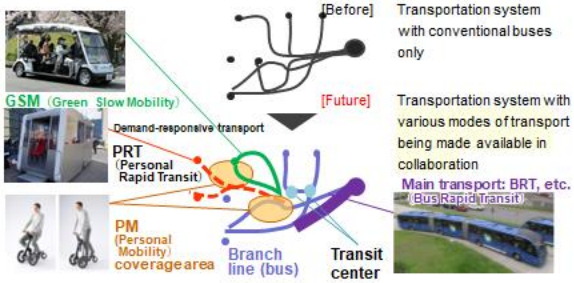

Fig.-2 New mobility that is readily available in the living-sphere

2. Development of ABS utilizing the nationwide PT survey data

For the purpose of EBPM (Evidence Based Policy Making) in local administration, in the planning for urban transportation planning, data of actual modes of movement in person trip surveys (urban region PT survey) are important, which grasp the activity and movement of each individual in the city, including the attributes, purpose, and means of transport as well. Besides, models for estimating changes in future activities are also important. However, the problem is that the implementation of surveys and the building of models entail a lot of cost, and in particular there has been a situation in which the application in local urban regions is unlikely to be advanced. Our Division is engaged in the development of a standard activity-based simulator (ABS) utilizing the nationwide urban transportation characteristics survey (nationwide PT survey), aiming at a world where a planning utilizing the data can be realized even in cities where the urban region PT survey could not be conducted until the present and in cities with financial and technological restrictions.

The standard ABS[1)] to be developed in this research consists of a "personal data generation model" that generates the attributes information on an individual (gender and age, status of work, place of work, place of employment, with or without a driver's license, household status, etc.) by using national census data and a Bayesian network, etc. and an "activity-based model (ABM)" that probabilistically estimates the movement of each individual from the trends of the nationwide PT survey data. If input data such as the population, facilities, transportation, etc. are prepared for each city, simulation in the city is enabled by inputting the data into the ABS, and the present status estimation data can be output in a form similar to that of the trip data in the PT survey. Also, movements that reflect more regional characteristics can be estimated by compensating the ABM by preparing data of actual modes of movement such as PT survey data with a small number of samples and big data including mobile spatial statistics and others. Furthermore, by changing the values of the input data, simplified analysis of a future scenario is enabled, such as population concentration and improvement of transportation services.

It is considered to be a useful material when examining the direction of the problems, policies and measures such as wide-area road networks in urban regions, arrangement of urban functions, and public transportation, and an ABS of the prototype version was completed and its rental services to those who wish to use it was started in October 2024[2)].

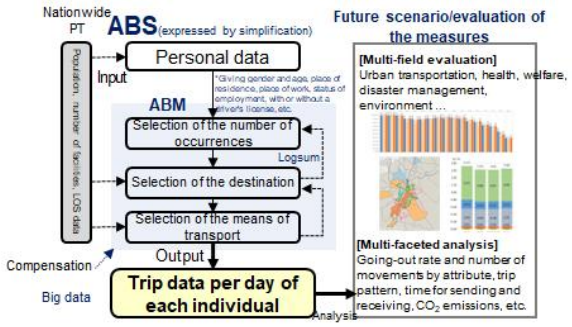

Fig.-3 Overall view of the ABS utilizing the nationwide PT survey data

3. Case of ABS application: analysis of a future scenario in the urban region of Yamagata

For the purposes of technology verification and the building of an illustration of utilization, the ABS was applied to Yamagata where an urban region PT survey was conducted in 2017, the reproducibility of the present status estimation data was verified and a future scenario was analyzed.

Regarding the present status estimation data, 2 patterns of output results in the case of applying the ABS as it is and in the case of compensating the data with the data of actual modes of movement in the urban region of Yamagata were compared with the PT survey data in the urban region of Yamagata, whereby the performance of the simulator without compensation was verified, and at the same time the validity of the method of compensation was also verified. As for the data of actual modes of movement, the trip pattern, destination, and means of transport data of the PT survey with small samples and the de facto population data of mobile spatial statistics were utilized. Consequently, it has been verified that the tendencies of the characteristics of movement in the entire urban region such as the going-out rate, the number of trips by purpose, and the modal share can be expressed even before compensation, and that by compensation the characteristics can be made closer to the actual modes of movement in the city.

Regarding the analysis of the future scenario, it has been examined in 2 patterns: change in the city structure and change in the public transportation 20 years later. In the analysis of the city structure scenario, it has been shown that evaluation can be made from a variety of viewpoints such as the sustainability of the city (maintaining the number of trips to the central city area, etc.), change in the way of life (improvement of the going out rate of the elderly), etc., concerning the case where the current problems have advanced and the case where urban transportation measures have been taken such as the Compact Plus Network, etc. Regarding the analysis of a public transportation scenario, analysis has been made on changes in the effects depending on the differences in the applicable area and the content of the measures including the introduction of the main transport such as BRT and the introduction of regional transport such as demand-responsive transport, from multi-faceted aspects such as the place of residence of people, destination, purpose and the attributes of users.

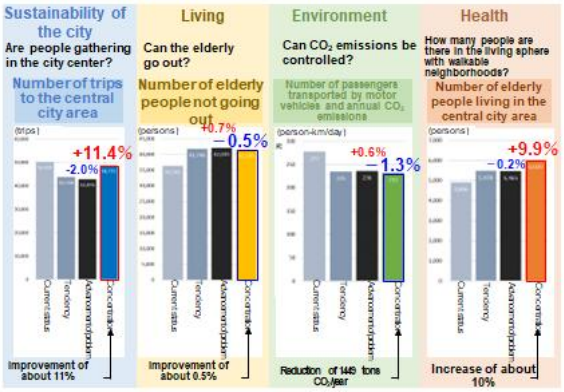

Fig.-4 Example of expressions in multiple fields of the results of analysis of the future scenario

4. Scenes of nationwide utilization of the ABS

Scenes of utilization of the ABS can include those in which local public entities efficiently grasp the current status of the movement of people in order to review the city structure in future, or carry out analysis of a future scenario in order to examine the order of priority of the areas of implementation of public transportation measures, when examining the comprehensive transportation strategy or a regional public transportation plan, location optimization plan in the next period. In particular, during times with many uncertain factors where prediction of the future is difficult, scenes can be assumed where various scenario patterns in the future are examined at low cost, speedily and efficiently, and also, the number of people in the living sphere with walkable neighborhoods, the number of passengers transported by motor vehicles and the annual CO_2 emissions thereby, as evaluation indexes related to the transportation behavior data of people, in multiple fields including health and welfare, environment, industry, disaster management, and others.

5. Toward the full-fledged operation of the ABS

In future, we will aim at full-fledged operation (publicizing) of an ABS that has higher practicality and is easier to use, while seeking the nationwide propagation of the ABS by accumulating and publicizing case studies, and through the expansion of functions by means of a combination with various types of simulators that represent multi-modal movement and the locus of movement in each route, as well as rebuilding of models by means of the next period nationwide PT survey (FY 2025) data, and others.

☞For more detailed information, visit:

1) Technology verification report (October 2024 initial version)https://www.nilim.go.jp/lab/jcg/pdf/commitee-2/gijutukennsyuurepoto.pdf

2) Press release: Opening of the specially established website of the Urban Facilities Division & invitation to the use case development fields (October 11, 2024)
https://www.nilim.go.jp/lab/bcg/kisya/html/kisya20241011.htm

Promotion of Research and Collaboration with External Research Institutions toward the Realization of Green Society

(Research period: FY 2023 -)

FUKUDA Yukihiro, Chairperson, Director-General
OSHIRO Nodoka, Secretariat, Research Coordinator for Digital Transformation of Infrastructure Systems
YOSHIDA Kuninobu, Research Coordinator for Integrated Water Disaster Management, Climate Change Adaptation Research Subcommittee,
Green Society Realization Research Promotion Committee

(Key words) global warming, climate change, green society, environmental action plan, research collaboration

1. Activities of the Green Society Realization Research Promotion Committee

The NILIM promotes collaboration and cooperation beyond the frames of organizations, by establishing the "NILIM Green Society Realization Research Promotion Committee[1)]" (hereinafter called the "Green Committee") in July 2023, in order to promote environmental research cross-functionally based on the "Ministry of Land, Infrastructure, Transport and Tourism Environmental Action Plan."

2. Promotion of cross-functional research within the NILIM

After the establishment of the Green Committee, committee meetings are held 4 times a year, in which information sharing and exchange of opinions are performed concerning the trends of policies and research concerning the environment.

In addition, a comprehensive research project is planned to be started, in which researchers in the two fields of civil engineering and building participate from FY 2025, with the Green Committee secretariat serving as a coordinator, and collaboration in specific research issues is also under way.

3. Cooperation with external research institutions

(1) Liaison for Environmental Research Facilities

The Director-General and the Research Coordinator for DX of the NILIM attended the "Research Exchange Seminar[2)]" (November 2024) held by the 13 institutes participating in the Liaison for Environmental Research Facilities, in which they gave presentations on the "Research and development that support the green innovation measures in the fields of housing and infrastructure," and at the same time held discussions with participants from the institutes (Photo-1).

(2) Research institutes liaison meeting concerning climate change adaptation

The researchers of the institutes participating in the Liaison, a research presentation meeting[3)] of the "Climate Change Adaptation Research Meeting" is held every year. In the research presentation meeting in December 2024, the Research Coordinator for Integrated Water Disaster Management of the River Department gave a presentation about the efforts of the NILIM, with the subject of "Study status toward social Implementation of remote sensing technology utilizing satellites in the field of infrastructure."

(3) Exchange of opinions among researchers in the field of the environment

Researchers from the National Institute for Environmental Studies visited the NILIM in September, who are engaged in activities for conserving biodiversity in the Tsukuba Science City as the "Network of Green Areas for Biodiversity in Tsukuba." The researchers paid a site visit in the premises, and at the same time presentations on efforts toward the conservation of biodiversity and exchange of opinions were carried out jointly with the Public Works Research Institute (Photo-2).

☞For more detailed information, visit:

1) Green Society Realization Research Promotion Committee, NILIM
https://www.nilim.go.jp/japanese/organization/gx_honbu/indexgx.htm

2) 6th Liaison for Environmental Research Facilities Research Exchange Seminar
https://kankyorenrakukai.org/seminar_06/

3) FY 2024 Climate Change Adaptation Research Meeting Research Presentation Meeting
https://adaptation-platform.nies.go.jp/archive/conference/2024/1217/

4) Network of Green Areas for Biodiversity in Tsukuba Activity Report
https://www.nies.go.jp/biology/greenareas/activity_record.html

Photo 1 Oral presentation in a research exchange seminar

Photo 2 Exchange of opinions with researchers from the National Institute for Environmental Studies

Safety Management of Dams Using Smal SAR Satellite

(Research period: FT2023 ~ FY2024)
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INOUE Kosuke, Visiting Researcher
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(keywords) dam, safety management, small SAR satellite, constellation

1. Introduction

Just after the 2024 Noto Peninsula Earthquake, 96 dams were subject to temporary safety inspections at the time of earthquake. There were several cases where personnel in charge of dam management could not access multiple dams for quite some time, as roads to dams were cut-off. As shown here, it might take some time to make temporary inspections in the event a large-scale earthquake occurs, depending on the damage situation around the affected dams.

As one of the methods to solve the above-mentioned issue, we, writers of this article, are studying the possibility of using SAR (Synthetic Aperture Radar) for safety management of dams. So far, we have done studies on the safety management of dams using such large-sized SAR satellites as ALOS-2 and publicly disclosed "NILIM Document No. 1233, Displacement measurement manual (draft) for rock-fill dam and slopes around reservoirs using satellite SAR data".

Taking these study results into account, in FY2023 ~ FY2024, we are engaged in research and development for the safety management of dams using small SAR satellites. This article introduces examples of observation of dams using small SAR satellites.

2. Small SAR satellite

We present basic information on various SAR satellites in the following Table. In recent years, various domestic private satellite operators have been establishing small SAR satellite constellations (making a lot of small non-geostationary satellites work together and operating them integrally) such as StriX and QPS-SAR.

As small SAR satellites use X band, having a shorter wavelength than L band used by ALOS, etc., the resolution for measurement improves. In addition, the frequency of measurement also increases by making multiple satellites operate.

By using these small SAR satellite constellations, we believe it is possible to implement more effective safety management of dams.

3. Examples of observation of dams using small SAR satellites

We made the observation of Nanase Dam, rock-fill dam type, (dam height 92m, crest length: 500m, managed by Kyushu Regional Development Bureau, MLIT). We present the aerial photo of Nanase Dam in Figure-1. We show, in the Figure, positions of reflectors currently placed to verify their utilization for safety management of the dam (functioning as a reference point and measurement point).

As an example, we show observation results (intensity image) made by StriX in Figure-2 and

Table: Basic information on various SAR satellites

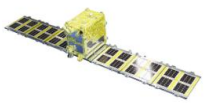
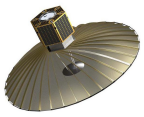
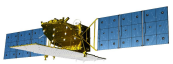
Satellite name		StriX	QPS-SAR	ALOS-2	ALOS-4
Image of satellite		 https://synspective.com/	 https://i-qps.net/	 https://www.jaxa.jp/	 https://www.jaxa.jp/
Spatial resolution (azimuth x range)	Spotlight	0.25m×0.9m (Staring spotlight 2 modes)	0.46m×0.46m	1m×3m	1m×3m
	Stripmap	3m×3m	1.80m×0.46m	3m×3m, 6m×6m 10m×10m	3, 6, 10m (for range direction)
Scene size (azimuth x range)	Spotlight	3km×10km (Staring spotlight 2 modes)	7km×7km	25km×25km	35km×35km
	Stripmap	50km×20km	14km×7km	50km×50km (high resolution 3m mode)	200km (for range direction)
Wavelength band		X band	X band	L band	L band
Number of satellites		5 satellites (as of January 2025) 30 satellites (targeted number of units in operation)	2 satellites (as of January 2025) 36 satellites (targeted number of units in operation)	1 satellite	1 satellite
Observation frequency for the same range		60 times per day (in case the number of satellites reaches the targeted number of satellites in operation)	Once per around 10 minutes (in case the number of satellites reaches the targeted number of satellites in operation)	4 times of basic observation per year (Stripmap mode)	20 times of basic observation per year (Stripmap mode)

Figure-3. Both Figures used Staring Spotlight 2 (refer to the Table for spatial resolution, etc.) as the observation mode. Figure-2 shows the observation results made from the sun-synchronous orbit (an orbit circling the earth always keeping the same angle against the Sun) and Figure-3 shows the results made from the inclined orbit (an orbit having a fixed angle (incline angle) in relation to the equator).

By comparing the observation results in Figure-1, Figure-2 and Figure-3, we recognize that we can accurately identify the shape of the dam body with the observation by small SAR satellites. Based on this, we believe it is possible to identify damage conditions with a single image after a large-scale earthquake occurs.

Now, if we pay attention to the difference in orbit between Figure-2 and Figure-3, in the observation results of Figure-2, a layover (a phenomenon in which the position of land shape or structures are displayed reversely in an image, as a reception order of reflected wave reversed due to steep slope or high building) occurred on the right side of the dam, however, in Figure-3, no layover occurred. Therefore, by taking advantage of the large number of small SAR satellites and having photo-shooting with multiple orbits, it is possible to mitigate the invisible areas in the dam body or slopes around the reservoir, and to improve the certainty of safety management.

In addition, we can see reflections of reflectors shown in Figure-1 at positions circled red in Figure-2 and Figure-3. Circular fence reflectors (C1 ~ C3) shown in Figure-1 can receive reflections from both the sun-synchronous orbit and the inclined orbit, so we have confirmed that it could respond to multiple satellite orbits. Based on this, we believe that it is possible to use reflectors in safety management of dams using small SAR satellites.

4. Conclusion

As a result of having observed dams using small SAR satellites, we have acknowledged that it would be possible to identify the shape, etc. of dams. From now on, we progress to quantitative evaluations to aid interference analysis and intensity difference analysis of dam bodies. Taking those results into account, we plan to prepare standard specifications and a usage guideline to develop a safety management method for dams using small SAR satellites.

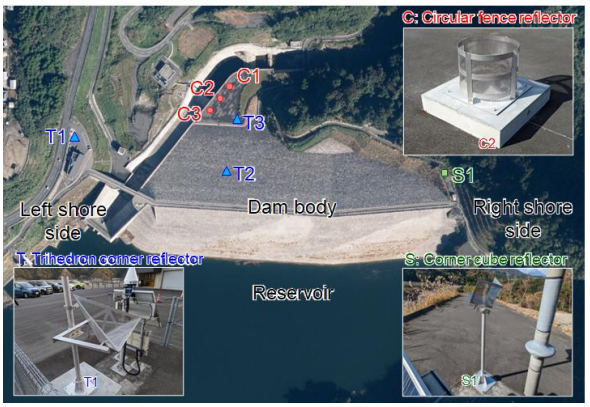


Figure-1 Aerial photo of Nanase Dam

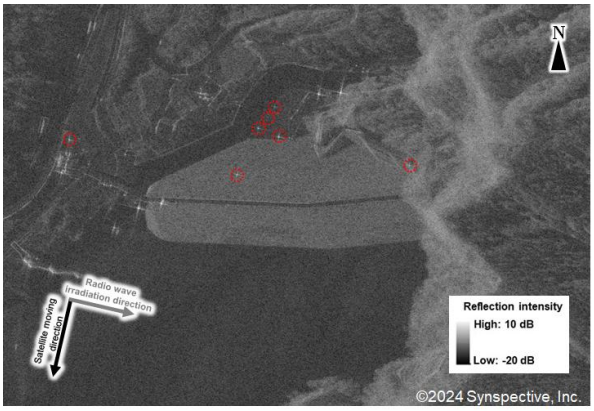


Figure-2 Observation results made by StriX (Intensity image, the sun-synchronous orbit)

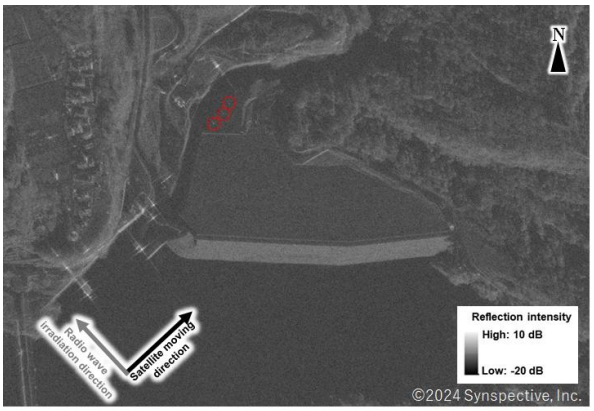


Figure-3 Observation results made by StriX (Intensity image, the inclined orbit)

☞Detailed information is as follows.
1) KOBORI Toshihide, INOUE Kosuke, SAKURAI Toshiyuki: Displacement measurement of rock-fill dam body using X band SAR satellites, civil engineering technology document, Vol. 66, No. 9, pp. 26 – 29, 2024.

Enhancement of Technical Information Associated with the Revision of the Regular Inspection Procedure for Road Bridges

(Research period: FY 2014 -)

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(Key words) *bridge, inspection, training*

1. Introduction

Triggered by the ceiling plate collapse accident in the Sasago Tunnel on the Chuo Expressway in December 2012, relevant laws and regulations were amended in 2013, and regular inspection are now required by law. The ten years after the regular inspection became legally mandate, the national bridge inspection standards referred to as the ministerial technical advice were revised in March 2024 based on a thorough technical review and analysis by Bridge and Structures Division, NILIM, on the quality of inspection records and lessons learned after the mandate bridge inspection took effect.

The regular bridge inspection is an essential part of bridge management, and revisions to the standards influence the day-to-day practices of every road owner. With the technical excellence of NILIM and the rich experience in MLIT's highway offices, the hands-on experience sessions and revised training courses were smoothly prepared and delivered to the road owners. This article summarizes efforts to enhance technical information on bridge inspection for road owners and engineers.

2. Details of the revision of the regular inspection procedure

In the revision, the requirement to record the bridge inspection results was made more stringent to ensure accountability for the inspection results. Plus, the standard part and recommendation part of the bridge inspection record were clarified. The law requires bridge owners to declare the maintenance policy for individual bridges, known as the bridge integrity classification. The revised standards now require that the load-carrying performance evaluation for vehicle traffic, earthquakes, torrential rains, and floods, etc., which are rarely expected at the time of the next regular inspection, be recorded. In addition, durability performance should be considered, and distress that may significantly affect life-cycle costs should be recorded. These technical evaluations should have been essential for bridge owners to decide the bridge integrity classification, but were not always shown in the bridge inspection record. To strengthen technical accountability for bridge inspection results for bridge users and avoid poor decisions due to the lack of relevant technical backgrounds, the standard record items were revised.

Although it was not mandatory, bridge owners sometimes recorded detailed damage distributions using their own protocols. However, such recording work was often cumbersome and labor-intensive. Still, it was understandable that the owners would want to record as much information as possible for future use in asset management. Accordingly, in addition to the national bridge inspection standards, MLIT has now provided a recommended objective data recording protocol from the owner's asset management perspective. As a merit, using the recommended protocol, the recorded data can be statistically comparable to deterioration curves obtained by NILIM from earlier damage records collected with an equivalent but more detailed data-recording protocol from more than 20,000 bridges operated by MLIT across Japan.

3. Hands-on experience sessions

The MLIT Headquarters, Regional Bureaus, and NILIM held hands-on experience sessions in every region across Japan within three months after the revision, such that bridge owners could attend and ensure the aim of the revision. A total of 8000 officers from bridge owners participated. The sessions were held at bridge sites. NILIM especially provided practical, hands-on guidance on conducting the bridge performance evaluation based on on-site observations of the bridge structure and condition. Observing the bridge together with the participants helped them experience the technical aspects of the performance evaluation for individual bridges during inspection, as well as the relationship between these evaluations and the owner's decision for the bridge maintenance policy.

Photo-1 Hands-on experience session on a bridge site

4. Support for acquiring knowledge and skills in the implementation of regular inspection

MLIT Regional Development Bureaus regularly provide road owners with the official training course for the mandated regular inspection, since the inspection became mandated. NILIM, in addition to its ordinary mission of research, plays a nodal agency role in providing the course curriculum, lecture materials,

follow-up documents, and the exam system, which are published as the official text and as a NILIM report. In line with the revision of the national inspection standards, NILIM has revised the lecture materials, on-site training materials, and exam structures.

The training course is designed to understand the legal aspects of regular and other inspections, and to efficiently and systematically acquire the essential technical knowledge and skills to observe the structural load-carrying system and distress of bridges, examine the causes and states of damage and the bridge performance conditions, and report these findings and technical reviews. The training course includes lectures, on-site training, and an achievement exam. In the exam, participants observe a bridge at a hands-on distance and describe their observations and technical views of its performance.

Table-1 Bridge Inspection Training Curriculum

Category	Curriculum
Laws, regulations, and standards	Code structures – Laws, regulations, and standards in mandated road structure inspection
	Art of bridge observation, bridge performance evaluations, and reporting
Performance evaluations for structural elements and components	Basics to bridge structures, roles of components and elements, loads, limit states, and structural mechanics
	Damage mechanism of steel members and its influence on resistance and durability
	Damage mechanism of concrete members and its influence on resistance and durability
	Damage mechanism of substructures and its influence on resistance and durability
	Damage mechanism of bearings and accessories, and its influence on resistance and durability
On-site exercise	On-site exercise for hands-on observations and technical evaluations for bridge performance
Related structures and facilities	Inspection for pedestrian bridges and overhead sign structures and supports
	Basics of the structural system of sheds and large-scale culverts
	Damage mechanism and technical evaluation for rock/snow sheds and large-scale culverts
Achievement examination	Practical and background knowledge of laws, requirements, and technical evaluations for mandated inspection (Select type test)
	Principle and practice of the bridge observation and technical evaluation examination (Written test)
Updates	Latest damage cases and takeaways

The course is not intended to teach the classification of damage types and their extents. The key is to learn the relationship between load paths and the roles of structural elements in bridges, the influence of distress on bridge load-carrying performance depending on the damage type and location, its cause and source, and to apply this knowledge to review bridge performance in bridge inspection reports. In addition, without an understanding of the legal and overall picture of bridge inspection administration, inspectors and related officials cannot provide a relevant technical review of the need for, or no need for, maintenance actions for individual bridges.

Table-1 shows the curriculum. The course starts with an understanding of the relevant regulations and standards, technical backgrounds, notable bridge damage events, and earlier struggles in bridge management in Japan. Then it covers the load-carrying mechanisms and the roles of the elements of bridges, with a brief catch-up on fundamental knowledge of structural mechanics, materials, loads and load effects, and bridge engineering. After that, through chosen case studies, participants study the mechanisms and progression of damage in steel and concrete members, foundations, bearings, and related components, with detailed characteristics of typical damage distributions and locations. Finally, by combining basic knowledge of bridge structure and condition with the causes, evolution mechanisms, and types of distress, the participants understand the principles and how to observe bridges and evaluate their load-carrying and durability performance individually. Then, participants train in the art of an articulate, technically sufficient description of bridge performance conditions through on-site exercise using an existing bridge. As shown in Photo-2, in the on-site exercise, participants conduct a hands-on observation of the bridge, record the damage and irregularities, estimate the cause and condition of the observed damage, and evaluate the bridge's performance. The achievement exam includes general technical knowledge and skills necessary for inspection. In particular, the written test covers the art of describing the technical considerations of the present bridge performance, its reasons, and supporting evidence for the bridge used in the on-site training.

Photo-2 Trainees conducting a hands-on observation on a bridge in the MLIT bridge inspection course

NILIM is the national institute for the research and development of technical policy and standards for bridges and structures, and it has a wide range of knowledge and experience in bridge performance evaluation. Accordingly, NILIM owned the update of the lecture materials, such as adding case studies and more comprehensive photo examples of bridge damage, and also has developed a new systematic learning process and guidance for the performance evaluation system of existing road bridges. NILIM also directly delivered lectures on related laws, regulations, and standards, on the observation and evaluation of bridge performance, and on the technical writing of inspection results.

5. Remarks

The introductory material, the official textbook, and other supplemental references for the training course are available on the website[1)-3)]. The Bridge and Structures Division will continue pursuing the mission of developing technical standards for bridge design, inspection, repair, retrofit, and rehabilitation.

☞For more detailed information, visit:

1) Website of the MLIT https://www.mlit.go.jp/road/sisaku/yobohozen/tenken/yobo7_17.pdf
2) Technical Note of NILIM No. 1307 (https://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1307.htm)
3) Website of the Bridge and Structures Division, NILIM https://www.nilim.go.jp/lab/ubg/index.htm

Promotion of DX in the Infrastructure Field

(Research period: FY 2021 -)

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(Key words) DX (digital transformation), human resource development

1. Introduction

In recent years, with the rapid advancement of technological reform due to the dissemination and enlargement of data and digital technology, Digital Transformation (DX) is advancing in various industries and types of industries.

The Ministry for Land, Infrastructure, Transport and Tourism formulated the "DX Action Plan 2 in the Infrastructure Field" in 2023, to respond to violent changes in the socioeconomic status in the infrastructure field, thereby implementing reform in social capital and public services by utilizing data and digital technology, and at the same time implements industry reform including the culture and environment of an organization and work style, in order to realize safe, secure and rich lives. The NILIM also established the "Digital Transformation of Infrastructure Systems Research Committee" and seeks the promotion of research and development.

2. Research for promoting DX in the infrastructure field

Regarding the research problems of the NILIM corresponding to the 3 fields presented in the "DX Action Plan 2 in the Infrastructure Field," typical examples are presented below.

(1) Reform in how to build infrastructures: Investiation and research concerning utilization of BIM/CIM, improvement in labor productivity by means of DX and promotion of i-Construction in the field of ports and harbors, and others.

(2) Reform in how to use infrastructures: Flood prediction systems for the effective utilization of dams, sewerage facility wide area management systems utilizing ICT, promotion of the next generation ITS, next generation pavement management, automation and energy saving in the airport ground support work, early grasping of sediment disasters utilizing satellites, and others.

(3) Reform in how to utilize data: Improvement in basin flood management digital test beds, building road data platforms, advancement of land, infrastructure, and transport data platforms, advancement of construction project management, etc. utilizing BIM, promotion of open city related data and its use and utilization, and others.

3. Efforts for the improvement of DX literacy of NILIM staff

Starting in this fiscal year, the NILIM is engaged in human resource development intended to improve the DX literacy of staff (hereinafter called the "Project DX"), in order to realize efficient research activities and the performance of normal work by proactively utilizing DX[1)].

The Project DX is managed under the system consisting of Professor Toshihiro Kameda and Assistant Professor Tsuyoshi Takatani, Institute of Systems and Information Engineering, University of Tsukuba, who provides specialized advice and guidance as the "Innovation Research Cooperative Strategy Official," and the Planning and Research Administration Department and the Research Center for Infrastructure Management that serve as the secretariat.

As for the efforts for human resource development, 2 types of training courses are implemented, "all staff training" and "selected team training" as shown in the table, by setting the training target and training details by referring to the "Digital Skill Standard" (the Information-technology Promotion Agency).

In future, we will seek improvements in the training details, methods based on the results of implementation, and will aim at cooperation with the Regional Development Bureaus and other organizations engaging in Infrastructure DX, and the propagation of the efforts.

Table Overview of the "Project DX" training

	All staff training	Selected team training
Training target	All the NILIM staff and visiting researcher (including part-time staff)	1 - 2 persons from each of the departments and centers (including the General Affairs Department and the Planning and Research Administration Department)
Target skill	• DX can be regarded as one's own matter • Can understand the details of work and research on DX • Can write work specifications concerning DX	• Can play a central role in the research and work concerning DX • Can provide the NILIM internally and for the Regional Development Bureaus with guidance and advice concerning DX
Training details	• Lecture meeting • Demonstration meeting (technical demonstration) • Site study meeting • Desk learning (e-learning)	• Active learning • Form of discussion face-to-face (+Web) (5 times a year)
Training method	• Lecture meeting to be implemented face-to-face (+Web). • Materials and videos are shared with those other than participants as well, over the Intranet. • e-learning is self-learning by means of videos +teaching materials	• Trainees provide topics concerning the problems in research (work) • Discussions by making an improvement plan concerning DX from each participant

☞For more detailed information, refer to:
1) Civil Engineering Journal, February 2025 Issue, pp. 6-7

International Research Activities

1. International Research Activities in the National Institute for Land and Infrastructure Management

The NILIM promotes international research activities based on the following three perspectives.

(1) Contributions to domestic policies from the technical aspect

While utilizing bilateral agreements concluded mainly with the NILIM and other agreements concluded by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), the NILIM builds networks with overseas government agencies and others, and at the same time gathers information on advanced cases, etc., and reflects that information in domestic policy proposals and technical standards.

(2) Contributions to technical cooperation with developing nations, etc.

Utilizing the findings obtained and lessons learned from the operation and maintenance of public facilities in Japan, disaster response and the results of research on advanced disaster prevention and disaster mitigation measures reflecting those resources, the NILIM provides support for the establishment of measures against advanced technological challenges faced by the local governments of developing nations, for the formulation of technical standards, and for the improvement of the capabilities of government employees holding technology-related positions.

(3) Contributions to overseas deployment of technologies in which Japan has strengths

Utilizing the findings for the formulation of technical standards that support policy deployment in Japan, the NILIM participates in international standardization activities such as those of the International Organization for Standardization (ISO), contributes to international standardization of technologies in which Japan has strengths, and also transmits information on NILIM's research results at conferences of international societies, the NILIM's websites in English, and others.

2. Major International Research Activities in FY 2024

(1) Contributions to domestic policies from the technical aspect

① Research cooperation with the Directorate of Road and Bridge Development Engineering (DRBE), Ministry of Public Works and Housing of Indonesia

The NILIM and the Public Works Research Institute respectively exchanged Memorandums of Understanding on research cooperation in 2009 with DRBE (its predecessor, Institute of Road Engineering (IRE), at the time), having been engaged in research cooperation in the five fields of transport, pavement, tunnels, earthworks and soft ground, and others.

In December 2024, a web conference was held between the relevant personnel of DRBE and the NILIM/Public Works Research Institute, and opinions were exchanged concerning the activity policy in future and research topics that were presented by the Indonesian side.

Photo-1　Scene of the WEB conference with DRBE

② Meeting between the Directorate for Roads of Vietnam (DRVN) and the NILIM concerning road bridges

With the Directorate for Roads of Vietnam (DRVN) of the Ministry of Traffic and Transport of Vietnam, the NILIM has been engaged in research cooperation based on a Memorandum of Understanding concluded in 2012 between the Ministry of Traffic and Transport of Vietnam and the Road Bureau of the MLIT. Furthermore, the NILIM has deepened its research cooperation activities by concluding a separate agreement on the maintenance and management of road bridges in 2020.

In FY 2024, information was shared on the overview of the revision of the regular inspection procedure in Japan and the statuses of disaster damage due to the Noto Peninsula Earthquake and response, and at the same time opinions were exchanged about the statuses of efforts being made on the inspection of road bridge scour and the building of a road bridge database among the road administrators, and others.

Photo-2　Scene of the meeting with DRVN

③ Research cooperation with the Korea Research Institute for Human Settlements (KRIHS) in the urban policy field

The NILIM and the Korea Research Institute for Human Settlements (KRIHS) continually engage in research exchanges based on a Memorandum of Understanding signed in 2012.

In FY 2024, a delegation from the KRIHS visited

Japan in September and conducted a joint survey on the moving of railway tracks underground, redevelopment of the above-ground areas. Also, in February, the NILIM's delegation visited South Korea and held a joint research workshop on the efforts for digital transformation both in Japan and in South Korea, and at the same time jointly conducted interview surveys with local governments and site surveys regarding the utilization of digital technologies in the field of disaster management in South Korea and the statuses of efforts for compact city policies.

Photo-3 Workshop with the Korea Research Institute for Human Settlements

④ Cooperation on the formulation of technical standards for port and harbor facilities

In September 2024, the Memorandum of Cooperation between the MLIT and the Vietnam Institute of Transport Science and Technology (ITST) was updated, concerning cooperation for formulating the national technical standards for port and harbor facilities in Vietnam. In response to this update, the NILIM invited the staff of the ITST in February 2025, and in March the same year the staff of the NILIM visited the ITST. It was determined between the two institutes that opinions would be exchanged on climate change and toward the decarbonization of port and harbor facilities, and discussions would be held continually on the techniques to reflect the content of such study in the technical standards for port and harbor facilities.

(2) Technical cooperation with developing nations

① Acceptance of trainees from the World Bank, JICA

The NILIM accepts trainees from overseas as requested by the Japan International Cooperation Agency (JICA, an Independent Administrative Agency), etc., and it gave lectures and offered experimental facility tours in the institution, such as the JICA training "Sediment Disaster Risk Reduction" and "Port Development and Planning." In addition, in response to a request made by the Ambassador of Japan to Chili," a delegation of the Chilean Chamber of Construction visited the NILIM in May, and exchanged opinions with the Director-General of the NILIM, the President of the Public Works Research Institute (National Research and Development Agency), and others.

Cooperation was rendered for training in various fields, such as lectures given in October in response to a request from the World Bank Tokyo Disaster Management Hub, concerning the evaluation of vulnerability of road networks using the Road Risk Assessment Procedure (draft) with the content related to the risk evaluation of roads, as training for the staff of the Government of the Philippines and the staff of local governments, etc. of the Philippines.

② Support for technical cooperation projects

In FY 2024, the NILIM dispatched researchers in response to a request by JICA, concerning investigation of the North-South Expressway Construction Project in the Country of Vietnam and support for the formulation of technical standards for the "Support Project for Formulation and Dissemination of Port Technical Standards" in Vietnam.

(3) Contributions to overseas deployment of technologies in which Japan has strengths

① ISO

In FY 2024, researchers of the NILIM participated in the following Technical Committees (TCs).

- TC 282/SC 3 (Risk and performance evaluation of water reuse systems)
- TC 98/SC 3 (Loads, forces and other actions)
- TC 205 (Building environment design)

② Participation in the International Commission On Large Dams

The NILIM participated in the Annual Meeting of the International Commission on Large Dams (ICOLD), which was held in Gothenburg, Sweden from September 29 to October 3, and engaged in discussions about a draft report on the “Interpretation of seismic records of dams” that the NILIM submitted as the elected member from Japan of Technical Committee B “Committee on Seismic Aspects of Dam Design.”

Photo-4 Scene of the Annual Meeting of ICOLD

③ Making available the English version of 20 Years of NILIM History

It has been made available on the English website for use for overseas researchers and engineers.

☞For more detailed information, visit:

1) NILIM website "International Activities"
https://www.nilim.go.jp/lab/beg/foreign/kokusai/kokusaitekikatudou.htm

2) NILIM website "International Coordination Division"
https://www.ysk.nilim.go.jp/kakubu/kanri/kokusai/

3) NILIM website "20 Years of NILIM History"
https://www.nilim.go.jp/english/20th_history/