Stock management and improvement of energy efficiency of wastewater systems

Yutaka Suzuki, Director of Water Quality Control Department

(Keywords) wastewater system, stock management, improvement of energy efficiency, technology development

1. Introduction

To deal with water pollution after a period of high economic growth, wastewater systems have been considered to be important water pollution control facilities, and have been actively developed. As a result, 77% of the population has adopted wastewater systems. The total cumulative length of wastewater systems is 460,000 km (corresponding to 11 times around the earth), and the number of sewage facilities has reached approximately 2,200. In the future, it is estimated that there will be an increase in the number of older pipes and facilities still in use a long time after their construction, which will make it necessary to perform appropriate stock management to maintain the functions of wastewater systems.

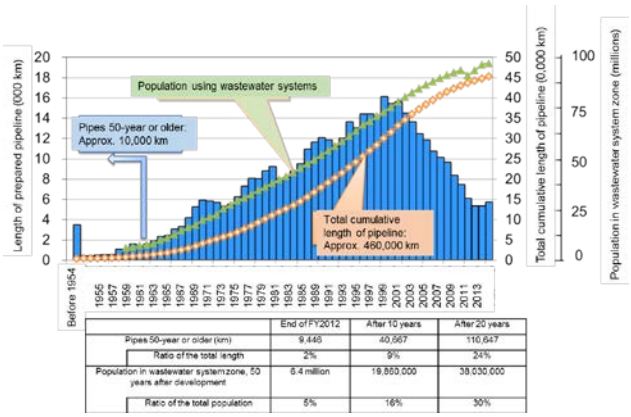
Along with the development of wastewater systems, three-quarters of domestic wastewater passes through the wastewater systems, and the total electric energy consumed by the wastewater systems is approximately seven billion kWh/year, making up approximately 0.7% of the total electric power consumption in Japan. While activities to improve the energy efficiency of wastewater systems are being conducted to prevent global warming, the effective use of the sewage sludge generated in the wastewater treatment process is limited, although this is a potential energy source. Thus, it is also important to develop technologies that allow the effective use of sewage sludge energy.

In addition, the Water Quality Control Department of the NILIM, as a national institute having wide and comprehensive views, manages the national technical policies of wastewater systems, toward which each local government has a direct responsibility.

2. Stock management of wastewater systems

Because wastewater pipelines, which have rapidly developed since around 1955 and will be aged in the future (Figure 1), may cause road cave-ins when corroded (Figure 2), we have to treat deteriorated wastewater pipelines appropriately.

However, the current investigation method only checks 1% of the total length of the pipelines per year. Therefore, (1) an effective new investigation method, (2) a deterioration judgment standard corresponding to the new investigation method, and (3) a selection method for appropriate repair and reconstruction technologies are required.



	End of FY2012	After 10 years	After 20 years
Pipes 50-year or older (km)	9,446	40,667	110,647
Ratio of the total length	2%	9%	24%
Population in wastewater system zone, 50 years after development	6.4 million	19,860,000	38,030,000
Ratio of the total population	5%	16%	30%

Figure 1: Development and total cumulative length of wastewater pipelines

Figure 2: Corroded wastewater pipeline (left) and cave-in of walkway (right)

Concerning (1), we will clarify factors affecting the deterioration using a pipeline information database, and set up a system to detect points needing early investigation. In addition, to promote a quick and inexpensive diagnosis after a deterioration investigation, we will develop, introduce, and evaluate research robots, etc. In addition, to detect air holes outside a wastewater pipeline to estimate its deterioration, we will utilize technology to detect the symptoms of road cave-ins with the "Breakthrough by Dynamic Approach in Sewage High Technology Project (B-DASH project)."

Concerning (2), we are waiting for a newly developed investigation method, and will create a deterioration judgment standard based on the relationship between the acquired data and deterioration levels. Concerning (3), we will set up a method to select an appropriate construction method based on the pipeline problems, considering the partial regeneration technology that has recently been developed.

As previously mentioned, we intend to prevent the road surface cave-ins and functional disorders caused by deteriorated wastewater systems, and contribute to a reduction of the public financial burden, and sustainable public services.

3. Improvement of energy efficiency of wastewater systems

The amount of energy consumed by sewage-treatment plants has been increasing, along with the increase in the amount of treated wastewater (Figure 3). Because the energy consumed for wastewater treatment makes up approximately 40% of the total electric power consumption, it is necessary to further improve the energy efficiency of the oxygen supply for wastewater treatment, in order to reduce the amount of energy consumption.

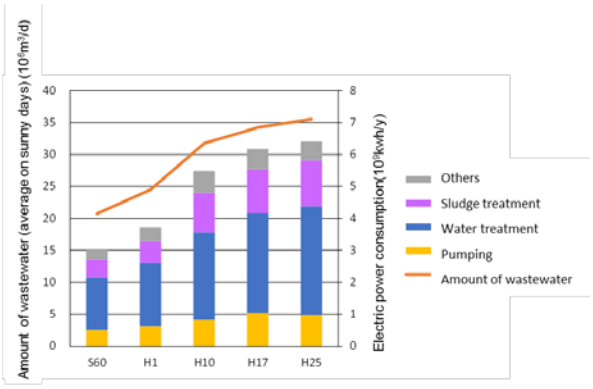


Figure 3: Transition in amount of wastewater and energy consumption in sewage-treatment plants

Nitrogen and phosphorus removal processes have recently caused an increased need for oxygen, and therefore consume much energy. In the B-DASH project, we will demonstrate technologies to continuously measure the dissolved oxygen (DO) and ammonium nitrogen (NH_4-N) concentrations in reactors to control the air supply, allowing an appropriate oxygen supply by avoiding its excess .

Moreover, although the biofilm process adopted by many small plants is losing ground because of problems such as turbidity in treated wastewater, its energy consumption is smaller than the activated sludge processes. Therefore, we will consider improving the pre- and post-treatment methods of the biofilm processes, along with optimization of the bioreactor maintenance method, and demonstrate an energy consumption reduction in the B-DASH project.

Concerning the energy recovery from sewage sludge, in order to support the development of a hydrogen society, we will demonstrate a technology to create hydrogen from digestion gas, along with a technology to effectively collect and use methane gas from multiple sewage-treatment plants in the B-DASH project.

With the technologies mentioned above, we intend to contribute to the prevention of global warming and the improvement of the management of wastewater systems by reducing their energy consumption.

4. Management of technology development of wastewater systems

Although wastewater projects are operated by local government, the following issues are important from a national comprehensive viewpoint.

○ To collect and analyze basic information regarding the wastewater systems in terms of their development, maintenance and disaster prevention, which should be the basis for national technical policies.

○ To clarify technical problems based on the analyzed information, and develop, introduce, and evaluate the required technologies

○ To determine the direction of future wastewater technologies, and manage the roles of industry, government, and academia for effective technology development

○ To analyze, evaluate, and introduce advanced knowledge for the development of future technologies

To support these goals, the Water Quality Control Department of the NILIM prepared the "Vision for wastewater technology" in FY2015, which provides the long- and mid-term orientation of the wastewater technologies.

The vision states that it is necessary as follow-ups to check the progress of the planned development and evaluate whether the promotion measures are working, and also to consider new topics corresponding to social changes, needs and demands for new technologies, and important programs and their goals. To meet these requirements, the Water Quality Control Department of the NILIM has taken an action of establishing a committee for technology development in wastewater fields consisting of industry, government, and academia, and will manage the follow-up of the vision and the improvement of the promotion measures for technology development, etc.

Challenge for Uncertainty

TORII Kenichi (Dr. Eng.), Director
River Department

(Key words) geophysical exploration, flood forecast, uncertainty, literacy, interdisciplinary fusion

1. Introduction

When society was not mature, there were vast wild frontiers and investment in such frontiers could earn very high returns. At such times, investment in technical development was also low-risk and high-return. Cost performance was also high since it was possible to choose fields with high efficiency of development. However, as potential of development has been shrinking in accordance with the progress of natural science, it would be very difficult to achieve a high return without innovative idea. On the contrary, without combination of or approach to fields other than natural science, it is difficult to achieve a return.

Meanwhile, we are faced with new challenges. Climate change by global warming has been increasing the frequency of disasters that had occurred at low frequency, and fear for major disasters is never groundless but is becoming a reality. Moreover, depopulation due to the progress in declining birthrate and aging population has been increasing the fear for "disappearance of municipalities."

This paper discusses the limit of existing technologies and a direction to overcome such new issues.

2. Geophysical soil investigation technology

Levees have the following characteristics.

1) Cross and vertical sections consist of non-uniform construction materials due to the long history of construction.
2) The soil of the ground is non-uniform in vertical section.
3) Subject to the effect of river channel, which significantly changes according to floods, which occur at irregular frequency and magnitude and are difficult to predict the occurrence.

It is therefore difficult to grasp the condition of levees spatiotemporally and continuously, and the required safety of levees is considered to have been secured by defining / securing the shape and material based on the long-term experience and performance.

As an approach to grasp continuously the property of levees and their foundation ground, the geophysical exploration method using vibration, electrical conductivity, etc. is being studied. If the study of this method gives a solution to the issue of non-uniformity in levees and foundation ground, it is expected to open a new era for levee management.

The present level of the geophysical exploration method is at most the estimation of soil classification. At present, detailed inspection of levees is based on boring survey. If this method aims to replace the present method, it would be a long-term objective to ensure the same precision as in the present level of boring survey. It is an important approach to pursue this new method. However, it is not necessary to limit the use of geophysical exploration, which is characterized by continuous grasp of the condition of levees, to replacement of boring survey for obtaining accurate information on the location.

Meanwhile, field sides desire to raise efficiency of flood control activities due mainly to the reduced number of flood-fighting team members and require technologies that are immediately available. To respond to pressing issues even in part, an approach for how to use geophysical exploration would be possible if the ratio of correct results using geophysical exploration is 60 or 70 percent, although it would be useless if the ratio of correct results is 50 percent or less.

Given the amount of information and precision, the present level of geophysical exploration may be useless for designing levees. However, since the amount of information available in risk management is limited on the whole, even uncertain information obtained from geophysical exploration may be helpful depending on how to interpret or use the information obtained. On the contrary, such approach is expected to clarify the outlet of development by geophysical exploration method and accelerate technical development.

3. Flood forecasting technology

For the rivers designated for flood forecast, the river administrators announce flood forecast jointly with the Meteorological Agency. Flood forecast aims to support

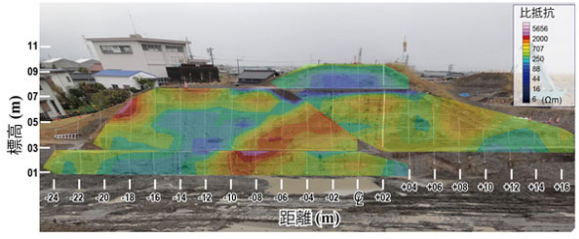


Figure 1: Comparison of levee section and geophysical exploration results [1)]

evacuation and the present level of forecast responds to floods, as assumed conventionally, where one or two hours are required for evacuation (including evacuation lead time). For this reason, the flood forecast mainly adopted at present forecasts water level about 3 hours later based on the data on past precipitations and water levels. This method has limitations on forecasting the time of flood occurrence but allows for rough judgment of rise / fall in water level based on the accumulated precipitation and for forecast of water levels with a certain level of accuracy based on correlation with upstream water level.

On the other hand, the present forecasting technology, which is based on actual precipitations and water levels, is not able to respond to cases where one or two hours are required for evacuation due to large-scale flood caused as a result of climate change etc. or where several tens of minutes are required for evacuation due to localization / centralization.

In order to ensure such lead time as responds to disasters, utilization of precipitation forecast is necessary, but result of precipitation forecast will change considerably even when the initial forecast value changes slightly. The ensemble forecast provides explicit precipitation forecast. The ensemble forecast evaluates the stability of forecast results by changing initial values for calculation, and has been practically used in forecasting the course of typhoons. The Meteorological Agency is also considering the provision of precipitation data based on the ensemble forecast.

Figure 2 is an example of runoff calculation using the ensemble forecast precipitations by 20 members. Each line represents the n-th forecast result at each time, red line shows the tenth line, and black line shows actual water level.

Since forecasts contain uncertainties as described, it is essential how to use them in practice while aiming to improve accuracy.

4. Literacy

Technologies addressing the new issues are provided by the individual fields where solutions are studied (e.g., disaster prevention engineering, river engineering for the former, and soil engineering, structural mechanics, concrete engineering, and information engineering for the latter).

A technology will be meaningful only when it is implemented in society. Many relevant technologies have reached the "last one mile," which includes the issue of accuracy.

Future technical development is expected to produce new information, e.g., the information containing uncertainties as mentioned above. To make the best use of such information, it is necessary to enhance literacy (ability to read/write and elicit and use information from given material or ability to apply them -- definition by Digital Daijisen).

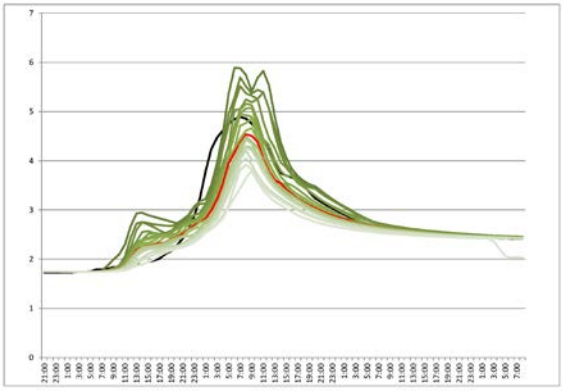


Figure 2: Processed the data of the image of forecast water level based on ensemble forecast precipitation (horizontal axis: time, vertical axis: water level) [2)]

Significant findings cannot be obtained without stepping into the issue of literacy development in addition to technical development. The issue of literacy pertains to individuals and organizations. It is therefore necessary to extend the area of our research activities to organizations and individuals who use the technologies.

Close connection of individual fields and different fields (e.g., organizational science, behavioral science, psychology, sociology) is expected to realize future growth of society.

☞See the following for details.

1) Inazaki, T (2013): Ground Truthing and Integrated Geophysical Surveying for the Safety Assessment of Dike Systems, Proceedings of the 19th Near Surface Geoscience, 4p. DOI: 10.3997/2214-4609.20131350

2) KAWASAKI Masao, INOMATA Hironori (2015) "For Extending Forecast Lead Time in Flood Forecast --- Probabilistic Flood Forecast using Ensemble Forecast" NILIM Report 2015, p.54

Research Activities in the Field of Sediment-related Disaster Measures

WATARI Masaaki, Director
Sabo Department

(Key words) sediment-related disasters, technical support, deep-seated landslide, early detection

1. Introduction

In 2015, 788 sediment-related disasters occurred across the country, killing 2 persons in total. As compared with the average data for the past ten years, i.e., about 1,050 disasters per year and fatalities and missing persons totaling about 35 per year, human damage caused by sediment-related disasters in 2015 was rather small. However, destructive damage occurred in some areas, including debris flow in Tarumizu, Kagoshima, in June to July, and the sediment-related disaster in Tochigi-ken caused by the Kanto-Tohoku Heavy Rain in September, and there were also not a few cases where local residents narrowly escaped damage as the result of evacuation based on warning. In recent years, large-scale sediment-related disasters involving many deaths occurred, including the August 2014 debris flow in Hiroshima-shi and the 2013 sediment-related disaster in Izu-Oshima, which gave rise to discussion among society about measures against sediment-related disasters in both structural and non-structural aspects.

Meanwhile, since the eruption of Mt. Ontake in September 2014, which was the most devastating volcanic eruption disaster in recent years, there is a serious social concern about increasing volcanic activities, as seen in the May 2015 eruption in the Kuchinoerabu Island, in which all the island residents were forced to evacuate from the island for more than six months, and the temporary rise in the eruption warning level in Mt. Hakone (June) and Sakurajima (August).

Under such circumstances, the Sediment Disaster Prevention Law and the Law concerning Special Measures for Active Volcanoes have been successively revised, and the NILIM should also be actively promoting technical development including researches and studies that would be helpful in disaster prevention and risk management in case of disaster.

2. Technical support

In case of a large-scale sediment-related disaster, NILIM provides technical guidance in cooperation with the Public Works Research Institute ("PWRI") on the site for prevention of secondary disasters according to request from municipalities, etc. In fiscal 2015, the Sabo Department dispatched a total of 23 experts / day to provide technical advice for safety check after rainfall, emergency measures, etc. from the viewpoint of preventing secondary disasters to the Regional Development Bureaus, Sabo Office under direct control, prefectures, and municipalities that implement measures for preventing sediment-related disasters.

In parallel, the NILIM has started a practical human resource development program, which utilizes the personnel concurrent service system, from last fiscal year in order to support the quality improvement of personnel in Regional Development Bureaus who engage in the advanced measures against sediment-related disasters. In fiscal 2015, a total of 9 persons from local Regional Development Bureaus joined this program, and the personnel of the Regional Development Bureaus in concurrent service have engaged in on-site technical support activities including the debris flow disaster in Serizawa District, Nikko-shi, Tochigi-ken together with the personnel of NILIM and PWRI.

Photo: Debris flow disaster investigation (Nikko-shi, Tochigi)

In view of the fiscal 2014 Hiroshima disaster, etc, the revised Sediment Disaster Prevention Law was enforced in January 2015, requiring the Minister of Land, Infrastructure, Transport and Tourism to endeavor to provide necessary advice, information, and other assistance to prefectures and municipalities. In response, we would like to strive to accumulate and utilize necessary findings and technologies so as to conduct technical support activities more appropriately in case of a disaster etc.

3. Research on large-scale sediment-related disasters

For deep-seated landslides, which may cause natural dams and large-scale debris flow, focused research is

going on, triggered in part by the 2011 Kii Peninsula flood disaster.

The conventional countermeasures against natural dams are focused on emergency measures to be implemented after formation of natural dam, but implementation of such measures before formation is considered to mitigate damage by natural dam. We have therefore started a research for establishment of measures practicable before occurrence of deep-seated landslide from fiscal 2015, such as reduction of the size of natural dams using existing "sabo" facilities in case of a deep-seated landslide.

For sediment-related disasters caused by heavy rain, it is also effective to forecast the effect accompanying sediment movement using the numerical analysis method and implement countermeasures. Therefore, we have summarized points of attention in the Technical Note of NILIM concerning the numerical analysis of sediment movement that reflects the characteristics of the complicated sediment movement phenomenon in mountainous watershed.

Further, the NILIM has participated in the Research Organization for Large-scale Sediment Disaster Countermeasures, centering on the Technical Center for Large-scale Sediment Disaster Countermeasures, Kinki Regional Development Bureau, to continue researches and studies, technical development, etc. concerning mechanism identification and countermeasures for deep-seated landslides and large-scale debris flow by academia-government collaboration.

4. Effort for early detection of sediment-related disaster

The successful launch of "DAICHI-2," JAXA's Advanced Land Observing Satellite (ALOS), in May 2014 has enabled "regular health check (routine observation)" and "emergency diagnosis (urgent observation)" using the Panchromatic L-band Synthetic Aperture Radar (PALSAR-2). We aim to develop technologies for locating the sites of deep-seated landslides and natural dams by monitoring areas vulnerable to landslide or deep-seated landslide at "ordinary times" and grasping signs (slope movement) of landslide etc. from the data observed by PALSAR-2 to be able to undertake countermeasures quickly in case of detecting abnormality, and by conducting emergency observation quickly and efficiently in combination of aircraft-mounted SAR (synthetic aperture radar) etc. with PALSAR-2 at the "first response stage" of a large-scale sediment-related disaster caused by heavy rain or earthquake.

Additionally, it has become possible to detect precursory phenomena of sediment-related disasters, which are important criteria for judging warning and evacuation from sediment-related disaster but were difficult to collect and share among the local community, by analyzing "twitter" information posted unintentionally on the network. We would like to advance the development of technologies that support determination to evacuate in "urgent stage" by complementing the information issued by users of SNS (Social Networking Service), which is also called "social sensor," with the rainfall observed by radar such as XRAIN etc. to enhance reliability.

Meanwhile, since the early detection method using a physical sensor is considered effective, we have newly started a study on the method, as a new challenge, for forecasting sediment-related disasters with high accuracy using real-time observation / monitoring data from fiscal 2015. This study examines the method for setting up standard values to determine the urgency of a sediment-related disaster using the monitoring / observation information on flow rate, sediment discharge, etc. that would be effective to determine the urgency of a sediment-related disaster. In fiscal 2015, we conducted a fundamental study for using observation results as reference, including specification of relations between changes in the sediment flow environment in basins and observation values by analyzing the observation results of sediment discharge in sediment movement including debris flow.

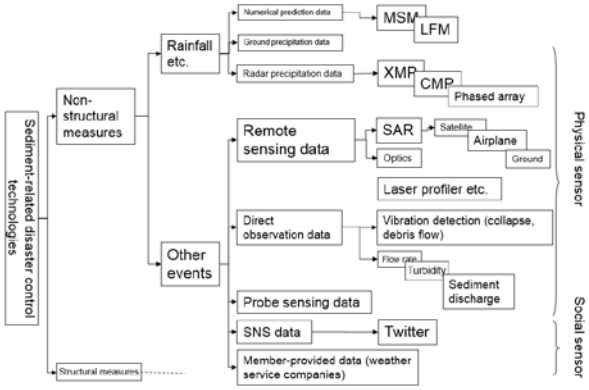


Figure: Various information available for early detection of sediment-related disasters

Ultimately, our policy aims to be able to provide the information concerning the risk of occurrence of sediment-related disaster, which has higher forecast accuracy and communicates urgency more easily by joint use with the conventional approach based on rainfall information.

5. Conclusion

In accordance with the increasing social concern about sediment-related disasters, relevant technical field is wide and expanding its base. As a state-run research institution, in collaboration with universities, government and private research institutions, etc., we will advance researches and activities with a sense of speed and respond appropriately to request and expectation from society.

☞See the following for details.

1) 2015 Sediment-related Disasters in Japan (Sabo Department, MLIT)
http://www.mlit.go.jp/river/sabo/jirei/h27dosha/H27_dosyasaigai.pdf

Orientation of technology development for realization of smooth, safe, and comfortable road traffic

Masahide Ito(Ph.D (Engineering)), Director of Road Traffic Department

(Keywords) road traffic, ETC2.0, smoother traffic, improvement of logistics efficiency, traffic safety, burying of electric cables

1. Introduction

Our country is facing difficult circumstances such as a population decrease, the escalation of a dwindling birthrate, an aging population, worsening disaster damage, the aging of infrastructure, and tough international competition. In the future, to support national life and economic activity, and construct road systems that are usable even during a disaster, we will focus on the preparation and efficient maximum utilization of the existing stock.

In this document, I will provide an outline of the orientation of the R&D in the road traffic field, along with approaches to the problems that we are facing, based on the activities of the NILIM from the long- and mid-term viewpoints.

2. Problems and changes in local circumstances

The problems surrounding road traffic and the basic orientation of policies were organized into a report by the Road Subcommittee, the Panel on Infrastructure Development [1)2)]. The following lists major problems from the research perspective:

(1) Although a highway network is being developed, the number of traffic lanes is small, and there are other quality problems. Moreover, traffic jams have not been eliminated.

(2) The international competition is getting fierce, and it is necessary to improve mobile productivity such as by improving the logistics efficiency.

(3) Although the number of traffic fatalities went down to approximately one fourth of the number at the peak, the number of fatal accidents involving walkers and bicycle riders is the worst for advanced countries.

(4) Better landscapes and the re-construction of the road space are important goals from the perspective of regional activation. Burying electric cables may contribute to these improvements, along with disaster prevention performance. However, this has been significantly delayed.

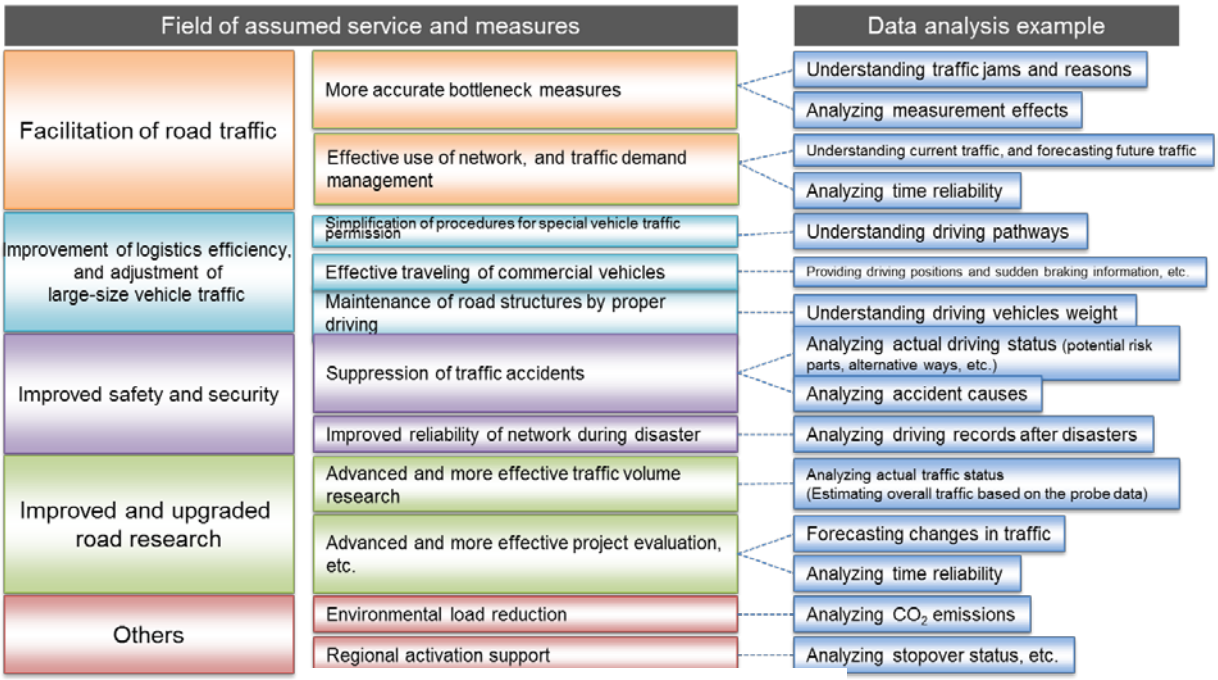


Figure 1: Problems with ETC2.0 data

(5) Because of innovations in information and communication technology (ICT), we will be able to collect road traffic big data (ETC2.0 probe, etc.) (Note that this item is not a problem.)

3. R&D of problems we are facing

1) Smart operation of roads, based on big data[3)]

Because ETC2.0 probes, etc. can collect precise traffic condition data all the time, they may contribute to the effective and efficient implantation of various policies. Figure 1 shows the concepts of the activities. The major ones are explained as follows:

(1) Smart use of road network

If we can identify the point of a traffic jam, and determine the contributing factors, pinpoint measures will be available. If we can supply appropriate traffic information to drivers, full-scale traffic demand management may be possible, including the avoidance of traffic jams and flexible tolls based on the traffic level. Furthermore, it is expected that supplying appropriate information will allow safe driving, and support a smooth evacuation and the transportation of critical materials during a disaster.

(2) Advanced and effective check of road traffic

The use of big data may improve the efficiency of the road traffic census currently conducted once every 5 years by drastically upgrading it. In addition, we have to work on the utilization of the big data to upgrade the measurement and evaluation methods for project effects, including stock effects and traffic jam elimination.

(3) Support of improved logistics efficiency and adjustment of large-size vehicle traffic

It is necessary to improve the logistics efficiency and productivity of transportation, by simplifying the traffic permission procedures for special vehicles, and supporting distribution operators' vehicle traffic. In addition, from the perspective of road life elongation, it is necessary to find methods to check and adjust the pathways and weights of vehicles.

(4) Visible environmental measures

If we can precisely calculate the CO_2 emissions of vehicles, the accurate prevention of global warming may be possible.

2) Traffic safety measures for community roads

The basic concepts of the traffic safety measures for community roads are controlling the through traffic and suppressing the vehicle speed.

(1) Switching of traffic from community roads to arterial roads

With the use of the big data, it is necessary to determine the actual state of the through traffic, extract areas where measures are necessary, and develop a method to switch traffic from the community roads to the arterial roads.

(2) Standardization of physical devices for speed suppression

Physical devices such as humps and narrowed areas are effective for vehicle speed suppression. Some places need guard fences with an appropriate shape and strength for community roads to physically protect walkers from collisions. It is necessary to prepare the environment for the standardization of technical standards for these hardware measures, along with their diffusion.

3) Promotion of electric cable burial

In addition to developing low-cost methods for burying electric cables, it is important to develop an evaluation method based on the policy purpose (better landscape, preparation of emergency transportation roads, etc.) with the use of ICT, and promote the consideration of a method to reconstruct the road space after the removal of electric poles.

4. Approaches to problems from long- and mid-term viewpoints

The people, vehicles, society, and technologies surrounding roads are changing drastically, because of the approaching ultra-aging society, improved vehicle performance, diffusion of speed control technologies, progress in driving techniques, development of super-compact mobility, energy revolution by fuel cell

vehicles, etc. I believe that approaches based on the following themes will also be necessary from the long- and mid-term viewpoints:

- Re-consideration of road structure, based on vehicle progress, etc.
- Ideal cooperative ITS service, in collaboration with vehicle technologies
- Impact of life-style changes (e.g., car-sharing) on road traffic
- Traffic safety measures based on human science, etc.
- Efficient collection of information about traveling vehicles, including the use of private technologies
- Relation between energy revolution and road infrastructure

Many of these do not currently appear in relation to problems, and we cannot reliably forecast the future social condition. However, it is estimated that the relationship between road traffic and infrastructure is significant. Thus, it is important to work on them from comprehensive and long- and mid-term viewpoints.

☞For more detail, access the following information:

1) Road Subcommittee, the Panel on Infrastructure Development: Interim guidelines for proposition, Jun. 2012 (in Japanese)
http://www.mlit.go.jp/common/000219233.pdf
2) National arterial road section, Road Subcommittee of Council for Social Infrastructure: "Activities for smart use of roads" focusing on highways, Jul. 2015 (in Japanese)
http://www.mlit.go.jp/common/001098868.pdf
3) Masahide Ito: Technological outlook of "smart use" of roads with ETC2.0, Civil engineering journal, vol.58 No.1, pp.30-33, Jan. 2016 (in Japanese)

Activities for maintenance and construction of road structures

Hideto Mashimo (Ph.D (Engineering)), Director of Road Structures Department

(Keywords) road structures, maintenance cycle, performance evaluation, technical support

1. Introduction

The aging of the road structures, which were intensively constructed during and after the high economic growth period, is becoming a serious problem nationwide, and it is necessary to properly maintain these road structures without excessive cost, in preparation for the coming depopulation. To properly maintain road structures, we have to follow a maintenance cycle that includes an inspection, diagnosis, treatment, and recording. Periodical inspections based on the laws for bridges and tunnels started in July 2014. From now on, it is important to take measures based on the inspection and diagnosis results and effectively follow the maintenance cycle. In addition, to ensure stability for people and an active local economy, it is necessary to more effectively and efficiently construct highly durable road structures on a limited budget. The utilization of new construction forms and materials is one of the methods for that purpose. Ensuring the security and durability of the constructed structures is necessary for the accurate utilization of these new technologies.

In order to maintain the road structures and support their effective construction from a technical perspective, in cooperation with the Ministry of Land, Infrastructure, Transport and Tourism and related agencies, the Road Structures Department prepares drafts of technical standards for bridges, tunnels, earthwork structures, pavements, etc.; investigates and researches matters required for the preparation of these technical standards; gives technical instructions and advice on problems in the actual field; and develops engineers with specialized experience.

2. Operation of reliable and effective maintenance cycle

For the reliable and effective operation of the maintenance cycle, reliable inspection and diagnosis systems and a reduction in the burden and costs of field works are necessary. In addition, the development of technologies to support the inspection and diagnosis systems, and measures such as for repair and reinforcement, are required. Therefore, the Road Structures Department is mainly conducting the following research:

1) Inspection

An evaluation on the adaptability of non-destructive test technologies using electromagnetic waves, X-rays, and infrared rays to check for damage not found by an appearance check such as corrosion inside concrete and underground foundations

Rationalization measures for inspections based on the analysis of the periodical check data of bridges and tunnels (inspection items, frequency, procedures, etc.)

2) Diagnosis

Procedures to determine the integrity of damaged bridges based on an analysis method with damage condition data and the actual material strength, and procedures to evaluate the condition of rusted weatherproof steel materials using binocular vision photos of rust

3) Repair and reinforcement

A design method for the repair and reinforcement of existing bridges (Photo 1), using a partial coefficients design that applies the variation in existing members and

additional members, and the actual material strengths and loads corresponding to a scheduled service period

Performance requirements and management items for the hot-work technology used for reinforcing steel bridges

Photo 1: Reinforcement of bridge with external cables

A method for evaluating the durability of fall prevention works used as tunnel repair measures, and a selection method based on an abnormal condition

The damage condition and repair and reinforcement effects of underground structures such as sheds and culverts, based on the analyzed inspection data

Regarding pavements that are not subject to periodic inspections, we are promoting research on appropriate maintenance methods based on the pavement condition by type (concrete pavement or asphalt pavement), and the life elongation effects of maintenance construction methods such as patching. In earthwork construction, for banking and cutting, which are not subject to periodic inspections, we are promoting research on maintenance methods that incorporate the viewpoints of road functions and risk management. Furthermore, we are promoting research on ways to create and utilize a plan for a longer-operating life, in order to establish a management method to maintain and upgrade road structures on a budget.

3. Construction of reliable road structures

To construct reliable, safe, and durable structures with new structural forms and materials, it is necessary to clarify the performance requirements of the structures, and set-up a design method for reasonably evaluating the characteristics of the structural forms and performance of the materials. In addition, to reduce the future maintenance burden, it is important to adopt a design that considers durability and easy maintenance, and to ensure quality at the time of construction. Therefore, the Road Structures Department is mainly promoting the following research:

1) Design method with appropriate performance evaluation

A partial coefficients design method, which can be used to individually consider the working loads and safety margins of materials, and appropriately evaluate the performances of bridges with various new forms, and a design method for bridges with complicated stress conditions, along with structural analysis methods such as constant shear flow panels and cubic lattice models

A method for setting the design load when designing a the covering structure of a tunnel to which no standard support pattern is applied (because of little earth covering, weak soil, etc.), along with an analytical method, and a performance requirements and performance verification method

A method for setting the design load to ensure the performance required for a large-scale earthwork structure, and also an earthwork structure with a new form, as shown in Photo 2, and a performance requirements and performance verification method

Photo 2: Example of earthwork structure with new form (abutment back approach part with reinforcing clay wall)

2) Design and construction method, allowing reduction of maintenance burden

Improved durability, structural details, and specifications allowing a reduction in the burden for inspection and repairs, and a quality management method for the construction phase, designed by integrating the knowledge acquired from analysis on inspection results

Application of concrete pavements with high durability, for pavement lifecycle cost reduction

In addition, regarding members other than these major structures, we evaluate the third-party damage risks quantitatively with the goal of preventing third-party damage, and promote research on design methods for effective prevention and measures procedures.

4. Human development, and technical instruction and consultation

To develop engineers with specialized experience, we prepare training textbooks and send lecturers to lectures and training, which contribute to the development of engineers and the improvement of their technical skills, targeting not only the staffs of the Regional Development Bureaus of the Ministry of Land, Infrastructure, Transport and Tourism, who are charged with the actual maintenance work for road structures, but also the staffs of local authorities and private engineers. In addition, we provide technical consultations regarding technology audits and evaluations, which require professional knowledge about disasters, serious accidents, failures, and advanced details of the standards, instruct the field staffs. We also participate in committee meetings to support them, and also send our staff to the "Direct Diagnosis" conducted by the "Road maintenance technology group," which consists of the Regional Development Bureau staff, as a support activity for the local authorities (two bridges and one shed in FY2016). Numerous lessons that we learned through technical consultations are introduced in the Civil Engineering journal, which is collaboratively edited by the NILIM and the Public Works Research Institute, under the title "Maintenance we can learn in field works (in Japanese)."

Research of the Building Department to realize a safe, reliable, and comfortable living environment

SAWACHI Takao (Ph.D. in engineering)
Director of Building Department

(Keywords) seismic performance, fire control and safety performance, safety performance of non-structural members, safety performance of building equipment

1. Overview of Building Department

The Building Department is aiming to satisfy the needs of citizens and societies and realize a safe, reliable, and comfortable living environment. In order to realize this goal, the Building Department set a mission to provide administrative support based on scientific and technical perspectives for plans, proposals, development and revisions in various aspects of building including structure, fire control, facility, and material in technical standards such as the Building Standards Act and the Housing Quality Assurance Act. The Department is conducting relevant researches and establishing standards with Building Research Institute. The Department is also providing technical instructions to promulgate the technical standards.

This paper introduces the following activities of the Building Department: (1) main research theme; (2) establishment of technical standards; and (3) other activities such as fire investigation.

2. Main research theme

1) Development of function-sustaining technologies of buildings used for disaster responses (Comprehensive technology development project: FY2013-2016)

Government facilities which should have been used as disaster response base lost their functions as they were damaged in the Great East Japan Earthquake because of (i) structural damage caused by tsunami and (ii) damage to non-structural members (e.g. non-structural walls and ceilings). Tornadoes that occurred in areas including Tsukuba City in May 2012 damaged windows and doors of buildings with flying objects. If such damage occurs to the disaster response base, continuous use of the bases will probably be difficult. The Building Department is developing technologies for buildings which are used as bases of emergency responses and restoration activities to sustain their functions immediately after a disaster by setting the following themes.

- Development of tsunami-resistant design method to prevent exfoliation of external walls
- Development of tsunami evacuation building which will not be damaged by tsunamis
- Investigation and analysis of technologies to deal with tsunami debris
- Development of method to test resistance of exterior materials against the impact of flying objects
- Investigation and analysis of technologies to sustain the functions of facilities and systems
- Development of non-resonant ceiling materials
- Development of damage-controlling design method using non-structural walls (Photo 1 shows a test piece of load test using an actual-scale five-layer reinforced concrete structure.)
- Establishment of a design guideline for sustained use of buildings used as disaster response bases

Photo 1. A test using an actual-scale five-layer reinforced concrete structure to propose structures that will not require repairing columns and beams after a massive earthquake

2) Study of a method to evaluate the safety and reusability of buildings damaged by earthquake-triggered fire (factual study: FY2015-2017)

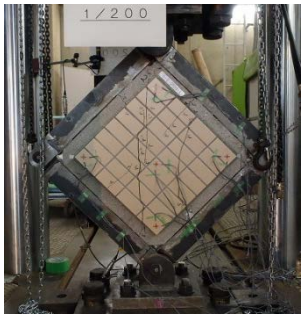
A massive earthquake directly hitting Tokyo and the Nankai Trough earthquake are expected to cause damage and trigger fires, and up to 410,000 to 750,000 buildings are expected to be damaged by the fires triggered by the earthquakes. Most of the damaged buildings are expected to be wooden buildings. Yet, estimating from damage in the Great Hanshin Earthquake and other earthquakes, tens of thousands of mid-to-high-rise fireproofed buildings will likely be damaged as well. Thus, research teams are conducting this research targeting mid-to-high-rise fireproofed buildings that are damaged by earthquake-triggered fire focusing on the following: (i) establishment of method to judge risks to secure

evacuation shelters immediately after an earthquake, reduce the number of people who cannot reach their destinations, and prevent secondary damage; and (ii) establishment and systematization of technologies to reuse buildings to quickly and efficiently recover from earthquakes using damaged buildings

3) Study of the fire safety of wooden, three-story school buildings (National Institute for Land and Infrastructure Management project research: FY2011-2014)

The aim of this study was to enable the construction of wooden, three-story school buildings. The team gathered necessary technical perspectives for revising the Building Standards Act and prepared proposals for standards to ensure safety by ensuring safe evacuation from fire, low effect of fire to nearby areas, such as effects of heat, sparks, and collapsed buildings, and reduced number of obstacles, such as collapsed buildings that slow down firefighting activities. The team also prepared examples of specifications using parts with enough performance. (Photo 2 shows an actual-scale fire experiment to verify the proposed standards.)

Photo 2. Actual-scale fire experiment to verify the adequacy of specifications to set standards for three-story wooden school buildings



[Lined with tiles with two layers of mortar base layer]

[Concrete on the back side]

Photo 3. Diagonal evaluation test conducted for verification

4) Study of evaluation method and standard of seismic safety of exterior materials (factual study: FY2012-2014)

Wet-tile exterior materials that are widely used on the outer walls of apartment buildings must be prevented from falling off and injuring people beneath during an earthquake. Thus, this study aimed to develop standard test methods to evaluate the performance to prevent exfoliation and technical references to evaluate the intactness of wet-tile exterior materials after an earthquake. The study verified the effect of an evaluation and test method using two types of small test pieces (Photo 3) based on conditions of tile exfoliation caused by inter-layer displacement (deformation) using a test wall lined with large tiles.

3. Activities related to the establishment and revision of technical standards

Building Structure Standard Committee (chairman: KUBO Tetsuo, professor emeritus of Tokyo University) and Building Fire Control Standard Committee (chairman: TSUJIMOTO Makoto, professor of Tokyo University of Science) and Building Department as a secretariat examined the draft of standards written based on Building Standards Act and other laws with the Housing Department of Ministry of Land, Infrastructure, Transport and Tourism. The former committee examines the prevention of long-period ground motion in super-high-rise buildings and the overall proposal of the technical standard of architectural structure. The latter examines the draft of technical standards concerning fire control and evacuation from buildings and revised proposal of the fire control standard for wooden three-story school buildings.

4. Other activities including the investigation of damage in disasters

In FY2015, the team investigated damage to the buildings affected by the overflow of the Kinu River (joint investigation with the River Department, September 2015) and damage from the fire at a multipurpose, multi-tenant building in Hiroshima (October 2015). The team also provided technical support for the investigation and examination of the Ministry of Land, Infrastructure, Transport and Tourism on unlawful practices involving anti-seismic building materials.

In terms of international activities, the team sent researchers to Technical Committee 43 for the International Standard (ISO), 92 (fire safety) and 163 (thermal environment and energy consumption of buildings) to examine standards to make them consistent with standards and specifications used in Japan and also propose international standards based on standards and specifications of Japan.

5. Conclusion

This paper introduced the overview of research themes that the Building Department was implementing or recently completed, and the establishment of technical themes and other activities such as fire investigations.

☞Details

1) Report of damage to buildings caused by the overflow of Kinu River that occurred in Joso, Ibaraki on September 10, 2015 (in Japanese) http://www.nilim.go.jp/lab/bbg/saigai/h27/20150910kinugawa.pdf

To realize the prosperous and comfortable living environment

FUKUYAMA Hiroshi (Ph.D. in engineering), Director
Housing Department

(Keywords) Living environment, housing stock, housing market, stable living, architectural production, energy conservation

1. Introduction

The mission of the Housing Department is to ensure that citizens can live in healthy and comfortable houses from the technical perspectives. The basis of this mission is that housing is one of the basic needs of people that include food, clothing, and shelter. This paper introduces some of the activities that the Housing Department is implementing.

2. Activities of the Housing Department are based on national policy targets

To fulfill the mission stated above, the Housing Department is conducting research and development to realize the following goals (i) to (iv) as stipulated in the Basic Plan for Housing (nationwide plan). The Basic Plan for Housing is a ten-year plan that is stipulated based on the Basic Act for Housing established in 2006. It is revised approximately every five years, and the last revision was in 2011.

In addition to these goals, the Housing Department is conducting research and development in the architectural production field described in (v) below, including architecture besides houses. In terms of the field of architectural environment, the Department is conducting research and development to improve the architectural environment shown in (vi) to improve energy efficiency including architecture besides houses.

Details of the main research that Housing Department is working on are introduced below for each category.

i. Establishment of the living environment to support safe, reliable, and prosperous lives
- ・Design of houses to suit the lifestyles of elderly and people with disabilities, and development and promulgation of renovation technologies
- ・ Development of evaluation standards for technologies to assist the elderly, people with disabilities, and young children to evacuate in case of a disaster

ii. Proper management and regeneration of houses
- ・Development and promulgation of methods to efficiently evaluate and diagnose conditions of currently available buildings and easily determine maintenance and management method and necessary renovations
- ・Development and promulgation of evaluation standards to elongate the service lives of houses
- ・Development of decision criteria to deal with vacant houses

iii. Development of the housing market in which diversified housing needs are properly satisfied
- ・ Development of effective methods to plan, implement, and evaluate housing policies based on diversified housing satisfaction levels
- ・Development of methods to plan housing to suit changes in regional social and economic situations

iv. Securing stable living (safety net) for people who require special consideration to secure housing
- ・Development of policies of using public housing and private housing (integration, abolition, rearrangement, and longer service lives, etc.) and development of policies to contribute to the rational renovation and repair for long-term uses of housing
- ・Development of plans to provide emergency housing and public housing for disaster victims

v. Rationalization of architectural production and quality assurance
- ・Development and use of databases and BIM technologies to improve the efficiency of the design and construction of new housing and renovation
- ・Development of methods to organize and manage housing history

vi. Promotion of energy conservation and reduction of CO_2 in the residential sector to mitigate the global warming
- ・Development of evaluation method in preparation for the mandatory energy conservation standards and improvement of the precision and convenience of the method
- ・ Organization of the information of energy conservation technologies of designers, contractors, and manufacturers of construction materials, facilities, and equipment
- ・Evaluation of effects to reduce energy consumption during peak hours

3. Guide to energy conservation designs for housing and architectures

The Act on Improvement of Energy Consumption Performance of Buildings (the Building Energy

Conservation Act) was established in July 2015, and mandatory application of the law to energy conservation standards is gradually starting. As seen in this trend, the movement to improve the energy efficiency of housing and buildings is expected to increase its speed and scale. This section introduces two activities that the National Institute for Land and Infrastructure Management is implementing to conserve energy and reduce CO_2 emissions.

The first activity is the development of technologies to support mandatory compliance with energy conservation standards for buildings. Specific activities include the development and distribution of evaluation programs to measure energy consumption and sheltering performance, as well as support for small and mid-size businesses by providing guidelines for energy efficient designs.

High equity and reliability are required to uniformly evaluate the energy conservation performance of various technologies and buildings. Thus, the Housing Department has conducted many experiments and investigated actual operations. The photo is an example of an experimental housing in which home appliances in buildings are automatically operated to simulate the lives of people to analyze actual values of energy efficiency. In addition, sensors were installed in 29 buildings that are actually being used to obtain actual data of energy consumption.

The Housing Department is using the outcomes of these experiments and investigations to develop and distribute programs to evaluate energy consumption. Specific computation methods (formulas) used in the programs and grounds of the methods are described in a technical reference to ensure transparency as much as possible.

Photo. Investigation of energy consumption by simulating lives of people

The second activity is related to the reduction of energy consumption during peak hours to rationalize the energy supply. The objective of this activity is to establish methods to evaluate the effect of technologies (e.g. use of unused heat, heat storage, and electricity storage) to reduce energy consumption during peak hours and to provide guidelines of designs.

While the theme of the first activity is to deal with annual energy consumption, the second is to compute the energy consumption at a given point. Thus, using and elaborating on the research outcomes related to the energy consumption computation program, which is the outcome of the first activity, enabled quantitative evaluation of peak-hour energy management technologies.

Technologies used here include the peak-shift in which electricity and heat stored during nighttime are used during daytime, and peak-cut in which the energy consumption during peak hours is reduced by using solar power and ground heat. These technologies cut energy uses during peak hours.

The goal of this study was to build a win-win relationship including the drastic reduction of energy consumption during peak hours and also the reduction of the overall energy consumption. The Housing Department is working to realize an energy efficient society without lowering the quality of the living environment.

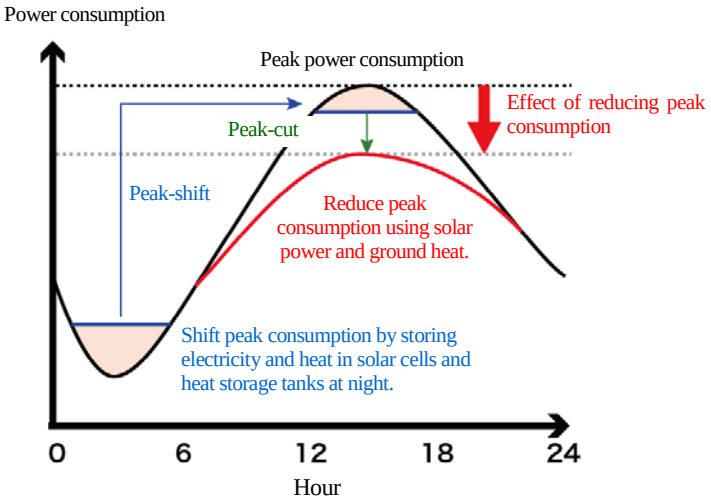


Figure. Evaluation of technologies to reduce energy consumption during peak hours

4. Conclusion

The Housing Department is working to improve the quality of housing as introduced in section 2. The revision of the Basic Plan for Housing, which will greatly affect the activities of the Department, is being planned in 2016. The Department is going to properly determine the direction of researches while taking into account of the revisions and social conditions.

We appreciate your continuous support. Thank you.

Reflection of research and development outcomes into policies

SATO Kenichi
Director of Urban Planning Department

(Keywords) Urban Planning Department, annual report of National Institute for Land and Infrastructure Management, reflection into policies, technical instructions

1. Fifteen years since the establishment of the Urban Planning Department

The Urban Planning Department was born as a part of the National Institute for Land and Infrastructure Management (NILIM) that was established when the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) was launched through the central government restructuring in April 2001. The Department celebrated the 15th anniversary in 2016.

The NILIM conducts comprehensive investigations, tests, research, and development of technologies, which are in the field of housing and social assets to use, develop, and conserve national lands as related to policy planning and proposals of the tasks of the MLIT. For 15 years since its establishment, the Urban Planning Department has been in charge of investigation, research, development, and provision of technical instructions in the field of urban planning, urban facilities, urban disaster management, and urban development.

As an organization of the MLIT, the NILIM is specifically in charge of the following: (i) investigation and research to contribute to policy planning, proposals, and implementation; (ii) preparation of drafts of technical standards based on laws and regulations; and (iii) research of technical instructions and promulgation of research outcomes. To mark the 15th anniversary of the Urban Planning Department, this paper describes, based on the annual reports of the NILIM, how the specific roles (i) to (iii) have been fulfilled, and how research outcomes have been reflected in policies and promulgated in the process. This paper thereby aims to gain future perspectives.

2. Reflection of research and development outcomes into policies

The annual report of the NILIM is the record that comprehensively summarizes activities of the NILIM and their outcomes for each year. The reports are released to the public so that people involved with the development and management of housing and social assets can refer to them. The report consists of Chapter 1 for introduction, Chapter 2 for the report of activities, and Chapter 3 for the report of outcomes and public relations. Chapter 3, outcomes and public relations, describes how research outcomes are reflected into policies, which is the main focus of this paper.

About 50 to 100 research outcomes of the NILIM as a whole are reflected in policies every year except for the aftermath of its establishment. About one to ten research outcomes of the Urban Planning Department are mentioned in the report every year. The methods of reflection range from technical standards based on laws and regulations to drafts of new policies and activities to spread the outcomes. The majority is technical standards and policies related to laws and regulations.

In chronological order, the annual reports show the records of activities related to technical support that is required as a part of the MLIT. Most outcomes in the early stages consisted of ones related to urban regeneration, which was a national policy back then, especially for the prevention of disasters in densely built-up areas. The following activities consisted of support for the urban policies of local governments around the time when the issue of the revitalization of central urban areas was one of the social issues. Investigations and researches of natural disasters, such as ground liquefaction management measures, were conducted after the Great East Japan Earthquake in 2011. The Low Carbon Urban Policy Act was enacted in 2012. The Urban Planning Department had been conducting researches in the global environment and reflecting the outcomes in policies since before the enactment. Now the Department's goal is to reflect researches of the Compact City under a declining society related to the revitalization of rural districts.

In general, research and development are roughly categorized into two types: those started after the onset of some social problem and ones started based on awareness of problems in research and policies, which are reflected in policies as social awareness changes. The matter is not which type is more important. Yet, the former quickly becomes policies and thus easier for citizens to understand. Meanwhile, the meaning of the latter type of research and development is often difficult to understand, because they require a long term, sometimes more than ten years, to be materialized as policies. The research and development related to the Urban Planning Department might seem to be classified at a high frequency into the former type. Yet, based on the above perspective, most of the recorded cases are actually the latter type of research and development.

Another characteristic of the Urban Planning Department is that they are also promulgating and providing technical instructions while reflecting research outcomes in policies. The national government sometimes plans and proposes policies for urban development for which the Urban Planning Department is responsible, but local governments and autonomous resident groups are the main executors of the policies. Technical support for users is essential along with the implementation of policies through research and development in order for the users to receive and use advanced and cutting-edge research and development as simple and widely applicable technologies.

3. Technical instructions as a reflection into policies

Technical instructions of the Urban Planning Department are mainly targeting local governments, especially wards, cities, towns, and villages. Technical instructions are the opportunity to directly apply knowledge and technologies gained through research and development to actual fields. It is also a valuable opportunity to improve technical levels and promote research and development by identifying needs and problems that actual fields are facing.

Meanwhile, enormous numbers of outcomes have been accumulated over the 15 years, and individually providing technical instructions to suit actual conditions is a difficult task that can require time and effort. There is a limit to responding to individual demands, but the Department has been putting efforts into doing so in recent years. The Department is planning effective and efficient technical instructions for users to autonomously use the research outcomes, such as releasing programs and providing manuals to users.

There are problems, however. Officers of local governments only have experience in administrative procedures; programs are a challenge for them, and they cannot continue using them. In addition, programs and manuals require maintenance, such as improvement and updating, which are difficult tasks that cannot be done in someone's spare time.

Some local governments are installing their own research organizations and researchers to work on urban policy. It may be worthwhile to strengthen the relationship with these research organizations of local governments not only for research and development, but also for the reflection of outcomes into policies. A benefit of such attempt is that it can cover wider research fields that cannot be covered by the Urban Planning Department of the NILIM alone.

Measures to generate time and funds for maintaining the programs and manuals must also be established. Here are some proposals; organizing efforts and creating specialties, cooperating with private organizations such as the Japan Association for Building Research Promotion, and collecting costs from users. In addition, funds should be allocated for the substitute costs of maintaining and managing experimental facilities.

Annual report of the NILIM: Reflection into policies (Urban Planning Department)
(Annual report for FY 2003)
-Revision of the Act on Promotion of Improvement of Disaster Control Districts in Populated Urban Districts and preparation of regional disaster management performance evaluation manual
(Annual report for FY 2005)
-Development and release of a simulation program to evaluate urban disaster management evaluation
-Establishment and release of "Guidance for using and planning LRT integrated with urban development"
(Annual report for FY 2006)
-Revision of the Act on Promotion of Improvement of Disaster Control Districts in Populated Urban Districts
-Preparation and release of Operation Guidebook for Organizational Regulations for the Development of Dense Urban Districts
(Annual report for FY 2007)
-Examination of technical standards in the enforcement regulation of the revised Populated Urban Development Act
-Development of Technical Policy for Planning Disaster Control District and Reorganization District
-Establishment of Urban Development Subsidy Index and Utilization Manual
-Promulgation of Operation Guidebook for Organizational Regulations for the Development of Dense Urban Districts
-Development and use of domestic roads -Reflection to the Regulation and Operation Policies related to Building Standards Act-
(Annual report for FY 2008)
-Promulgation of Operation Guidebook for Organizational Regulations for the Development of Dense Urban Districts
-Reflection to the Low Carbon Urban Development Guideline (draft) and technical support for Environmental Action Plan Model Project
(Annual report for FY 2009)
-Reflection to the Low Carbon Urban Development Guideline
-Promulgation of Operation Guidebook for Organizational Regulations for the Development of Dense Urban Districts
(Annual report for FY 2010)
-Reflection to the revision of Populated Urban District Development Policy in Basic Plan of the Living Environment (national plan)
-Promulgation of Operation Guidebook for Organizational Regulations for the Development of Dense Urban Districts
(Annual report for FY 2011)
-Publication of Investigation and Research of the Earthquake in the Pacific off the Coast of Tohoku (quick report) in 2011
-Publication of the summary of the Field Survey and Research on "The 2011 off the Pacific coast of Tohoku Earthquake (the Great East Japan Earthquake)
-Publication of Investigation Report of Damages caused by the Earthquake off in the Pacific off the Coast of Tohoku in 2011
-Promulgation of Operation Guidebook for Organizational Regulations for the Development of Dense Urban Districts
(Annual report for FY 2012)
-Release of the Examination and Investigation for the Restoration of Cities Damaged by Ground Liquefaction in the Great East Japan Earthquake (Guidance (draft))
-Development of software that can quickly compute effects of using the groundwater lowering method to control ground liquefaction in residential areas
-Release of the Examination and Investigation of Groundwater Lowering Method to be used in Cities Damaged by Ground Liquefaction (Guidance (draft))
-Development of software that can quickly compute effects of using the grid-like underground wall construction method to control ground liquefaction in residential areas
-Promulgation of Operation Guidebook for Organizational Regulations for the Development of Dense Urban Districts
-Technical advice for the management of heat island in the Law for the Reduction of Carbon in Cities
(Annual report for FY 2013)
-Release of the Examination and Investigation of Grid-like Underground Wall Construction Method in Cities Damaged by Ground Liquefaction (Guidance (draft))
-Restoration Committee for Cities Damaged by Ground Liquefaction
-Dialogue session for working-level officials of disaster-hit municipalities to control ground liquefaction in urban areas
-Description of the accessibility index in the Urban Planning Basic Investigation Officer Meeting
-Reflection of contents of the accessibility index in the Examples of Data Analysis in Basic Investigation of Urban Planning (draft)
-The 2013 Urban Disaster Control and Management Officer Meeting
-Preparation of the draft of JIS, "method to test the spread of fire in building facade"
-Promulgation of Operation Guidebook for Organizational Regulations for the Development of Dense Urban Districts
-Support for investigation to partially revise the Building Standards Act
(Annual report for FY 2014)
-Promulgation of Operation Guidebook for Organizational Regulations for the Development of Dense Urban Districts

Productivity improvement in infrastructure development process using i-Construction

Atsushi Suzuki, Director of Research Center for Land and Construction Management

(Keywords) infrastructure development, productivity improvement, i-Construction, CIM

1. Infrastructure development process

The development process, the infrastructure consists of the project execution process for planning, investigation, design, construction, maintenance, and procurement and the contract fulfillment process for individual projects involving cost estimation, bid contracts, fulfillment, inspection, and evaluation. It is necessary to review both aspects of the development process, corresponding to changes such as in the social and economic situation.

Recent tasks for the infrastructure development process include responses to natural disasters, which occur frequently and are intensifying, maintenance of numerous aging public facilities, and decrease in the workforce in response to the declining birthrate and growing proportion of elderly people. Although the construction industry plays an important role, the working population of the construction industry is decreasing, and as a result, there is rising concern about securing sufficient quality and maintenance for the infrastructure development in the future.

It is necessary to promote efficiency improvement, rationalization, and upgrades and improvements in productivity in each phase of the infrastructure development process, together with the reliable preparation of public and private human resources for the future. In this report, we introduce the current topics that we are working on as a part of work procedure innovation, regarding productivity improvement in the infrastructure development process.

2. Implementation of i-Construction

In November 2015, the Minister of the Land, Infrastructure, Transport and Tourism proposed “i-Construction”. With three major concepts, including the full utilization of information and communication technology (ICT), technical standardization, and equalization of construction periods, the i-Construction aims to optimize and upgrade the whole process from investigation and design, construction and inspection, up to maintenance. It will also increase the productivity of individuals working on construction sites, improve the administrative circumstances in companies, and raise the wage level of workers engaged in construction, while simultaneously ensuring security. As a part of the i-Construction promotion project, we are promoting research on improving the productivity at the sites of earthworks and concrete works.

Approximately 30% of the workers employed in the construction industry are 55 years of age or older, and aging in this industry is more serious than in other industries. It is almost certain that a large number of workers will leave their jobs in the near future. According to an estimation by the Japan Federation of Construction Contractors, on the assumption that the construction investment will be the same as the current investment level, it aims to acquire 900,000 new workers in the industry and save a manpower equivalent of 350,000 workers, to compensate for the lack of skilled workers by 2025. We have to enhance recruitment and human development measures, and prepare attractive construction sites for young people, by improving their productivity through the utilization of ICT.

According to the data on the skilled workers at construction sites grouped by construction type, almost 40% of workers in the projects implemented by the national government are in engaged earthwork and concrete work (Figure 1). In the case of tunnel construction projects, the number of workers per unit of construction volume has become approximately one tenth that of approximately 50 years ago, and the productivity of the workers has increased significantly. On the other hand, regarding earthworks and concrete works, the number of workers has remained constant for 30 years, and there is room for improvement.

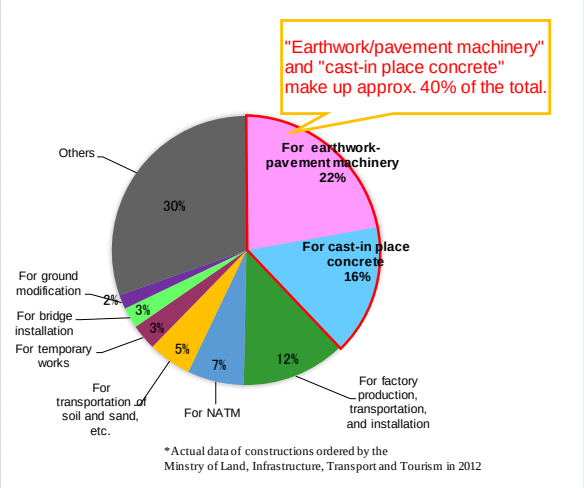


Figure 1: Proportion of skilled workers at construction sites by construction type

At the earthwork construction sites, three-dimensional design data are introduced for the automatic control of ICT construction machines to increase the construction volume of heavy equipment per day, and save manpower simultaneously. However, the early phases of construction, like the measurement and design phase, are still conducted using two-dimensional data, and three-dimensional data are created for construction separately. In addition, work completion drawings are created in a two-dimensional data format for inspection after construction. Therefore, construction works based on three-dimensional data and transactions between an orderer and a contractor based on two-dimensional data exist together in one construction case. The full utilization of ICT by the three-dimensionalization of all the processes from measurement to inspection is desired (Figure 2). For that purpose, it is necessary to develop measurement rules, allowing utilization of three-dimensional data collected by unmanned aerial vehicle (UAV) as a measurement result, along with inspection standards that can be used for progress assessments and completion inspections.

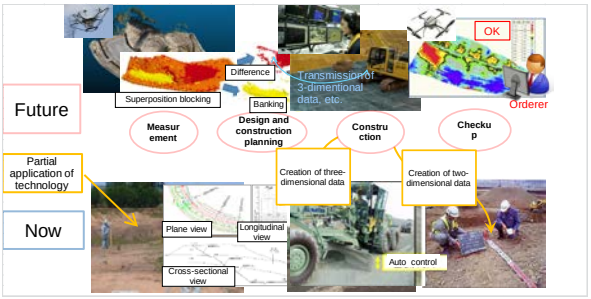


Figure 2: Overall earthwork productivity improvement with utilization of ICT

Regarding concrete works, it may be possible to improve the effectiveness of the work conducted at the site, and save labor in the formwork and reinforcing-bar placement by the introduction of labor-saving technologies such as pre-cast concrete. However, in some cases, pre-cast concrete is not adopted in the design phase because of the high costs. It is expected that the utilization of pre-cast concrete will shorten the construction period, and improve the quality and safety. We propose an evaluation indicator for such labor-saving effects of pre-cast concrete, while simultaneously promoting research on the technical standards for pre-cast concrete and their incorporation into design guidelines.

3. Promotion of CIM

With Construction Information Modeling/Management (CIM), a three-dimensional model is introduced in the planning, investigation, and design phases, and also collaboratively incorporated into the construction and

maintenance phases. As a result, information is completely shared by related parties of the overall project, and a series of production systems can be more effective and advanced. The goal of CIM is largely related to i-Construction.

Since FY2012, CIM has been deployed on a trial basis for the design and construction of projects implemented by Ministry of Land, Infrastructure, Transport and Tourism. While the effects and problems found in these trials are cataloged, a joint study team from industrial, academic, and governmental organizations, which was established in January 2015, aims at the preparation of CIM introduction guidelines in FY2016. We are promoting a research on how to create and use a CIM model in the maintenance phase, targeting bridges and rivers. It tends to consume time and money excessively. Thus, it is necessary to review the level of detail for the three-dimensional model to be created, along with the functions and attribute information to be attached, before the maintenance phase, considering an appropriate balance between the effects and costs. It is important to be used on actual construction sites, and aim to prepare one that allows the intuitive searching and viewing of information by connecting Geographic Information System (GIS) data and locations in the three-dimensional model.

4. Reception of merits

All of the related parties shall share the merits and convenience brought by a productivity improvement. Public and private organizations, or orderers and contractors, as well as contractors, subcontractors, and workers at the sites should be included in the related parties. If any one of these receives adverse effects secondary to the shifted burden, labor shortage both in the private and public organizations will not avoidable, and it may be difficult to deploy the infrastructure development process continuously. In addition, although ICT has progressed remarkably, and various tools and paraphernalia are becoming available, it is important to put these things to practical use at the actual sites sufficiently. Needless to say, we will continue to do our best to understand the actual conditions at the sites, and research to satisfy the requirements at the sites.

Empirical Study on B-DASH Project (ICT-applied operation management / deterioration diagnosis)

YAMASHITA Hiromasa, Head, TAJIMA Atsushi, Senior Researcher, SHIGEMUARA Hiroyuki, Senior Researcher, MICHINAKA Atsuko (Dr. Eng.), Researcher, MATSUMOTO Ryu, Researcher, ITAKURA Mai, Researcher, YAMAGUCHI Shuji, Guest Research Engineer
Wastewater and Sludge Management Division, Water Quality Control Department,

(Key words) sewerage, water treatment, ICT, energy saving, operation management, maintenance, deterioration diagnosis, innovative technology

1. Introduction

Since fiscal 2011, the Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") has been implementing the "Breakthrough by Dynamic Approach in Sewage High Technology" (B-DASH) project, and the NILIM has been serving as an executing agency of this empirical study. The objective of this project is to realize the reduction of cost and energy consumption, etc. in whole sewerage works by promoting disseminating and development of innovative technologies through demonstration, and to support the overseas development of the water business by Japanese enterprises.

In addition, ICT (Information and Communication Technology) is expected as means of solution in sewerage works, as known from the holding of the "Workshop on ICT Utilization in Sewerage" in fiscal 2012 by the MLIT.

This paper introduces the outlines of two empirical studies that started in fiscal 2014 for operation control technology using ICT and another two empirical studies that started in fiscal 2015 for technology to diagnose sewerage deterioration using ICT.

2. ICT-applied operation management technology for water treatment facilities

(1) Empirical study on efficient water-treatment operation management technology by process control and remote diagnosis using ICT (Joint Research Organization of Toshiba Corp., Japan Sewage Works Agency, Fukuoka Prefecture, and Public Interest Incorporated Foundation Fukuoka Prefecture Sewerage Management Center)

The technology discussed herein is a system with combination of three component technologies: (i) Aeration air-flow control technology using NH_4-N sensor, (ii) Control performance improvement technology, and (iii) Multivariate statistical process monitoring technology. Aeration air-flow control technology using NH_4-N sensor aims to reduce aeration air-flow while keeping the target water quality by utilizing dissolved oxygen (DO) sensor and NH_4-N sensor. Control performance improvement technology aims to reduce the operation risk such as water quality deterioration while enhancing control effect using NH_4-N sensor by conducting automatic diagnosis and adjustment of control parameters. Multivariate statistical process monitoring technology detects abnormal signs and estimates causes of abnormality by analyzing correlation of many process data in treatment facilities by statistical approach.

The fiscal 2014 empirical study achieved certain results for cost reduction and energy saving effects, etc. and in fiscal 2015, verification throughout the year is going on as well as verification of total effects on combination of the aforementioned three technologies.

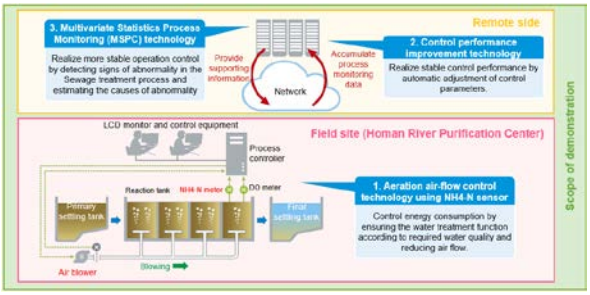


Figure 1: Process control and remote diagnosis technology

(2) Empirical study on technology for practical use of ICT-applied efficient operation control for nitrification (Joint Research Organization of Hitachi Ltd. and Ibaraki Prefecture)

This technology enables both stable processing and reduced aeration air flow in combination of feedforward (FF) control to forecast air flow required for processing and Feedback (FB) control to determine air flow based on difference between forecast and measured values by utilizing information measured by two ammonia meters, one of which was intalled at the upstream of the aerobic tank and the other, at the middle of aerobic tanks. The model used for mathematical operation is automatically updated every day based on the ammonia concentration processed while passing through the ammonia meters at two points and the value of accumulated air flow provided during the processing and consequently data on changes in the processing property caused by active sludge (microorganism) is continuously incorporated into FF control to continue demonstration for enhancing the efficiency of maintenance work.

The fiscal 2014 empirical study has achieved the target effect of air flow reduction while keeping treatment water quality. In fiscal 2015, year-round verification is going on.

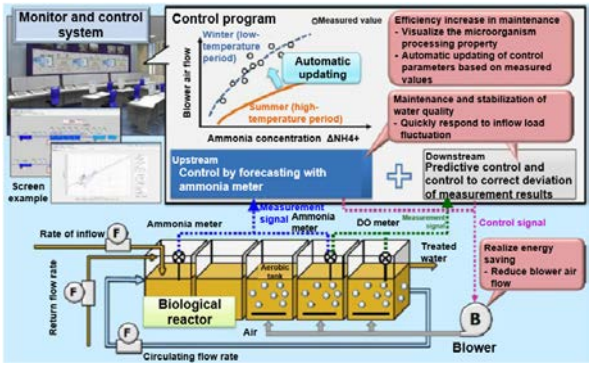


Figure 2: Outline of the monitoring and control system for nitrification operation

3. Technology to diagnose sewerage deterioration using ICT

(1) Empirical study on technology for grasping / diagnosing deterioration of sewerage facilities by vibration diagnosis and big data analysis (Joint Research Organization of Water Agency, NEC, Asahi Kasei Engineering, Japan Sewage Works Agency, Moriya City, and Hidaka City)

This technology is a combination of sensing technology and big data analysis technology. The sensing technology detects deterioration by continuous monitoring using vibration sensors installed on rotating equipment such as pumps and blowers. The big data analysis technology detects signs of abnormality and forecasts deterioration by conducting big data analysis using a large amount of operation data for all facilities and vibration sensor data ("big data"). Then, we demonstrate that promotion of efficient facility management by condition-based maintenance can be achieved by combination of the two technologies above.

In fiscal 2015, we are continuing demonstration in order to verify that the sensing technology can extend the overhaul interval of equipment and the big data analysis technology can detect signs of abnormality earlier as compared with the conventional technologies.

(2) Empirical study on technologies for deterioration diagnosis and equipment inspection by sensor continuous monitoring and cloud server concentration

(Joint Research Organization of Swing Corporation and Sendai City)

This technology is a combination of equipment state monitoring by sensor and tablet inspection system. Equipment state monitoring by sensor targets blowers and main pumps and continuously monitors vibration, temperature, and sound by sensor to transmit monitoring data to the cloud server. Tablet inspection aims to digitalize inspection record in normal daily inspections by introducing tablet system instead of recording in the conventional paper form.

Then, we demonstrate that combination of these two technologies will lead to establishment of an efficient equipment degradation diagnosis method and to effective use of accumulated diagnosis data to stock management. In fiscal 2015, we are working for collection of vibration data etc. by sensor and collection of data through tablet inspection.

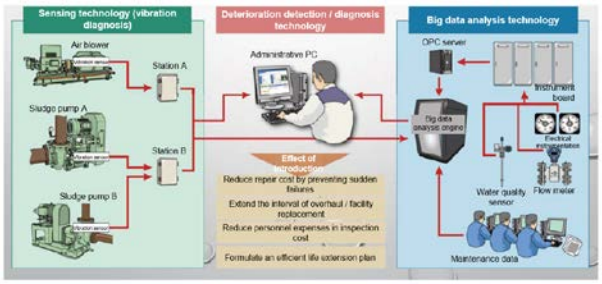


Figure 3: Sensing technology and big data analysis technology

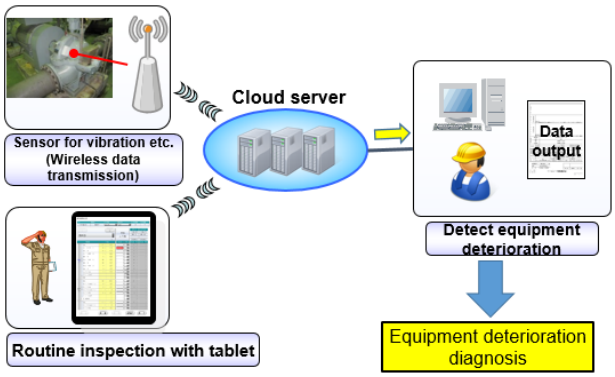


Figure 4: Technology for equipment deterioration diagnosis, etc. using sensor, etc.

4. Future development

The NILIM will continue to lead the B-DASH Project and formulate guidelines for innovative technology introduction based on results obtained from the Project and disseminate / promote such technologies. With these technologies, we endeavor to promote power saving in water treatment and improve the accuracy of deterioration diagnosis for sewerage facilities using ICT.

[Reference]

http://www.nilim.go.jp/lab/ecg/index.htm

Development of technology to determine the degree of priority for investigation of sewerage pipes

Toshihiro Yokota, Head
Wataru Fukatani, Senior Researcher
Toyohisa Miyamoto, Researcher
Daisuke Takeuchi, Guest Research Engineer
Wastewater System Division, Water Quality Control Department

(Key words) sewerage pipes, screening, rough set analysis

1. Status of sewage pipe maintenance

The deterioration of sewage pipes has been progressing in the same way as other infrastructure facilities. As a realistic measure to deal with the increase in the total length to be investigated under limited budget and human resources, it would be desirable to develop a technology to determine the degree of priority for the investigation, as a desktop application, using data such as a sewerage register.

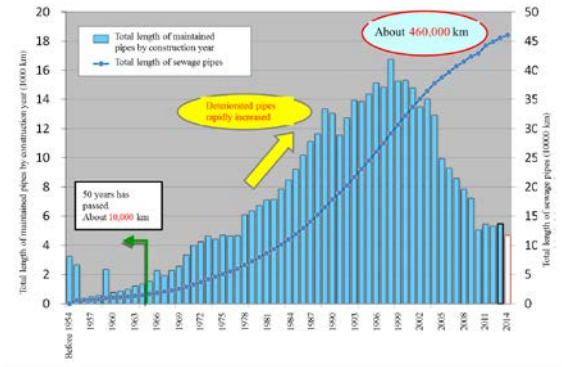


Figure 1 Total length of maintained pipes by construction year

2. Examination of causes of sinkholes using rough set analysis

2.1 Rough set analysis

At the NILIM, we have been examining methods to determine the degree of priority for an investigation based on the type of pipes and construction year from a macroscopic viewpoint, using multivariate analysis and the AHP method. In these methods, it is assumed that the variables used are independent, and we can define a determination function that has linearity. However, in reality, there is an interrelationship between variables, and it is possible for the occurrence rate of a sinkhole to specifically increase if particular conditions are simultaneously satisfied; therefore, sufficient accuracy has not yet been obtained. To understand what combinations can enhance the occurrence possibility for a sinkhole or malfunction, we conducted a study focusing on a rough set analysis, where "we compared two sets and studied how close they were by investigating the inclusion relation." In this analysis, we extracted "a rule for the combinations that were necessarily included" for combinations that had a high sinkhole occurrence probability. Please refer to the reference[1)] for the calculation details.

2.2 Analysis example

Here, we show an example of a rough set analysis for concrete pipes in City A, considering the relationship between the existence of a sinkhole on a road caused by the main pipe, and the result of an investigation using a TV camera. As factors in the high occurrence rate of a sinkhole on a road caused by the main pipe, this analysis not only extracted "corrosion at a moderate or higher level," which was pointed out long ago, but also the "protrusion of a sewer lateral," which has not previously been given attention, in combination with "damage," "misalignment of a pipe joint," and "invading water." Using the rough set analysis, we suggested that it was possible to extract information that had previously been overlooked (data mining).

Table 1 Result of rough set analysis

Combination	Damage	Misalignment of a pipe joint	Invading water	Protrusion of a sewer lateral	Corrosion	Corresponding number of spans	Occurrence rate of sinkholes caused by the main pipe
Rule 1	-	Moderate or higher level	Moderate or higher level	-	-	102	17.6%
Rule 2	Moderate or higher level	-	Moderate or higher level	Moderate or higher level	-	106	11.3%
Rule 3	Moderate or higher level	Moderate or higher level	-	Minor	-	30	26.7%
Rule 4	Moderate or higher level	-	Moderate or higher level	Minor	-	38	21.1%
Rule 5	-	Moderate or higher level	-	Moderate or higher level	-	75	13.3%
Rule 6	-	None	Moderate or higher level	Moderate or higher level	-	31	6.5%
Rule 7	-	Moderate or higher level	Minor	-	-	8	25.0%
Rule 8	Moderate or higher level	-	None	Minor	-	17	29.4%
Rule 9	None	None	None	Minor	-	22	9.1%
Rule 10	-	-	-	-	Moderate or higher level	5	40.0%

[Notes]
・In each rule, "-" represents "arbitrary," and "None" is shown when the judgment was that "it did not ".
・Each rule connects the corresponding item with "&."

[Calculation condition]
・In this analysis, a total of 430 spans were analyzed, and they were compared with the results of sinkholes on roads that occurred in the past nine years.
・For the following nine items, "damage," "crack," "misalignment of a pipe joint," "slack," "invading water," "protrusion of a sewer lateral," "corrosion," "invading tree root," and "removal of a rubber ring," we used the three ranks of "Moderate or higher level," "Minor," and "N ".
(Rank A and Rank B in the guideline for sewer system maintenance are categorized as Moderate or higher level, and Rank C is categorized as Minor.)
・We excluded the calculation for a combination where only one exists.

3. Future development

We have just started to develop a technology to determine the degree of priority for an investigation of pipes, in which this analysis method is used. We will

examine numerous issues such as data preprocessing, weighting, how to discriminate the determining attributes, and useful utilization methods.

☞Detailed information:

1) For example, Norihiko Mori and Sayuri Morita, Data analysis closest to how people think, Kaibundo, 2013 (in Japanese)

Topics

For Optimization of Inspection Result Evaluation of River Structures

SUGIHARA Naoki, Research Coordinator for River Structures, River Department
MORI Hirotoshi (Dr. Eng.), Senior Researcher, SASAOKA Shingo, Researcher, River Division

(Key words) River Structure Management Research Task Force, strategic maintenance, inspection result evaluation procedure

1. River Structure Management Research Task Force

The NILIM established the River Structure Management Research Task Force ("River Structure TF") in April 2012 jointly with the Public Works Research Institute (PWRI) as a group of researchers who follow up the structure management technologies suitable for rivers, and is developing activities including (i) research and technical support aiming to upgrade (develop) river maintenance in both technology and management, and (ii) holding of technical consultation events and seminars aiming for on-site introduction and establishment of advanced technologies for effective and efficient river maintenance.

2. Activities in 2015

The River Law was revised in 2013 to specify under law the obligations to maintain and repair river management facilities and requires river administrators to inspect visually or by other means levees, revetments, sluices, sluice pipes, water gates, dams, and other facilities at least once every year. In response, the Ministry of Land, Infrastructure, Transport and Tourism worked on the formulation of criteria for determination of actions according to the conditions of facilities and formulated the inspection result evaluation procedure (draft) in 2015 for levees with many facilities, revetments (those demonstrating the function in combination with levees etc.), sluices, and sluice pipes. Accordingly, the functional conditions of river facilities are evaluated with visual inspection, so that the basic concept of evaluation is that evaluation is classified into the four stages -- (i) No abnormality, (ii) Monitoring required, (iii) Preventive maintenance, and (iv) Actions, which are determined according to the indicators of facility deterioration that appears according to functional conditions.

Photo 1: Levee inspection

We are going to accumulate technical knowledge by performing the procedure (draft), etc. on a trial basis and improve the criteria for determining evaluation classes. Findings from the study for specification of the mechanism and progression of alteration that leads to functional decline of river structures, which PWRI has been progressing for three years until fiscal 2015, are considered available for optimizing evaluation of soundness of river structures. In addition, the River Structure TF held the river structures management research seminar on March 2, 2015 with the subject of "Forefront of river structure inspection / diagnosis technologies including robot technology and standardization. The seminar was attended by a total of about 100 persons and all engaged in enthusiastic discussions.

Photo 2: Seminar hall

3. Future development

The River Structure TF will act positively for efficiency enhancement and upgrading of river maintenance, including improvement of inspection result evaluation, in close cooperation with the Ministry of Land, Infrastructure, Transport and Tourism and Regional Development Bureaus.

☞See the following for details.

1) Homepage of River Structure TF
http://www.nilim.go.jp/lab/fag/

Manuscript for individual articles (one-page manuscript)

For Establishment of Nationwide Sandy Beach Monitoring by Satellite

SUWA Yoshio, Head, HARANO Takashi, Senior Researcher, HAMAGUCHI Kohei, Researcher
Coast Division, River Department

(Key words) sandy beach erosion, satellite images, monitoring

1. Importance of country-wide sandy beach monitoring

High waves caused by the typhoon that hit Seisho Coast, Kanagawa, collapsed the bypass (Photo). This is partly attributable to the erosion of the sandy beach in front of the bypass and further erosion of the ground that was supporting the bypass by high waves caused by the typhoon.

Sand beach is natural and local infrastructure with multilateral functions, such as the effect of reducing the impact of storm surge and tsunami, provision of recreation space, and ecosystem conservation. Therefore, conservation of sandy beaches is indispensable to maintain the sound national land.

However, erosion of sandy beaches is progressing in many coasts and countermeasures are urgently needed. In order to take measures efficiently starting with high-priority coasts within the limited budget, sandy beach monitoring is required across the country.

2. Issues of the conventional monitoring method

As for the conventional method of reading shore lines on the topographic map issued by the Geospatial Information Authority, the topographic map is updated only once in a dozen or so years and time of observation differs according to locations.

Since preventive maintenance has been promoted in maintenance of infrastructure, monitoring is important for conservation of sandy beach. In order to find coasts where erosion is progressing at an early stage and take measures before suffering damage, it is required to develop a method for monitoring sandy beaches across the country with a high frequency.

Photo: Damage to Seisho Bypass in 2007 (Source: Homepage of Yokohama River and National Highway Office, Kanto Regional Development Bureau)

3. Usability of monitoring using satellite images

For monitoring sandy beaches across the country with a high frequency, development of a method using satellite images is under consideration. Use of a satellite for monitoring will enable simultaneous photography of a large area. Satellite observation is conducted several times a year and observation results are accumulated.

As shown by Google Earth, etc., images provided by an optical satellite are clear enough to identify sandy beaches, while images are costly and no observation is made when cloudy.

In contrast, images taken by SAR (synthetic aperture radar) satellite (see Figure) are available at lower cost and observation by SAR is not subject to weather, while it is visually and technically difficult to identify coast lines, so that consideration is required for technical development and practical use.

4. Future perspective

From fiscal 2016, in the public offer for research and development of technologies for river works, "Technical research development for coastline monitoring using satellite images" will be conducted and development of coastline monitoring method using SAR satellite will also start by executing an agreement with the Japan Aerospace Exploration Agency (JAXA). The NILIM aims to establish a country-wide sandy beach monitoring system with focus on the development methods provided by the public offer and in combination with other monitoring methods including images by optical satellite.

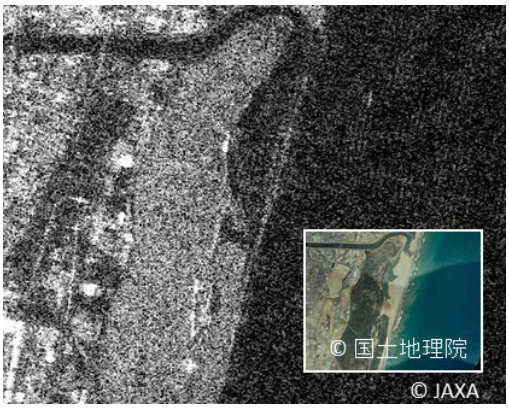


Figure: Satellite image and aerial photograph of the mouth of the Ishizaki River, Miyazaki by SAR satellite (Advanced Land Observing Satellite "Daichi") (right frame)

Monitor Coastal Protection Facilities by Airborne LP Survey - Detect deterioration from existing data -

SUWA Yoshio, Head, HARANO Takashi, Senior Researcher
Coast Division, River Department

(Key words) airborne LP survey, coastal protection facilities, big data

1. Grasp of microtopography by aerial laser survey

Aerial laser survey is a method of survey widely used in recent years for grasping topography with reflected waves obtained by irradiating laser pulses from an airplane to the ground surface. This survey method is considered effective for grasping the condition of coastal protection facilities since it can survey a wide area and easily survey offshore breakwaters, jetties, private facilities and other places difficult to access.

2. Grasp of microtopography by aerial laser survey

The number of footprints discharged in aerial laser survey varies according to the conditions of airplane such as altitude and speed. For example, tens of thousands footprints are discharged per second, each of which corresponds to a diameter of about 30 cm and measurement density of about 50 cm on the ground surface. These footprints discharged reflect on the ground surface, buildings, structures, trees, etc. and information of their height is included in the results of aerial laser survey. With such data, it is considered possible to identify the height of parapets about several of tens cm but how to use the data and limit of application are not established. Therefore, the study herein considered methods for grasping the condition of coastal protection facilities including parapets using the measurement data obtained from an aerial laser survey.

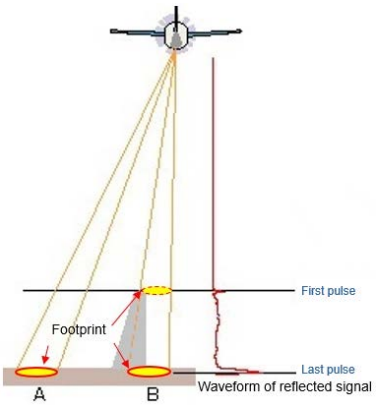


Figure 1: Image of airborne LP survey

3. Example of consideration (Jonanjima Seaside Park, Ota-ku, Tokyo)

In this study, based on the results of the airborne LP (laser profile) survey conducted by the Geospatial Information Authority ("GSI") in 2002, we overlapped Digital Surface Model (DSM) (Figure 3), which was created with the data directly obtained from the aerial photo (Figure 2) and airborne LP data (including the height of buildings and trees on the ground), and the original data (information on the positions and height of random footprints) with the simple orthoimage (photography taken in the airborne LP survey), and compared the footprints around structures that were picked and sorted by color according to height (Figure 4). The areas compared are indicated with red frames in each image.

The parapets and piers that can be recognized in the aerial photograph cannot be identified in the DSM figure (5m mesh DSM) but the positions and height of such structures could be identified from the original data.


Figure 2: Aerial photo

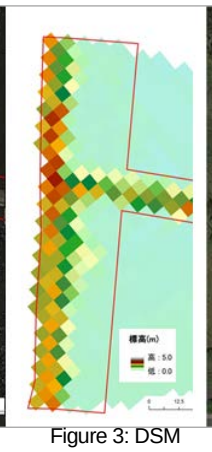


Figure 3: DSM (5m mesh)

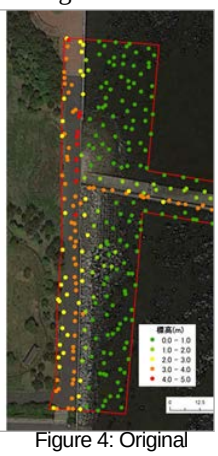


Figure 4: Original data

In addition, the height of the parapets identified from the original data was favorably consistent with the result of the ground laser survey separately conducted on the site (Figure 5).

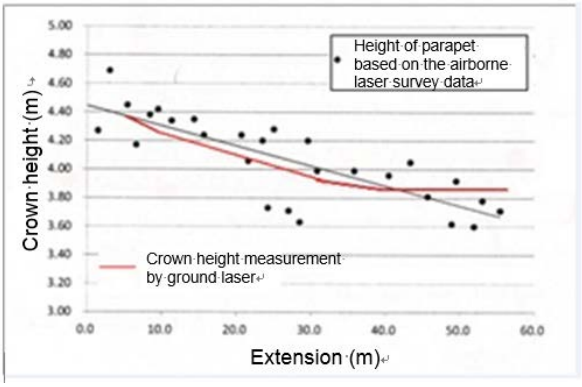


Figure 5: Comparison of parapet height based on aerial laser survey original data and local survey results
(* Figure 2: Conducted a ground laser survey for the parapet (crown width of 37 cm) located at the yellow line position in the aerial photo and compared the results)

Impact of Climate Change on Dam Reservoir Water Quality

NISHIMURA Sorin, Senior Researcher, KAWASAKI Masao, Head
Water Cycle Division, River Department

(Key words) climate change, dam reservoir, impact assessment, water quality, water temperature

1. Introduction

The fifth report of the U.N. Intergovernmental Panel on Climate Change (IPCC) forecasts that the world's average temperature will rise even if any scenario occurs to greenhouse gas emissions, raising the risk of suffering impact from climate change toward the end of the 21st century. In response to such view, the Central Environment Council documented "Report and future issues on the evaluation of impact of climate change in Japan (opinion offering)" in March 2015. This Report states that no studies have been found that provide specific forecast about the impact on water environment including lakes and dam reservoirs from changes in river flow or increase in frequency or magnitude of extreme events due to changes in precipitation or space-time distribution of rainfall caused by climate change.

Accordingly, this study attempted quantitative evaluation of the impact of climate change on the water quality of the reservoir of the case study dams using the results of calculating the present and future climates based on climate models. In addition, water quality improvement measures were discussed for eliminating present and future changes in water quality.

2. Results of study 1)

For each of the four case study dams, we built the model for water run-off / utilization in the basin of each dam and the water quality model for the dam reservoirs. We estimated the impact of climate change on the water quality and temperature of the dam reservoirs by inputting the results of output from the climate models in terms of the current climate and future climate on six cases of RCP 2.6 to 8.5 through bias correction. The Figure shows some examples of estimation.

Results of estimation were organized by classifying them into water quality change phenomena that may be caused to the dam reservoirs by climate change, i.e., "algal growth", "bottom water quality deterioration", "rise in turbidity", and "rise in water temperature." Although the types of phenomena considered to show major change were different according to each dam, a water quality change event that may indicate so-called degradation trend was seen in all the case study dams. In order to eliminate the difference in water quality changes in current and future climates, we set up measures based on the introduction of the water quality improvement measures that have been conventionally adopted

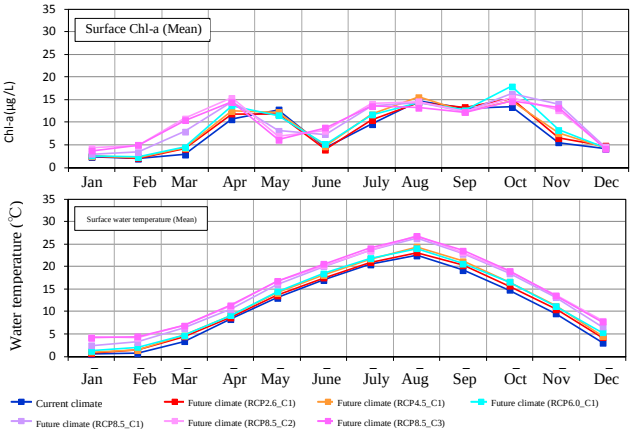


Fig. Example for estimation of impact on water quality / temperature

(including operational change and reinforcement of existing facilities), including selective water withdrawal facilities and aerating circulation facilities and estimated the effect of these measures, and found that they are effective.

3. Conclusion

In the MLIT Climate Change Adaptation Plan formulated by the Ministry of Land, Infrastructure, Transport and Tourism in November 2015, it was determined with regard to the climate change adaptation measures for the water environment of dam reservoirs to continue to implement the measures for water quality conservation including selective water withdrawal facilities and aerating circulation facilities and to consider the review of operation method for water quality conservation facilities according to changes in water quality.

Considering that it functions as climate change adaptation measures to further reinforce management cycle including investigation, consideration of measures, operation, effect verification, etc. concerning water quality conservation in dam reservoirs and apply them without interruption, we would like to advance the review of the measures for water quality conservation in existing dams as well as systematic organization of above-mentioned management cycle.

☞See the following for details.

1) Technical Note of NILIM, No. 856 (August 2015)
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0856.htm

For Upgrade of Maintenance Technology Supporting Long Life of Dam

OKOSHI Moriyuki, Researcher, ONODERA Aoi, Researcher, SASAKI Takashi (Dr. Eng.), Head
Large-scale Hydraulic Structure Division, River Department

(Key words) long life of dam, maintenance, database

1. Introduction

Dams have the functions of flood control, water utilization, etc. and constitute important social capital. Many dams have been constructed to date in Japan. The Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") controls about 120 dams at present, and started management more than 50 years ago for about 10% of them and more than 30 years ago for about 50%.

2. Efforts for upgrading dam maintenance technology

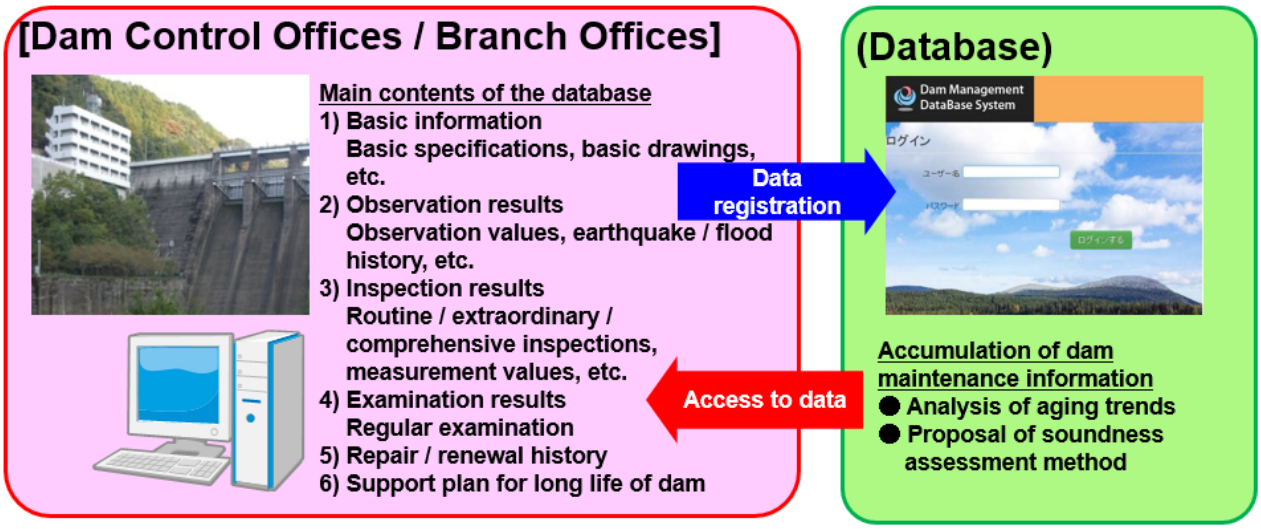
Maintenance of these dams has been conducted by determining the matters concerning inspection and maintenance in accordance with the dam inspection and maintenance standards. Information of each dam on inspections, measurements, repairs, history, etc. have been accumulated by the individual dam manager but not been shared. In order to upgrade the dam maintenance technologies, it is required to create a database of the maintenance information accumulated separately in individual dams in an integrated form of electronic information for easier comparison and to propose methods for grasping aging trends and assessing soundness of dam civil structures.

Accordingly, the NILIM initiated the work to establish a dam maintenance database system in fiscal 2014 and started operation of the system in March 2015 to accumulate maintenance information for the dams under control of the MLIT.

In view of the importance of information managed by this system, Internet is not used for network connection and much attention has been paid to ensure security including access control with ID and password and log recording. We designed the system by ensuring redundancy from the initial stage, and integrated the system in fiscal 2015 with the multipurpose dam management annual report database, in which dam water quality and hydrological data are registered. We also organized data on the conditions of aging according to the variation of structures of the dams registered in the dam maintenance database by associating the conditions of component , deterioration, repair, component replacement, etc. for each dam.

3. Future Plan

We are going to promote registration of maintenance results by dam managers and improve the convenience of the system. Further, through comparative study and trend analysis on the maintenance data collected, we will continue to clarify the aging characteristics and consider proposal for soundness assessment method for dam civil structures.



Noise barrier characteristics with change in road traffic noise

Ryuji Inoue, Head
Hiroshi Yoshinaga (Ph.D. (Engineering)), Senior Researcher
Keiko Ohkouchi, Researcher
Road Environment Division, Road Traffic Department

(Key words) road traffic noise, noise barrier, vehicle unit regulation

1. Introduction

Various measures (Figure 1) are used by road administrators to suppress road traffic noise. A noise barrier is one of these measures. Although its performance does not degrade over time, and there is no need for replacement, we still need to consider that it will deteriorate in the same way as other structures. On the other hand, vehicle noise regulations will be tightened in stages[1)], and it is expected that road traffic noise will be reduced. At the NILIM, we study the most appropriate future characteristics for a noise barrier, considering the previously mentioned situation.

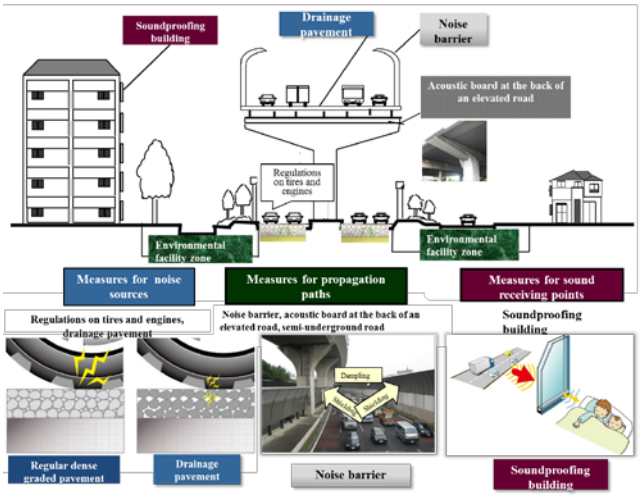


Figure 1 Schematic diagram of road traffic noise measures

2. Status of noise barrier maintenance

Many national roads under direct control utilize noise barriers with metal sound insulating boards, as shown in Photo 1, and some areas contain noise barriers with transparent sound insulating boards, as shown in Photo 2[2)]. Each road administrator has their own installation and maintenance criteria based on the design criteria of NEXCO. A repair is performed when damage by a third party is expected. An update is performed only to restore parts damaged by an accident to their original state; therefore, it is possible that new and old insulating boards will be mixed, and the sense of unity will be lost in the landscape.

3. Influence of tightening vehicle noise regulations

According to a report by the Central Environment Council[1)] (July 30th, 2015), the acceptable limit of acceleration running noise will be tightened in stages in 2016 (Phase 1) and 2020 (Phase 2). In addition, an acceptable limit for tire noise will be introduced, and it will be applied to passenger vehicles in 2018, small trucks in 2019, and medium-sized and large-sized vehicles in 2023.

We are examining a way to properly predict the influences of these regulations on road traffic noise.

4. Examination of future noise barrier characteristics

We would like to organize the technical issues and examine the future policy by considering various scenarios for changes in road traffic noise and the future characteristics of noise barriers.

Photo 1 General noise barrier (metal sound insulating boards)

Photo 2 Transparent noise barrier (transparent sound insulating boards)

☞References

1) Central Environment Council, Section of Air, Noise and Vibration, Special committee for vehicle noise, “Future measures to reduce vehicle noise” (The third report) (in Japanese)
https://www.env.go.jp/press/files/jp/27682.pdf

2) Technical Note of NILIM, No. 788 “Research on landscape assessment and case studies for road noise barriers”
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0788.htm

Investigation for inspections and lining design of road tunnels

Yoshiaki Inamoto, Senior Researcher
Toshiaki Mabuchi, Head
Shigeru Takagi, Senior Researcher
Foundation, Tunnel and Substructures Division, Road Structures Department

(Key words) tunnel, periodic inspection, lining design

1. Purpose of this study

We examined road tunnel inspection methods to improve their efficiency and simplify them. We also studied and examined ways to formulate design criteria by evaluating the performance of tunnel linings for newly constructed roads.

To obtain the basic data needed for such an examination, we analyzed the results of periodic road tunnel inspections, studied ways to apply the limit state design method to tunnel lining design, and examined the load for tunnel lining design.

2. Research contents

We organized the results of periodic road tunnel inspections for every span, and analyzed the relationship between the percentage of each cause of deformation, such as external forces, material degradation, and water leakage, and the judgment criteria.

For tunnels where inspections have been performed multiple times, we organized and analyzed the differences in the results due to different construction methods, elapsed years after construction, and changes in the judgment criteria.

By determining the relation between the natural ground classification (an index for the degree of excavation difficulty)[1)] for lining by using the NATM construction method and the occurrences of cracks, we confirmed that cracks occur mainly under the natural ground classifications of D I, C II, and D II (Figure 1).

We examined the load to design a tunnel support structure. In particular, for tunnels where a standard support pattern is not applied because of a small overburden, we collected and analyzed the support patterns at the time of construction, along with the observation and measurement data (B measurement) during construction, and performed an analysis based on three methods: FEM analysis, FRAME analysis, and balance calculation focusing on the axial force of the side walls.

As a result, we found that even though these three methods gave three different values for the same cross section, there was a tendency for the height of the load obtained by the balance calculation to be smaller than those obtained by the other two methods. In addition, there was a case where we needed to consider the total load of the overburden as the design load, up to an overburden of approximately 1D, when we designed a support structure by using the FRAME analysis (Figure 2).

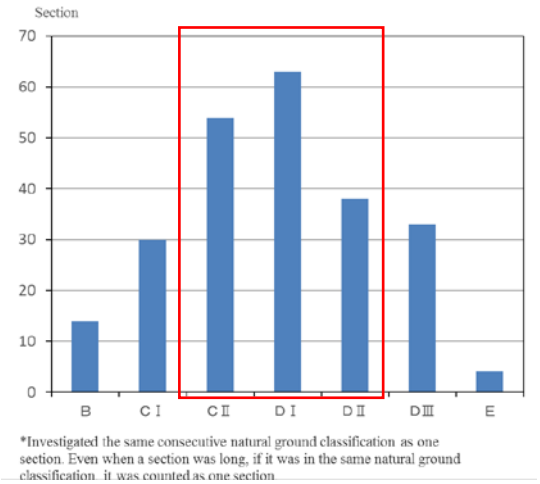


Figure 1 Occurrences of cracks classified by natural ground classification

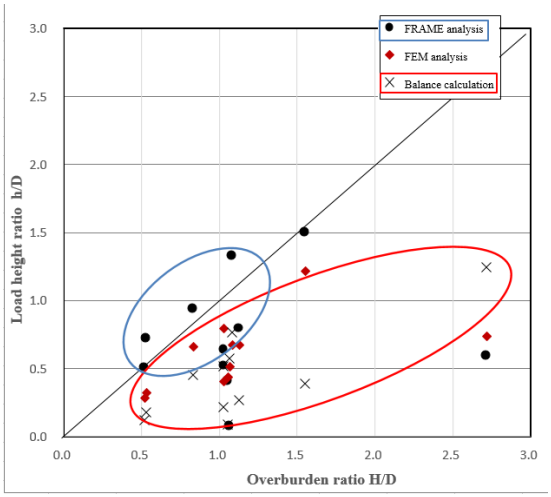


Figure 2 Relationship between overburden and height of load

3. Concluding remarks

Using the results of periodic road tunnel inspections, we will continue to determine the soundness of tunnels,

analyze the causes for the occurrence of deformation, and examine ways to simplify and improve the efficiency of periodic tunnel inspections.

In addition, to examine the load on design tunnel linings, we plan to evaluate the load on a support structure and investigate and study these design methods.

---

1) Technology criteria of road tunnels (structures), and explanation (November 2003), Japan Road Association (in Japanese)

Investigation for damage to civil engineering structures on existing roads

Toshiaki Mabuchi, Head
Minoru Abe, Senior Researcher
Jun Nishifuji, Researcher
Foundation, Tunnel and Substructures Division, Road Structures Department

(Key words) civil engineering structure, damage, periodic inspection

1. Introduction

It is desirable for civil engineering structures on roads to maintain their functions and performance to ensure safe and smooth road traffic. Therefore, we need to properly grasp the state and any deformation of civil engineering structures on roads and take appropriate measures if necessary to prevent disasters from occurring. We will examine the damage conditions and effect of reinforcement and clarify any issue that needs to be resolved, by considering the results of inspections, such as an overhaul, of civil engineering structures on existing roads.

2. Characteristics of damage to civil engineering structures on existing roads

We organized various parameters such as the types of damage and conditions of structures based on the results of inspections of civil engineering structures on roads (retaining walls, culverts, and sheds). We then analyzed the tendency for the occurrence of damage.

We confirmed that there is a large amount of damage in the main parts (the pile cap, side walls, and bottom slab) of culverts (709 places) by extracting them from the nationwide inspection results for civil engineering structures on roads. Cracks, crevices, and fissures account for approximately 40% of the damage (Figure 1).

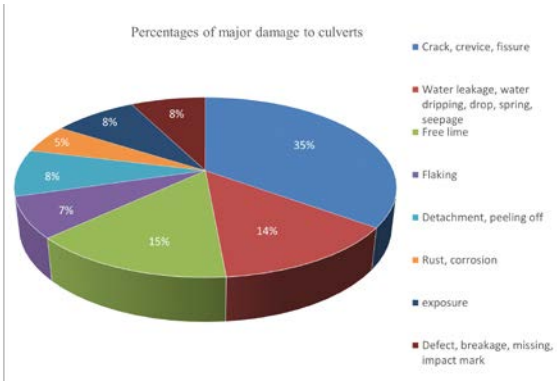


Figure 1 Percentages of major damage to culverts

Organizing the relationship between the types of damage and degrees of damage (classified using five ranks from a to e, where the most severe damage is classified as e) to sheds (62 places), we found that the percentages for corrosion, cracks, and reinforcing bar exposure were high, with degree of damage levels of d and e (Figure 2).

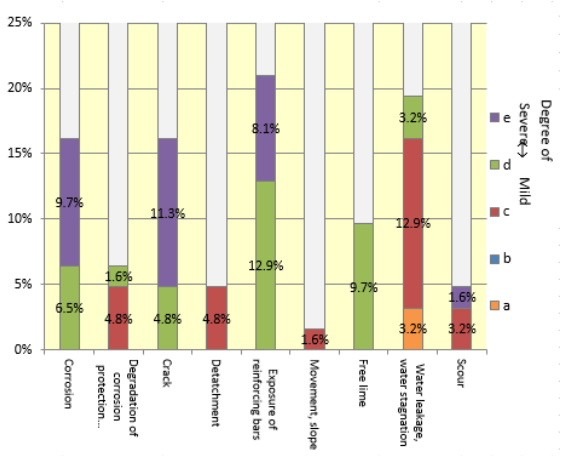


Figure 2 Breakdown of types of damage and degrees of damage to sheds

In addition, we organized and wrote explanations of the damage conditions categorized by the types of damage as case examples of the damage to various civil engineering structures on roads.

We organized the results of the 2014 inspection of structures under the direct control of the Ministry of Land, Infrastructure, Transport and Tourism. This was conducted based on the "Manual for periodic inspections for sheds, large culverts, etc.," which was established in June 2014.

In relation to the soundness of structures, structures meeting criterion III (the early measures stage) accounted for more than 40% of the sheds, whereas structures meeting criterion III for large culverts only accounted for

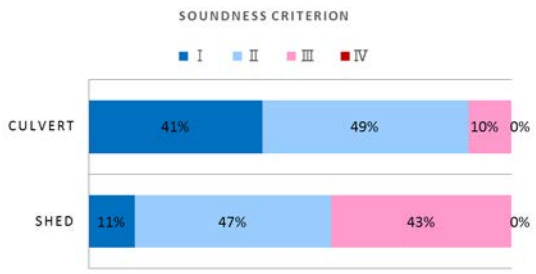


Figure 3 Breakdown of soundness criteria

10%. We found that the damage conditions varied depending on the type of structure (Figure 3).

3. Concluding remarks

There are many unknown points, including the material degradation, degree of damage to existing structures, and residual strength. We plan to organize the repair and reinforcement work done in the past, and examine the reinforcement priority and repair and reinforcement methods.

Method to accumulate and use investigation and diagnostic records using the building information model of outer walls

TAKAHASHI Satoru, Research Coordinator for Housing Information System, Housing Department
SATO Hideaki, Head, Housing Stock Management Division
MAKATAYAMA Miho (Ph.D. in Engineering) Head, Material and Component Standards Division, Building Department

(Keywords) Periodic inspection report, falling of outer wall, Building Information Model

1. Introduction

The risk of people being injured by falling objects that peel or deviate from the outer walls, outdoor units of equipment, and signboards is increasing as the number of decades-old buildings increases. Periodic investigations and diagnoses by engineers are obligatory when the building is true to certain conditions with regard to the scale and applications to avoid in order to reduce these risks. However, the information on the outcomes of the investigations is not fully utilized.

This paper describes the investigation, diagnosis, and records of the outer walls of buildings to share the information among relevant personnel and to report the overview of research and development concerning methods of using the information for the offer of guidance and advice to owners and managers of buildings.

2. Challenges in the management and use of investigation and diagnostic records

The purpose of the periodic inspection report system stipulated in Article 12 of the Building Standards Law of Japan is to ensure the safety of buildings by mandating that owners and managers report the outcomes of periodic investigations and inspections of buildings and equipment, such as elevators. In an example of a building that has outer walls with materials that may fall off, such as tiles, the periodic report requires a hammering test for the entire surface of the outer wall when it faces a public road, passage, or space where many people walk within the horizontal surface that is one-half of the height of the wall as a section with a high risk of injuring pedestrians in case of exfoliation. The outcomes of the investigation are reported to designated administrative agencies. Yet, the outcomes are commonly kept in files as paper documents mainly consisting of written information for specific buildings. No attempt has been made to improve the accumulation, management, and everyday safety so that the status of inspections, results of investigations, and diagnoses can be checked for wall surfaces located along a road in a certain area.

3. Ways to use the building information model of outer walls

The research team focused on information utilization technologies using the building information model that is becoming common in the architectural industry in recent years. The team developed a method of accumulating and using the data of periodic inspection reports submitted to designated administrative agencies (with diagrams and pictures of reports describing the outcomes of investigations and diagnoses concerning the risk of exfoliation of the outer walls) by adding geographic information to the building information model of the outer walls.

Specifically, the team examined the method of investigation to measure the appearance and sections of a building from an adjacent road, the method of correcting the coordinate data, and the level of detail to categorize the materials of the outer walls, facilities, and other attached objects. The use of the building information model for the outer walls creates images of the quantity and location of parts with the risk of falling, status of inspection, and risk of exfoliation based on the outcomes of investigations and diagnosis, for example. This enables users to show specific images of the importance of maintenance and management, as well as areas with the risk of falling, to owners and managers of buildings who do not have architectural knowledge. The information is expected to be used in places where proper responses are advised.

Figure. An example of a viewer that visualizes the risk of falling outer walls

4. Conclusion

The team is going to explore methods to use the information to improve the safety of continuous road spaces by expanding the method of using the tool for individual buildings and linking it to GIS and other tools.

☞Detailed information

http://www.nilim.go.jp/lab/ieg/index.htm

Simplified Cost-Benefit Evaluation Tool for the Operation and Maintenance of Public Infrastructure and Services in Suburban Built-Up Areas

KATSUMATA Wataru (Doctor of Engineering), Head,
KIUCHI Nozomu (Doctor of Engineering), Head
SHINGAI Hiroyasu (Master of Engineering), Head
Urban Development Division, Urban Planning Department

(Keywords) Centralized urban structure, suburban built-up area, public infrastructure and services, operation and maintenance, cost-benefit

1. Foreword

With the rapid aging and decline of the population in Japan, we have been seeing an increasing number of abandoned houses and vacant lots in the suburban areas of cities (see photos below), decaying local communities, a deterioration in the quality of life from the removal of facilities to enhance the convenience of life and other causes, and an increase in local governments' expenditures under severe fiscal constraints to support elderly care and welfare, as well as the operation and maintenance of public infrastructure, among other things. These and other urban problems may likely become increasingly more serious going forward. Given these circumstances, a shift in urban structure to a more centralized one is one of the major tasks of urban planning today. To support local governments' efforts to develop cities with a more centralized urban structure, NILIM is currently engaged in the development of a prototype Simplified Cost-Benefit Evaluation Tool regarding the operation and maintenance of public infrastructure and services at the district level, which NILIM believes is useful for reference when local governments consider the development of policies and plans for the downsizing or restructuring of suburban built-up areas.[1]

Photos: Examples of Increasing Number of Abandoned Houses and Vacant Lots in Suburban Built-Up Areas

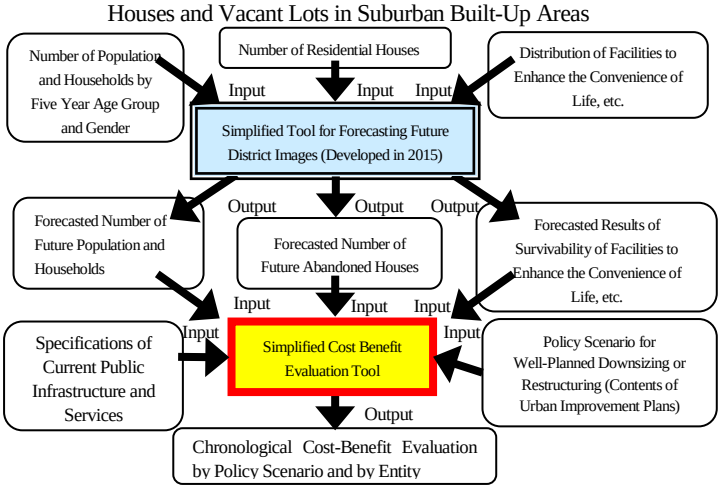


Figure. Image of Simplified Cost Benefit Evaluation Tool

2. Overview of Simplified Cost-Benefit Evaluation Tool

Based on the results of forecasting at a district level, the future population, number of households, and empty houses, and the survivability of facilities to enhance the convenience of life, among other things, by using the Simplified Tool for Forecasting Future District Images as developed by NILIM in 2015[2], specific information such as the specifications of public infrastructure (such as water supply and sewerage systems, roads, electricity and gas supply systems) and public services (such as garbage collection, bus, and snow removal) in each district, and a strategic policy scenario for each district (plans for the maintenance, downsizing, or abolition of public infrastructure and public services, among other things, with chronological factors and processes taken into account) is fed to the Simplified Cost-Benefit Evaluation Tool. With this, the Simplified Cost-Benefit Evaluation Tool makes it possible to calculate chronologically and then compare and evaluate costs to be required and benefits to be gained (such as lower transportation costs, incremental tax revenue, and reduction of carbon dioxide (CO^2) emissions) by scenario and by entity (such as local governments, district residents and business operators) (See the figure below). This tool is based on Microsoft Excel and is designed to ensure that input items are simple and that the interface and output evaluation results are easy-to-understand so that it is easy to use by local government officials and other related personnel.

3. Conclusion

This Simplified Cost Benefit Evaluation Tool is intended to help local governments make specific decisions and actions in the downsizing and/or restructuring of suburban built-up areas. It is expected that this tool will be utilized as one of the tools for studying the methods for objectively evaluating and selecting potential areas for downsizing or restructuring, as well as methods for the operation and maintenance of suburban built-up areas according to project phases.

☞For further information, please visit the following websites:

1) Development of Methods for Operation and Maintenance as well as for Location Evaluation to Support the Well-Planned Downsizing or Restructuring of Cities
http://www.nilim.go.jp/lab/bcg/mailmag/pdf/ml177_1.pdf
2) NILIM's report of 2015 entitled "Easy Forecast Methods of Future District Images to Prepare for the Well-Planned Downsizing or Restructuring of Cities"
http://www.nilim.go.jp/lab/bcg/siryou/2015report/ar2015hp101.pdf

Topics

More than 50 Years Have Passed Since the Birth of Tsukuba Science City

KAWANAKA Takashi (Doctor of Engineering), Researcher, Urban Development Division, Urban Planning Department

(Keywords) Tsukuba Science City, Tsukuba, new urban construction

1. Birth of Tsukuba Science City

The construction of Tsukuba Science City was approved at the Cabinet meeting in 1963. More than 50 years have passed since then, and Tsukuba Science City, which shares the same area as Tsukuba City of today, was constructed to become one of the leading cities in southern Ibaraki Prefecture. The shape of Tsukuba Science City has been changing day by day ever since. We believe that it is one of the roles of NILIM, which is located in Tsukuba Science City, to record, as succinctly as possible, the history of the formation of this new city, which has been in existence for more than 50 years, as well as problems and issues that the city had to address along the way, together with their solutions. This is the reason why we published our research paper on Tsukuba Science City.[1] Here in this paper, I would like to introduce a general outline of the Research Paper.

2. Period from Phase I to Phase III in Urban Development

In the Research Paper on Tsukuba Science City,[1] we developed our own definitions of the development phases of Tsukuba Science City, and we call, as Phase I, the period from September 1963, when its construction was approved at the Cabinet meeting, until March 1980, when the relocation or establishment of 43 institutions in the city were completed, the so-called general completion of city construction as a national project. We define the Phase I period as the period for urban development as a national project by the public sector. We call the period from April 1980 until July 2005 the Phase II period when the city expanded due to joint development initiatives by the public and private sectors. In 1985, this city hosted the International Exposition on Science and Technology, which made the name of Tsukuba widely known to the world. We call the period from August 2005, when the Tsukuba Express (TX) train services were launched, and onwards the Phase III period. The launch of TX train services linking Tsukuba City to Akihabara in Tokyo brought about transformative changes and further expansion in the city. The Phase III period until March 2013 has been covered in our research paper.

All through these periods, there were always many issues in the development of Tsukuba Science City in terms of both its hard and soft aspects. However, most of them were overcome and resolved through new legislation and creative solutions devised by our predecessors. I firmly believe that the framework for the urban development of Tsukuba Science City that had been established, riding on the wave of great economic growth in Japan before the first oil shock in 1973, has contributed positively to the development and expansion of Tsukuba Science City.

I encourage the readers of this paper to read the research paper[1] as it is intended to provide a comprehensive history of Tsukuba Science City, focusing on the accurate description and interpretation of facts. Also I recommend the readers to read the literature on Tsukuba Science City noted below[2] as well for reference.

Photo 1. Underground TX Tsukuba Station and Traffic Square

Photo 2. Former Takezono 3-Chome National Public Officer's Housing Complex and Private Sector Housing under Construction at the Vacant Lot of the Former Housing Complex

3. Is Tsukuba Science City Now Entering Phase IV Period?

Tsukuba Science City underwent drastic changes with the inauguration of TX train services. Since then, a number of other changes are taking place, including the sale of vacant lots of former national public officers' housing complex to the private sector and more active implementation of new housing construction activities by the private sector. Tsukuba Science City used to be mostly populated by academic researchers, who were then called new residents in the city, but the composition of residents in the city is changing. In addition, as part of initiatives to renovate and enhance research systems, which is one of the purposes of the construction of this new Tsukuba Science City, the fruits of scientific and technological development are actively being applied and commercialized. We view such trends as a sign of the beginning of the new Phase IV period and continue to collect relevant information on a routine basis.

☞**For further information, please refer to the following documents:**

1) NILIM's Research Paper No. 815 of January 2015 by Takashi Kawanaka and Hiroshi Kaneko, "Tsukuba Science City's Problems on Formaion Process through a Present State and Subjects".
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0815.htm

2) Yasuhisa Mitsui's "Tsukuba Science City Theory" published by Kajima Institute Publishing Co., Ltd., May 2015. The author views Tsukuba Science City as the fruit of Japan's urban planning system that has been deployed since the pre-World War II era.

Initiatives for enhancing safety of street trees

Yasuo Iizuka, Senior Researcher
Masao Kurihara, Head
Landscape and Ecology Division, Research Center for Land and Construction Management

(Key words) street tree, falling down, branch falling, safety measure

1. Introduction

There has been an increase in the number of street trees with large diameters and trees that have weakened with age because many years have passed since planting these trees. As a result, these trees sometimes become traffic obstacles when they or their branches fall because of strong winds such as a typhoon. Thus, measures have been taken, such as inspections to prune branches and remove trees that pose high risks. However, it is desirable in the future to establish a method to plant trees with a reduced risk of falling, using regular maintenance measures, and the redevelopment of street trees.

At the NILIM, after grasping the status of the fallen street trees and branches, along with their growth status, we attempted to clarify why they fell. We are examining an effective way for road administrators to maintain street trees, along with a maintenance method to reduce the occurrence of falling street trees and branches.

2. Status of falling street trees and branches and growth status of those trees

In the fiscal year of 2015, after performing factual investigations of falling street trees and branches based on media reports and comments from road administrators, we categorized the reasons that these trees and branches fell, as well as the characteristics of the tree species and tree shapes. Based on the number of media reports, we found that there has been an increasing tendency over the past ten years (Figure 1), with many cases involving zelkova, cherry, platanus, and willow trees.

We also collected data from inspections performed by road administrators to determine the unsoundness of street trees (defects in tree vigor, abnormalities in the structure of its body, etc.), and we extracted factors related to trees and branches falling classified by tree species and shape. In the data classified by tree shape, we found that there was a tendency for a street tree to become unsound if its diameter became larger, and abnormalities were confirmed in more than approximately 60% of the trees if the trunk circumference was 60 cm or larger (Figure 2).

3. Future development

In the future, we will estimate the occurrence factors for falling trees and branches, such as the tree species, tree shape, and type of planting area, and we plan to examine planting methods that deal with these factors (tree species that rarely fall, structures for planting areas that allow for the sufficient extension of tree roots, etc.), along with better operation and maintenance methods (pruning to prevent branch falling, effective and efficient inspections, proper treatment for unsound trees, etc.).

Figure 1 Number of newspaper reports[1] and number of typhoons that approached during year[2]

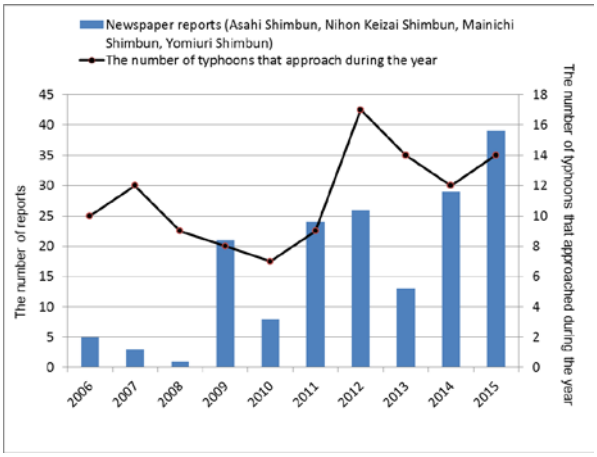
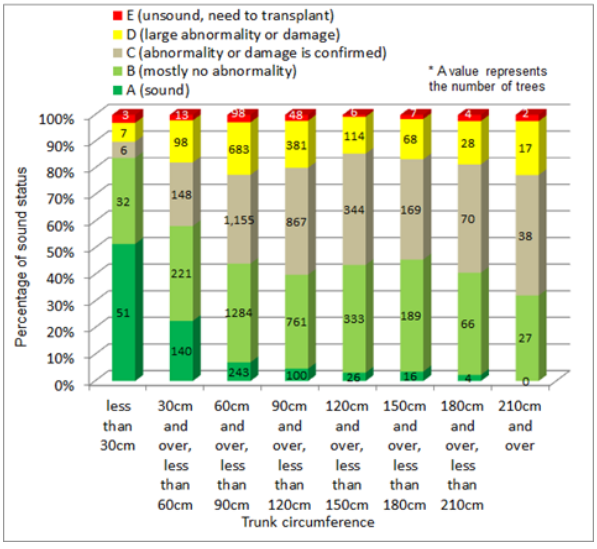


Figure 2 Soundness of street trees classified by trunk circumference (national highway example)



[References]
1) National Diet Library, Online Public Access Catalog (NDL-OPAC)
2) Web site of Japan Meteorological Agency
http://www.data.jma.go.jp

Empirical study on B-DASH Project (Stormwater management technology for local torrential rain in urban area)

YOKOTA Toshihiro, Head, MATSUURA Tatsuro, Senior Researcher, NAKAMURA Hiromi, Researcher, MUGITA Ai, Guest Research Engineer
Wastewater System Division, Water Quality Control Department

(Key words) B-DASH, urban inundation countermeasures, self-help and mutual help, small radar

1. Urban inundation countermeasures required for sewerage

In response to the recent increase in the risk of inundation damage in urban areas due mainly to the frequent occurrence of local heavy rain, advanced land utilization, and concentration of population and assets resulting from urbanization, there is pressing need for urban inundation countermeasures.

In order to undertake countermeasures promptly, maximum utilization of the facilities that have been improved for inundation control and exist in urban areas in a certain number is also important, as well as structural improvement measures, which require a lot of cost and time. Further, it is also important for mitigating inundation damage to promote self-help and mutual help among residents. [1)]

2. Outline of empirical study

As one of the means for implementing these countermeasures effectively, it is possible to provide supporting information actively that is necessary for facility managers and local residents to take appropriate responsive actions.

This study is focused on the technology (the "Technology") for providing supporting information on real time including inundation forecast by analyzing the data obtained from observation of rainfall in target areas with a radar smaller than the conventional X band radars, such as XRAIN, and the data collected concerning water levels etc. in sewage pipes. This study also demonstrates the effect of mitigating inundation damage by applying the Technology and choosing some part of Fukui-shi and Toyama-shi as field. Figure shows the system image of the Technology.

One of the features of the Technology is use of a radar smaller than conventional ones. Since this radar, about 1 m in diameter and about 65 kg in weight, is smaller and lighter than conventional ones, has less restriction on the place of installation. Taking advantage of this feature, this study aims to install the radar at a lower place to the extent possible to detect rainfall at a lower altitude than before. This attempt is expected to detect earlier heavy rain caused by cumulonimbus that develops at a lower altitude, such as cumulonimbus in summer. Another feature is to forecast inundation in a short time. Accordingly, forecast accuracy is expected to improve by repeating short-time inundation forecast using consistently the observed water level in the pipe as initial value. Utilization of such supporting information is expected to enable facility managers to operate their facilities efficiently, and distribution of such information is expected to encourage local residents to perform self-help and mutual help activities appropriately. These are considered to lead to mitigation of inundation damage.

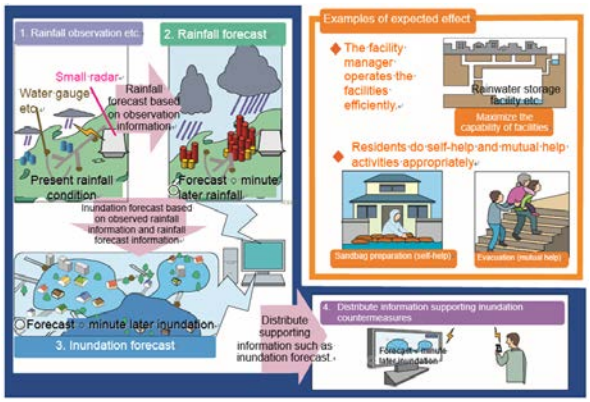


Figure: System image of the Technology

3. Utilization of empirical study result

The system has been completely established and started operation. We are going to collect data and verify the effect of mitigating inundation damage by introduction of the Technology. We are also going to prepare technical guidelines based on the results obtained in order to disseminate widely the technologies used in this study.

[Reference]

1) Working Committee for Improvement of Urban Inundation Control Function Utilizing Stock, "New Basic Concept for Improvement of Urban Inundation Control Function Utilizing Stock," April 2014

New Monitoring Method for River Levee

HATTORI Atsushi (Dr. Eng.), Head, MORI Hirotoshi (Dr. Eng.), Senior Researcher, SASAOKA Shingo, Researcher, KURATA Daisuke, Guest Research Engineer, SHIMOKAWA Daisuke, Guest Research Engineer
River Division, River Department

(Key words) river levee, seepage, piping, uplift

1. Introduction

River levees, which protect houses and fields from floods, are constructed of soil. Generally, river levees run a number of kilometers along the river and have been constructed over the years, so it is unknown what kind of soils they are constructed of.

Also, river levees will be failed when hit by a major flood, as seen in the Kinugawa River last year, which is called levee breach.

2. Catch signs of breach!

In 2012, river water in the Yabe River, Fukuoka, leaked through the foundation of the levee, and sand in the foundation boiled, which resulted in a levee breach. Such phenomenon is called "piping." The cause of this breach is considered to be the sand layer under the levee, though which river water is likely to leak.

To investigate what kinds of soils lie in and under levees, "boring," a method for sampling long cylindrical soil samples, has generally been used. However, the sand layer that caused the aforementioned breach was present in a section of only 130 m in length in the river levee running a number of kilometers, so it was almost impossible to find such layer. The river levee has been inspected by staff twice a year, but it is very difficult to grasp a sign of damage just by looking at the surface of levee that appears in normal time. Therefore, we are studying whether we can find weak areas of river levees by mechanical measurement of ground uplift that appears in case of a flood and would be a sign of piping.

Figure 1 is a photo taken in the experiment of measuring the ground uplift with a laser scanner by creating a sand layer under the levee to check what kind of uplift appear on the ground when the level of river water is high. The figure shows that a large uplift has the size of slightly less than 3 cm (brown part in Figure 2). In this experiment, piping occurred later and resulted in levee breach.

3. What is dangerous uplift?

What is the limit of ground uplift at which a levee breach occurs? To find that out, it is important to grasp what is happening in the foundation of river levees when piping occurs. However, it is impossible to directly see piping that occurs in the soil. We are therefore using the particle method, which calculates soil movement with computer, in order to find out the relations between ground uplift and what is happening under the uplift. [2)]

Figure 3 shows the result of calculating the data of the experiment above by the particle method. The Figure shows the sand from the ground under the river levee blowing out of the ground.

4. Conclusion

River levees have been mainly constructed and maintained based on empirical wisdom. We are going to continue the study consistently so that we can provide new monitoring methods for river levees by using up-to-date technologies and considering as well variations including uplift and sand boil.

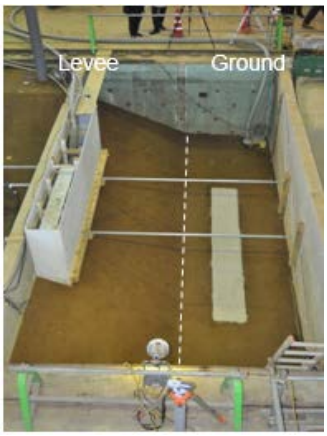


Figure 1: Photo of experiment

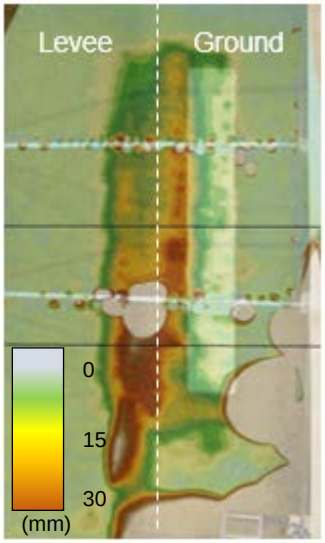


Figure 2: Ground uplift

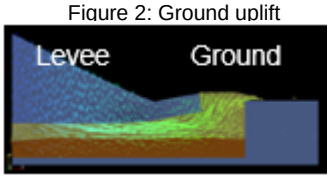


Figure 3: Sand boiling (sectional view).

☞See the following for details.

1) Kurata et al., "The Model Experiments for the Precursor of the Progressive Failure of a River Levee by the Measurement of Surface Displacement," The 3rd Symposium for Levee Technologies from the Viewpoint of Geotechnical Engineering," pp. 17-20, Dec. 2015, Japanese

2) Shimokawa et al., "The SPH method for simulating a slip and piping of a river levee by a permeable foundation ground," The 3rd Symposium for Levee Technologies from the Viewpoint of Geotechnical Engineering," pp. 81-82, Dec. 2015, Japanese

Making Opportunities For Everyone to Evacuate in Case of Approaching Flood

HATTORI Atsushi (Dr. Eng.), Head, YAMAMOTO Yoko, Senior Researcher, YANAGAWA Kazuhiro, Researcher
River Division, River Department

(Key words) Kanto-Tohoku torrential rain, flood risk assessment, evacuation

1. Background

In view of the possibility of unexpected intensification of flood disasters due to climate change and other factors, the NILIM has studied assessment methods for flood risk in the whole basin including floods exceeding the planned scale together with the Water and Disaster Management Bureau, Ministry of Land, Infrastructure, Transport and Tourism ("MLIT"). Then, we experienced the levee break in the Kinugawa River and serious flood damage following the break in the September 2015 Kanto-Tohoku torrential rain.

Effective combination of structural and non-structural measures has already been recognized as valid in active promotion of basin management measures to prepare for floods, but there are almost no cases where such measures took shape. This is partly because no method has been established for actually evaluating the effect of combination of such measures and materializing the plan. Hence, we are attempting to create a map ("risk map") that specifies the locations of houses where evacuation is impossible in case of a flood and reasons thereof in cooperation with Upper Arakawa River Office, Kanto Regional Development Bureau, as an approach for studying combination of specific measures to realize environment that can provide one or more means of evacuation to all the residents of areas with high risk of levee break and consequent flood. With utilization of such tools, we aim to study specifically the effective combination of structural and non-structural measures to be implemented by river administrators and local governments on the site.

2. Outline of risk map

The approach discussed herein is characterized in that various issues to be addressed by regions will be made clear by (i) considering inland flood prior to flood in the river, (ii) indicating the locations of individual houses on the map and specifying the areas of residents who particularly need to evacuate from there due to the relations between inundation depth, building structure, etc., and (iii) following the progress of flood in time series. In the case of the following figure, we specified the locations of individual houses where evacuation was impossible as well as the factors of impossibility, including the houses (pink points on the Figure) where evacuation was impossible because houses and/or evacuation routes were already inundated by inland flood when evacuation recommendation was issued and the houses (blue points) that were isolated because low-story floors of the shelter were unavailable due to inundation or the shelter was too far. Based on the information of this risk map, it is possible to determine the clarification of areas requiring specific measures and strategies for each area, covering all the areas not provided with measures, including inner water drainage by reinforcing pump facilities for areas with many pink points representing houses where evacuation is impossible due to inundation by inland water and combination of structural measures such as establishment of more shelters for individual houses represented by blue point and non-structural measures such as prior strengthening of promotion of evacuation in large area.

3. Future development

At present, we are attempting what we have studied in the model area and intend to expand applicability to other areas with various characteristics.

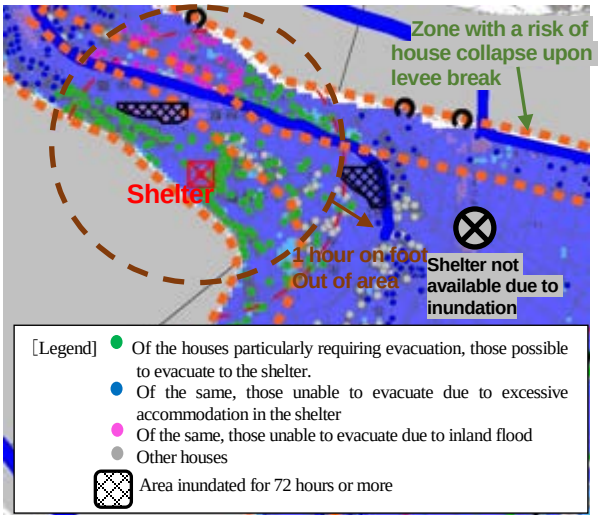


Figure: Risk Map (image)

Topics

Renewed Coastal Plane Wave Generator - For assessment of erosion control measures for long-extended coast -

SUWA Yoshio, Head, NOGUCHI Kenji, Senior Researcher
Coast Division, River Department

(Key words) hydraulic model experiment facilities, coastal protection, littoral drift

1. Sole experiment facility for plane wave generation dedicated to coast littoral sediment transport

A test facility with a coastal plane wave generator was built in 1973 when the Public Works Research Institute ("PWRI") was relocated to Tsukuba for organizational integration, in order to obtain technical findings that could help determine policy for coastal protection projects. Since then, in response to the frequent occurrence of coastal erosion, many hydraulic model experiments on movable beds have been conducted in order to develop countermeasure technologies and solve issues along individual coasts. This coastal plane wave generator is Japan's sole plane experiment facility of this scale dedicated to coastal sediment transport.

2. Update of wave generator and long-extended coast tank

The aged wave generator, which has been used over a quarter century, was repaired in a large scale.

First characteristic: The maximum experimental width of the water tank was 24 m in the old facility. In the new facility, the wave generator was extended to 60 m by combining and expanding water tanks. With this extension, a wider area that is required for considering littoral drift management within such limited area as shown by the light blue area in Figure 2 (Model scale: 1/100) can be covered.

Second characteristic: With the number of wave generators and extension of water tanks, a group of these simple wave generators with high reliability can reproduce multiple wave directions with long coastline by changing arrangement. This is expected to contribute to solution of the phenomenon that coastline comes up and down like a seesaw due to change of wave direction resulting from seasonal changes or passage of a typhoon.

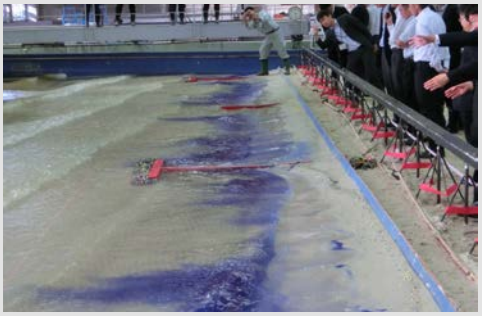


Figure 1: Wave generation facility contributing to study of coastal erosion countermeasure works

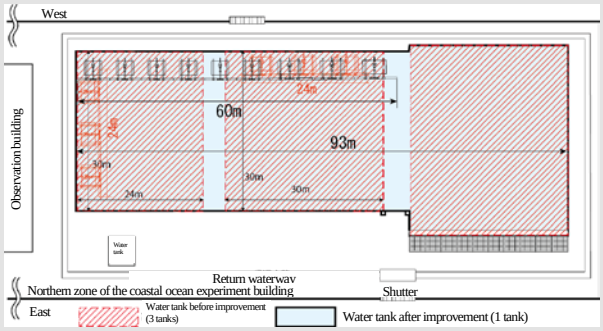


Figure 3: Tank scale after repair

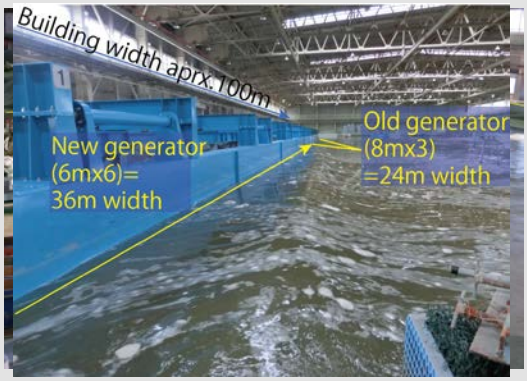


Figure 4: Group of generators after repair

Figure 2: Image of expanded experiment area after repair (Example of Kaike Coast)

Manuscript for individual articles (one-page manuscript)

New Stage for Preventing / Mitigating Storm Surge Disasters in Coast - Guide for Preparing a Storm Surge Inundation Area Map -

SUWA Yoshio, Head, TAKESHITA Tetsuya, Senior Researcher
Coast Division, River Department

(Key words) storm surge, high wave, assuming storm surge inundation

1. Background

In Japan, development of storm surge hazard maps is behind as compared with tsunami hazard maps (Figure 1). Possible reasons for this are no rise in risk awareness due to no experience of a major high-tide disaster since the 1959 Ise Bay Typhoon and unclear setting of external force in the expected maximum magnitude. However, since large-scale storm surge disasters have recently occurred in many places in the world, it is required to take measures for preventing / mitigating storm surge disasters.

Then, the Flood Control Law was revised in May 2015 to require prefectural governments to prepare a storm surge inundation area map in the expected maximum magnitude and municipalities to prepare a storm surge hazard map. Accordingly, Coast Division of the NILIM is required to provide technical support to prefectures as "Consultation Center for Storm Surge Inundation Simulation."

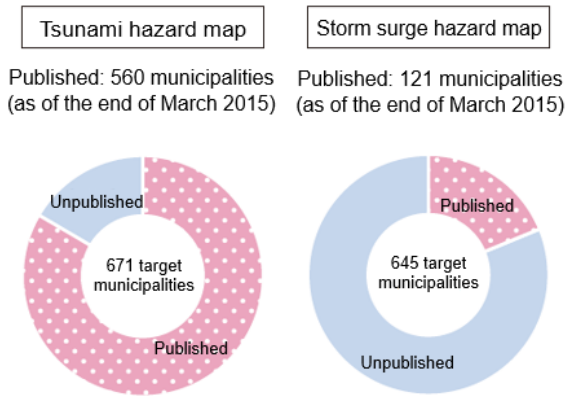


Figure 1: Hazard map preparation for tsunami and storm surge
(Source: White Paper on Land, Infrastructure and Transport in Japan, 2015)

2. Outline of the Guide for Preparing a Storm Surge Inundation Area Map

A "guide" describing technical matters for preparing a storm surge inundation area map under the Flood Control Law was documented based on the opinions, etc. of academics and published in July 2015. In the course of formulating this guide, the NILIM Coast Division provided technical support as outlined below.

(1) Setting of external force conditions

- Based on the 1934 Muroto Typhoon as the typhoon with the expected maximum magnitude, increased / decreased the central pressure according to latitudes in reference with actual typhoons in the past (Figure 2).
- Considered the low pressure based on the 2014 Nemuro Storm Surge for Hokkaido, Tohoku and Hokuriku Regions.
- Considered the river flow (design flood discharge) for the rivers under the control of the country.

(2) Setting of break conditions for levees etc.

- Levees etc. will break when the water level reaches the design condition.

(3) Storm surge inundation simulation

- Based on the typhoon model (formula of Myers), waves (spectral method), and storm surge flooding calculation (nonlinear long wave theory).
- Adoption of methods other than this guide is also acceptable in accordance with technical progress.

(4) Output of the results of storm surge inundation simulation

- In addition to inundation zones and inundation depth, output inundation duration time from a viewpoint of utilization for evacuation, corporate BCP, etc.

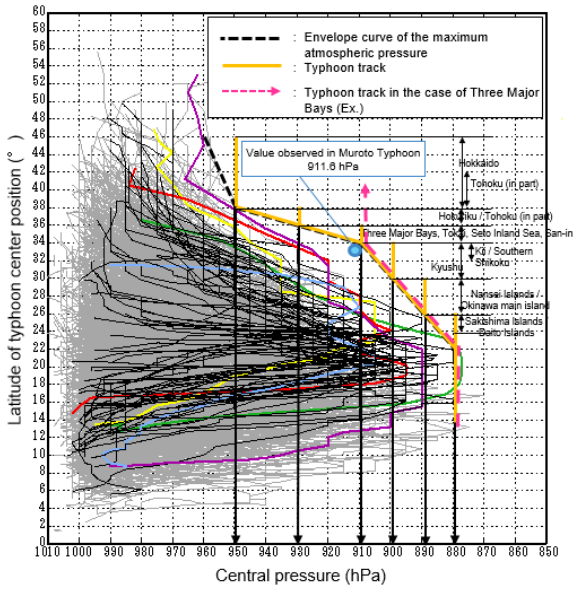


Figure 2: Setting of central pressures of expected typhoons

☞**See the following for details.**

1) Guide for Preparing a Storm Surge Inundation Area Map, ver. 1.00
http://www.mlit.go.jp/river/shinngikai_blog/saidai_takashio/pdf/takashio_tebiki_151102.pdf

Precautions for Artificial Reef

- Not evaluated only by wave-absorbing performance -

SUWA Yoshio, Head, NOGUCHI Kenji, Senior Researcher
Coast Division, River Department

(Key words) coastal erosion control measures, artificial reef, on-shore current

1. Artificial reef with difficulty in estimating the effect of coastal erosion control measures

Artificial reef is a structure for breaking waves by shoaling and reducing wave height on the shore side. There are some successful cases of constructing an artificial reef keeping moderate coastline and off-coast view. However, there are also cases of failure to form a shoreline as contemplated, so artificial reef is actually a coastal structure that is difficult to plan or design.

The NILIM has been conducting researches and studies for appropriate planning and design of artificial reefs.

2. "On-shore current" formed by forced wave breaking and its flow regime

Waves broken on the artificial reef cause "on-shore current," which flows toward the shore and causes a sharp retreat to the shoreline.

Figure 2 shows the flow regime patterns for surface and bottom layers obtained by the experiment of changing the crown height and offshore distance as shown in Figure 1. When the surface layer type c, where the flow from the artificial reef hits the coastline, is combined with the bottom layer type C, it is particularly dangerous.

3. Importance of flow regime patterns

Performance of artificial reef is often evaluated with the wave height transmission rate, which represents the wave absorbing effect on the shore side of the artificial reef. The location of artificial reef may be shifted to the shore side from the ideal off-coast location due to social constraints. As shown in Figure 3, however, when the crown is raised and water depth is reduced, the wave height transmission rate will fall but the flow regime pattern will shift to a regime where onshore current hits the shoreline, which is not favorable for shoreline conservation. Evaluation of only wave absorbing effect may lead to shoreline retreat and result in adverse effect.

4. Policy to address strong on-shore current

"Policy to address the move of artificial reef to the shore"[1] is to "study for devising the shape to let water into the opening on the crown and reduce on-shore current." There are previous studies [2] and examples concerning this policy available as reference.

☞See the following for details.

1) Civil Engineering Journal, vol.58, No.2 pp. 42-45, 2016
2) Figure 4 in the collection of coastal engineering papers, vol. 51, pp.606-610, 2004

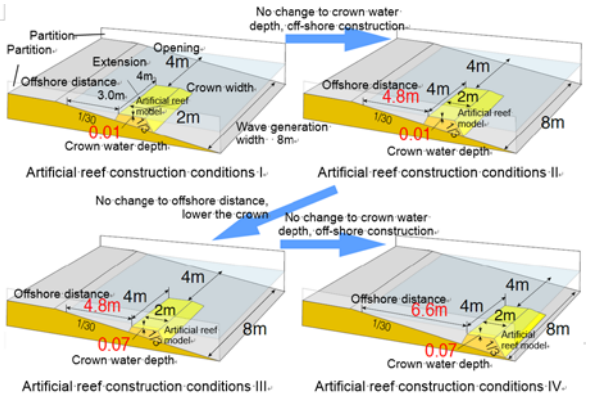


Figure 1: Installation conditions experimented

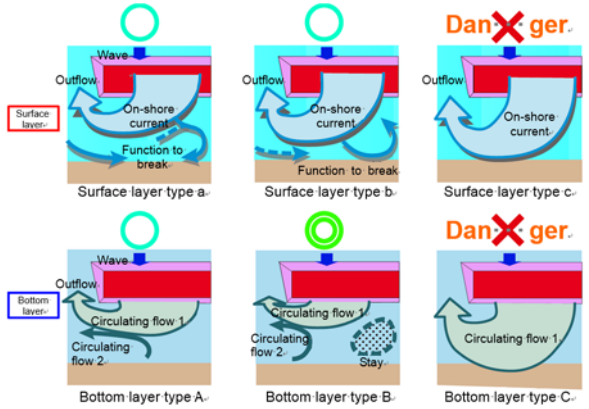


Figure 2: Flow regime types obtained by experiment

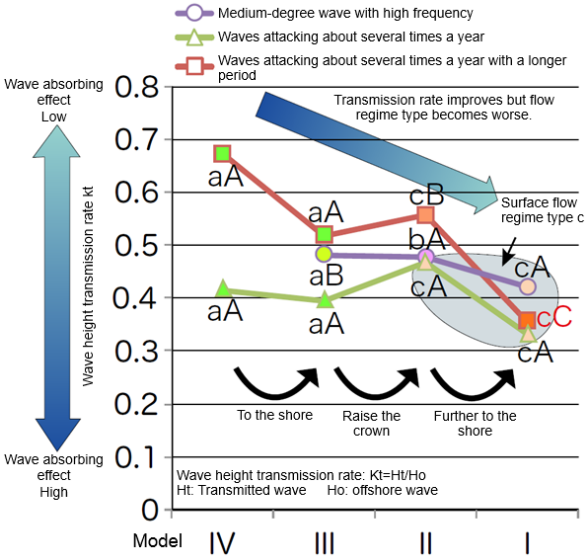


Figure 3 Wave height transmission rate and flow regime type according to construction conditions

A Case of Utilizing Results

Results of Study on Resilient Structures for Coastal Dikes

SUWA Yoshio, Head, TAKESHITA Tetsuya, Senior Researcher, HIMENO Kazuki, Researcher
Coast Division, River Department

(Key words) tsunami, coastal dike, resilient structure

1. Introduction

The Coast Division of the NILIM studied resilient structure for coastal dikes from fiscal 2011 to fiscal 2014. The results of this study were organized as Technical Note of NILIM, and this paper introduces its outline.

2. Table of contents

Table of contents of the Technical Note is as listed below.

3. Outline of contents

The content of each item is outlined as follows according to the table of contents.

1. Outline

The position of the Technical Note, characteristics / technical limit / study policy for resilient structure, etc. is described.

2. Hydraulic phenomenon caused by tsunami overflow and mechanism of levee break

As hydraulic phenomena caused by tsunami overflow, which have been identified from damage in affected sites and model experiments, five phenomena have been cited --- "tsunami wave force, high flow rate, pressure change on the armor surface, scouring at the landward slope toe, and penetration and rise in the internal pressure of the dike." Also, as phenomena that trigger dike failure, seven phenomena -- "damage to parapet work, unstable landward slope foundation work (Photo), unstable landward slope armor, unstable top of slope, suction of dike material, piping, and slide / fall of upright breakwater" -- have been provided with the explanations of break failure mechanism.

3. Considerations and device for structure

Based on the break mechanism explained in Chapter 2, considerations are provided according to the structures of landward slope foundation work, landward slope armor, armoring work on crown, outer slope armor, outer slope toe, and embankment fill material.

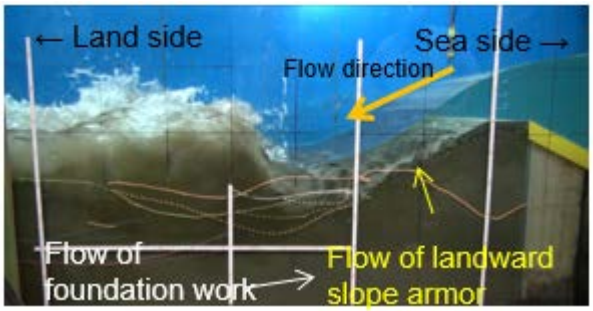


Photo: Experiment of break from the landward slope foundation work

4. Review based on break mechanism

Review items were determined by setting up tsunami wave force and estimating outer force and conditions for review according to each phenomenon that triggers break. For example, in review of the landward slope foundation work, slide and fall are reviewed based on outer force / conditions for review using fluid force, scouring amount, and load from armor works. The Figure below shows outer force / conditions for review and review items.

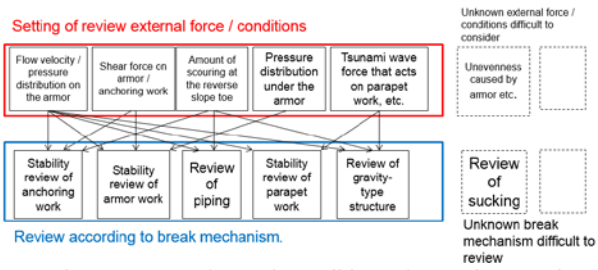


Figure: Outer force / conditions for review and review items

5. Disaster reduction effect of resilient structure

Resilient structure means device concerning structure and is in principle excluded from flood assumption, etc. for encouraging evacuation from tsunami. However, in order to expect effect appropriately in project evaluation, damage estimation, etc., the method of setting break delay time / complete collapse rate to be estimated in tsunami simulation and the result of sensitivity analysis were provided.

Appendix: Collection of data obtained by the model experiment

Flow rate / pressure distribution and amount of scouring at landward slope toe obtained from the model experiment were organized as appendix for reference in review.

Full-scale High Flow Rate Hydraulic Model Experiment using Local Ground Sample

SUWA Yoshio, Head, HARANO Takashi, Senior Researcher, HAMAGUCHI Kohei, Researcher
Coast Division, River Department

(Key words) tsunami, erosion, hydraulics model experiment

1. Background and Objectives

The NILIM aims to evaluate the effect and limit of disaster prevention / mitigation for nature and local infrastructure such as dunes and beach ridges. However, there is little knowledge concerning the response of dunes and beach ridges (including vegetation) to high flow rate like tsunami. Therefore, this study aimed to grasp the erosion process of the ground where vegetation has grown up, which can be verified only with field experiment.

2. Experiment method

Two types of specimens, an artificial broad-leaved forest and pine trees on a dune (with underbrush) as shown in Photo 1 below, were used in this experiment. Specimens used in this experiment were taken so as not to disturb the soil of the site containing the root systems of trees. (Photo 2, Left)

The specimens were placed in the high flow rate experimental channel and the high flow rate of approx. 7 m/s at maximum was repeatedly applied as shown in Photo 2, right, assuming tsunami, and the depth of erosion in the surface was measured.

3. Examples of experiment results

The surface of the specimens were divided into lattices to measure the variation of erosion depth with time in each lattice and compare the perpendicular distribution of erosion depth and the amount of root hair.

Photo 1: Locations of sampling Left: Artificial broad-leaved forest (Izumo-shi, Shimane), Right: Pine trees on the dune (Fukuroi-shi, Shizuoka)

Photo 2: Sampling (left) and flow experiment (right)

Erosion rate (gradient of the line graph) is small in the layer near the ground surface, and then trend of rapid progress in erosion is seen. The graph shows that erosion proceeds at the depth where the amount of root hair (bar graph) sharply falls, which is the same trend as in the result of the erosion experiments [1)] conducted for slopes of levees.

4. Future outlook

We intend to increase the number of experiment samples to identify the effect and limit of dunes and beach ridges on tsunami.

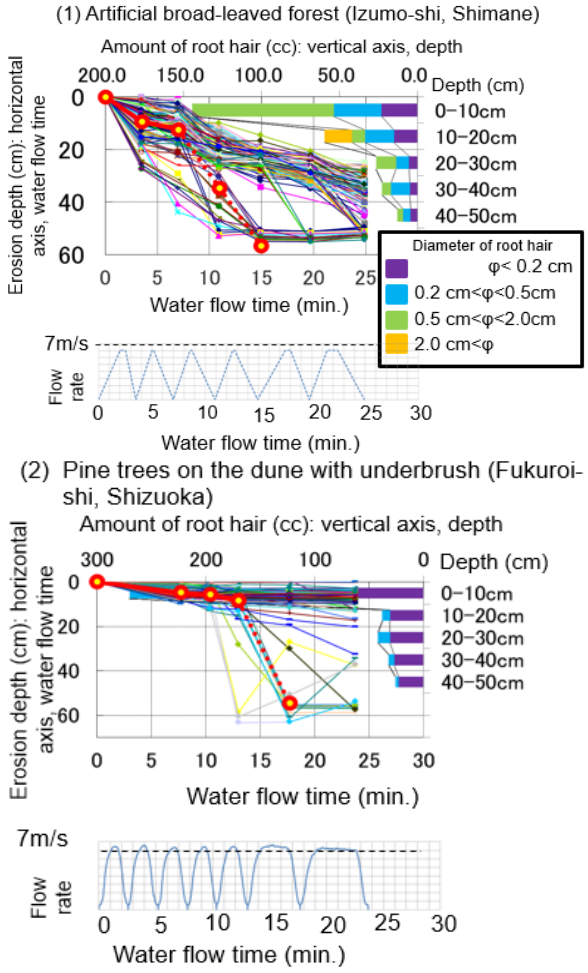


Figure: Extent of erosion, amount of root hair, and flow rate

---

☞**See the following for details.**

1) PWRI material, No. 3489 pp. 97-214

Flood Risk Visualization Project

- Addressing the issue of "last one mile" to use river information for evacuation behavior -

TSUCHIYA Shuichi (Dr. Eng.), Researcher, KAWASAKI Masao, Head
Water Cycle Division, River Department
TORII Kenichi (Dr. Eng.), Director, River Department

(Key words) flood risk, visualization, evacuation behavior, crisis management

1. Background of the project

Many issues have been recognized by the occurrence of the flood of Kinugawa River in the September 2015 Kanto-Tohoku Heavy Rain. Of those, one of the most outstanding issues is the presence of areas where residents were isolated due to delay in evacuation etc. and no recommendation or directive for evacuation was issued before the levee break.

In case of such a large-scale flood, the river administrator needs to ensure the appropriate issuance of recommendation / directive for evacuation by municipalities and provide information on the river status to encourage residents to evacuate at their own decision. At present, river administrators provide information only on points, such as water level observed at the water level observation points and the estimated water level at flood forecast points. With such discrete information, however, in order to image the condition of the river on the whole from upstream to downstream, determine the risk or urgency of flood etc. for each site, and perform evacuation operation timely and appropriately, abundant knowledge and experience concerning the floods of the relevant river are required. However, for local government etc. that receive river information, it is very difficult to ensure and foster human resources immediately who are able to grasp and determine the situation appropriately from the information given at present. In other words, such information would not be used effectively for evacuation behavior or risk management due to the issue of the information provided in case of a major flood and its literacy.

In such circumstances, the River Department of the NILIM launched the Flood Risk Visualization Project immediately after the Kanto-Tohoku Heavy Rain in order to address the issue of "last one mile" to use information provided by river administrators in case of a major flood effectively for evacuation behavior and risk management.

2. Flood Risk Visualization System

As a tool for solving issues on the present information and its literacy, we have undertaken to establish "Flood Risk Visualization System." This System aims to provide visualized information on the flood risk of rivers on the whole from upstream to downstream (including risk and urgency of flood and extent of rescue operation, evacuation population, etc. in the event of a flood) (See Figure). This System also aims to support the river office and relevant municipalities in grasping and sharing flood risk and making decisions for risk management in case of a flood, and to serve as a common tool for communication between the river office and municipalities at ordinary times, contributing to improvement in river information literacy through use in disaster training, etc. In accordance with these purposes, we are working for system establishment by setting up the following three points as requirements of visualized system; "Recognize flood risk etc. comprehensively by integrating various information concerning flood risk, etc.", "Recognize flood risk on each site with the profiles of water level, levee height, levee ground height, etc.", and "Recognize urgency of flood with expressions with reality, etc."

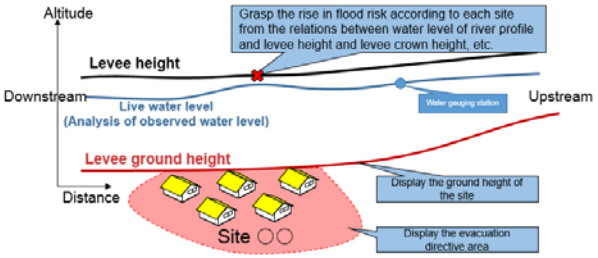


Figure: Image of the profile of river level, levee height, etc.

3. Future development

For visualization system, integration of observation, analysis, and expression skills is indispensable. Particularly, expression skills play an important role for solving the issue of last one mile to use information for evacuation behavior, etc. Therefore, we continue to study the content and expression of information from the viewpoints of sociology etc. and reflect knowledge obtained from study in the System.

A Case of Utilizing Results

Examples for Utilization of XRAIN Precipitation Information

YAMAJI Hideyuki, Researcher, KAWASAKI Masao, Head, TSUCHIYA Shuichi (Dr. Eng.), Researcher
Water Cycle Division, River Department

(Key words) XRAIN, X Band MP Radar, flood disaster

1. Introduction

Water and Disaster Management Bureau in the Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") has worked for establishment of "XRAIN" (X-band polarimetric (multi parameter) RAdar Information Network)[1] in order to strengthen the monitoring system for water disasters that occur in various places in Japan and respond to local heavy rains and torrential rains. With the start of XRAIN operation in Hamamatsu Bureau in June 2015, all the designated cities have been covered on the whole by XRAIN. Also, with the commencement of the service for distributing river information numerical data, anyone can obtain precipitation data provided by XRAIN with high resolution and immediacy.

The NILIM has been conducting a technological study for practical use of XRAIN, including establishment of a data processing / distribution system for X Band MP Radar. This paper introduces some cases of using XRAIN precipitation information in society as a result of the technical development by the NILIM for practical use of XRAIN.

2. Examples for utilization of XRAIN precipitation information

(1) Examples for utilization in disaster response

Rokko Sabo Office in the Kinki Regional Development Bureau is using XRAIN for speedy disaster response by distributing alert e-mails to the persons concerned (see Figure) when XRAIN observes precipitation exceeding the preset value.[3] Also, in the 2011 Niigata-Fukushima Heavy Rain, the personnel of municipalities along the downstream of the Shinano River used XRAIN precipitation information as data for directing flood control activities including sandbag stacking and for determining whether to issue evacuation recommendation.

(2) Examples of utilization in other fields

Using XRAIN precipitation data, the Japan Weather Association has opened a website to indicate rainfall intensity forecast and provides a smart phone application that displays observation data overlapped with camera images by AR (Augmented Reality) function.[3] Higashi Nippon Broadcasting Co, Ltd. (KHB) started the broadcasting of XRAIN observation information in June 2012 for the first time as TV station.[3] Moreover, the Vehicle Information and Communication System Center has started in April 2015 a service using XRAIN observation data to provide information on areas in heavy rain of 50 mm/h or more, which is considered the rainfall intensity where the driver's frontward visibility falls. [4]

3. Conclusion

This paper introduced some examples for utilization of XRAIN precipitation information in society. In the future, further advanced use of XRAIN is expected, such as use for disaster response by forecasting real time inundation by inland water and river water level based on XRAIN precipitation data.

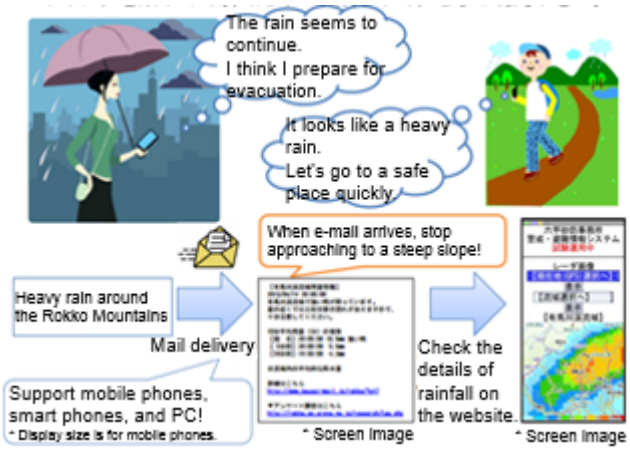


Figure: Alert mail distribution using XRAIN precipitation data
(Source: Website of Rokko Sabo Office, Kinki Regional Development Bureau)

☞See the following for details.

1) XRAIN precipitation information
http://www.river.go.jp/xbandradar/
2) River information numerical data distribution service
http://www.river.or.jp/01suuchi/index.html
3) Rokko Mountain System "Rainfall Notification System"
http://www.kkr.mlit.go.jp/rokko/camrain/pdf/rainfall.pdf
4) Ministry of Land, Infrastructure, Transport and Tourism: XRAIN (X Band MP Radar Network)
New distribution area, Press release material, July 2014
http://www.mlit.go.jp/common/001046713.pdf
5) VICS WIDE
http://www.vics.or.jp/know/wide/04.html

Manuscript for individual articles (one-page manuscript)

Protect the Life from River Flood

ITO Hiroyuki, Head, YAMAMOTO Akira, Senior Researcher, YUASA Naomi, Researcher
Flood Disaster Prevention Division, River Department

(Key words) flood, large-scale flood, means of evacuation

1. Introduction

The September 2015 Kanto-Tohoku Heavy Rain caused serious damage in many places in the Eastern Japan. Particularly, the levee of the Kinugawa River broke around noon of September 10th and an area of about 40 km^2 was flooded in Joso-shi, Ibaraki, and two persons were killed. Further, many residents failed to evacuate and some of them were rescued by helicopter from houses being washed away. Moreover, at night of the 10th, the southern part of Joso-shi was also hit by a large scale flood caused by inland water flood and flood flow from the broken levee, and many houses were isolated, so large-scale rescue using helicopters and boats was carried out on and after the 11th. As the result, more than 4,000 people were rescued, which was achieved under conditions favorable for helicopter flying and rescue activity, including favorable wind and rain conditions, occurrence of levee break in the daytime, and presence of a heliport near the site. We should recognize that there might have been a lot of victims if the flood had occurred under unfavorable conditions.

The following briefly describes the hazardous events caused by the river flood as well as the matters that should be recognized by individuals to protect their lives.

2. Collapse and washing-away of houses by levee break

At Kamimisaka, Joso-shi, the levee broke about 12:50 on September 10th due to overflow and the houses located at the front of the broken levee began to collapse or be washed away soon after the break. As a result of the investigation of the washing-away of the houses, etc., it was found that the flood flow caused by the break of the levee with the relative height of about 4 m or less washed away about 20 houses located in the area 150 m from the broken levee (see Figure 1). If levee break in a larger scale occurs, houses in a wider area are expected to be washed away, but it is difficult for local residents etc. to have an image in advance about the extent and area where such an event occurs. Therefore, guidelines for horizontal escape would be needed.

3. Large-scale inundation by flood flow, etc.

The flood flow generated about noon of the 10th ran down to the south along the landside and caused inundation in a wide area up to the south of Joso-shi in combination with the inland flow by the Hakkenbori River. Consequently, more than 4,000 households were inundated above the floor level and some of the inundated houses were temporarily isolated. The flood water was mostly drained on the 19th as the result of drainage activities by the Hakkenbori Drainage Pump Station and the drainage pump vehicles that assembled from many places across the country. However, the living environment after the flood was horrible since it was summer and air conditioners and other home appliances as well as toilet were unavailable due to power breakdown and suspension of water supply. There was the risk of occurrence of health damage etc. if there were delay in drainage of inundation.

4. Conclusion

After the occurrence of this flood, the Ministry of Land, Infrastructure, Transport and Tourism launched the Vision for Reconstructing Society Aware of Water Disaster Prevention, in which the Ministry aims to promote information provision for local residents to be able to detect risk and evacuate at their own decision. Taking this opportunity, local residents are recommended to confirm the location of their houses with the hazard map etc. and to consider unexpected problems and how to protect their lives.

Figure 1: Washing-away of houses

Protect Urban Functions by Speedy Inundation Forecast

ONUMA Katsuhiro, Senior Researcher, ITO Hiroyuki, Head, HOSODA Satoshi, Researcher
Flood Disaster Prevention Division, River Department

(Key words) sudden localized torrential downpours, underground space, inundation forecast, real time information distribution system

1. Introduction

Since sudden localized torrential downpours (so-called "guerrilla downpours") have been increasing in recent years, it has become necessary to establish disaster prevention / mitigation measures for more speedy and accurate flood control activities, evacuation guidance, etc.

This study aims to develop a program by fiscal 2016 to more speedily and accurately forecast inundation, using observation data of water levels in rivers, etc. and rainfall data, and to build a prototype system for distributing the computation results of the inundation forecast.

2. Development of inundation forecast program

We are developing an inundation forecast program for processing data on inland and river floods as a whole by integrating the models of river and sewerage hydraulic analysis and flood analysis covering the basins of Kanda River and Shakujii River. This program aims to improve the accuracy of forecast by using real-time data on river level, etc. and have the high-speed performance enough to distribute computation results every 10 minutes. In fiscal 2015, we are working to improve the accuracy of models and to refine models for key areas including the vicinity of Shinjuku Station.

3. Establishment of an inundation forecast information distribution system

We are also working to build a system having the functions to collect the aforementioned data on real time, convert the data for input in the inundation forecast program, and convert computation results into the data format for distribution to distribute them on the web (see Figure). We are going to study the contents to be distributed by grasping information needs of expected users including local governments through hearing, etc. and reflect the study results in the system.

4. Perspectives for implementation of urban inundation countermeasures using inundation forecast information

This system is expected to support speedy and accurate disaster prevention / mitigation activities in urban areas, including the issuance of evacuation recommendations, etc. by local governments, opening of evacuation shelters, flood control activities, evacuation guidance and inundation countermeasures in underground shopping centers and subway stations, and water cut-off measures for stores and offices.

We aim to complete and put into service this system by reflecting the rainfall data from a new type of radar to be developed by other institution, and the rainfall forecasts based on that data, and by tooling this system for disaster prevention activities through social experiments.

* This study has been conducted under the SIP (Cross-ministerial Strategic Innovation Promotion Program) of the Council for Science, Technology and Innovation, titled "Strengthening resilient disaster prevention / mitigation functions."

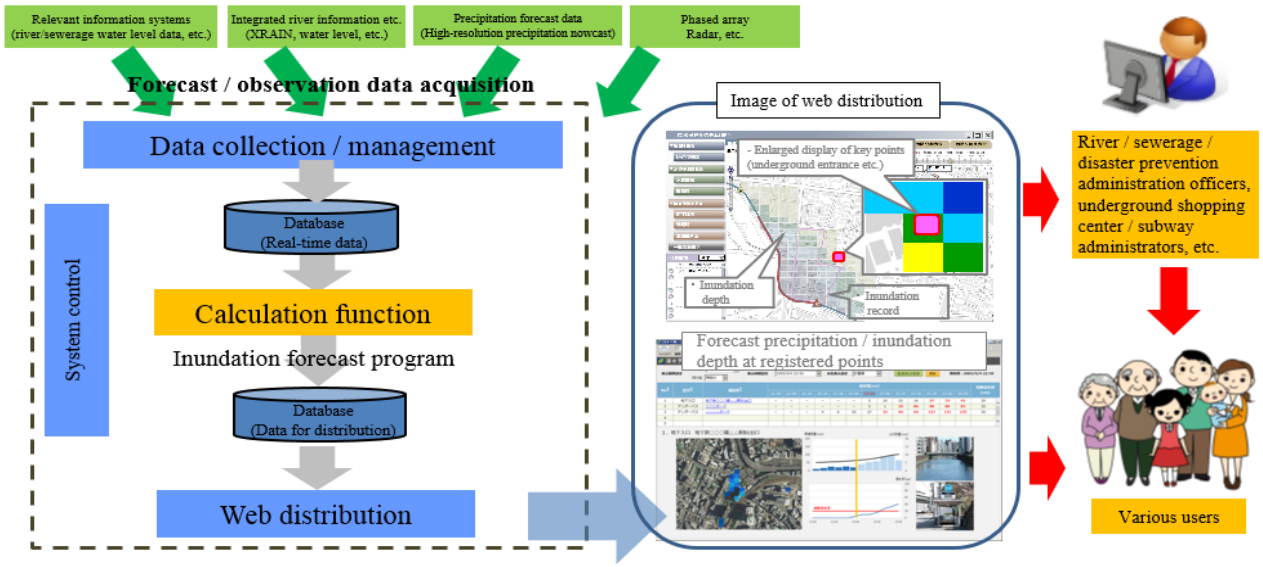


Figure: Whole picture of the system

Study of methods to reduce risks of flood damage integrated with urban planning

TORII Kenichi (Ph.D. Engineering), Director
FUKAMI Kazuhiko, Research Coordinator for Integrated Water Disaster Management
River Department

(Keywords) Ways to adapt to climate change, excessive flood , disaster reduction and management, overland flooding

1. Necessity of the joint effort to reduce disasters with societies

As we face the risk of increased intensity and frequency of water-related disasters caused by climate change, societies are expected to steadily develop infrastructures and implement disaster reduction measures integrated with urban planning (example: responses in the Social Infrastructure Development Council, "Ways to adapt to climate change in the field of water-related disasters – To share the information of disaster risks and sense of crisis to build a society to reduce disasters – " August 2015). The team started a study of measures to reduce disasters in urban planning and lifestyles and methods to evaluate them by focusing on cities with high vulnerabilities and identifying the vulnerabilities to water-related disasters. This paper introduces this study.

2. Three focuses

(1) Identification of flood hazards for both overland flooding and river flooding

Many hazard maps have been created for class 1 water systems if the annual flooding probability is 1/100 to 1/200 and the external force of flooding with the scale of 1/5 to 1/10 of sewage planning (overland flooding and river flooding). Yet, hazards are not well known for overland flooding that exceeds 1/100, such as cases of so-called guerrilla rainfall and cases with simultaneous overland flooding and river flooding. Thus, the team develops methods to analyze actual flooding hazards for various external forces, such as for a case in which the overland flooding expands to a scale that exceeds 1/100 and a case in which overland flooding is joined to river flooding.

(2) Interpretation of damage risks from flooding hazards based on urban diversity

Even when the information of hazards, such as flooding depths, is released, business owners and residents cannot easily understand what kind of risks they are facing. Thus, the team analyzed characteristics (attributes) of buildings, business owners, and residents for which flood damage can be defined. The team then developed a model to convert the obtained information into information on the damage risks for specific urban conditions (Fig.-1). For example, the evaluation of the relationship between flooding depths and damage to assets for individual attributes of buildings will enable the identification of damage risks as well as the quantitative evaluation of the effects of damage reduction measures, such as the use of piloti, water stops, and the relocation of assets.

(3) Suggestions for measures based on regional abilities to prevent and reduce damages

Even if detailed information on the hazards and risks is released, it is meaningless unless local governments, business owners, and residents can understand what kind of measures they should combine. Thus, the team also looks for methods to present the information by examining proper response menus for specific damage prevention measures and abilities (strengths and weaknesses of society) of above attributes and target areas to reduce damage.

3. Research system integrated with urban planning and damage prevention departments

Three-year cross-sectional research studies are being implemented using the system from the Climate Change Adaptation Research Group in which the following research divisions related to river and wastewater management, urban planning, and disaster prevention can work together: River Department (River Division, Water Cycle Division, Flood Disaster Prevention Division); Urban Planning Department (Urban Planning Division, Urban Disaster Mitigation Division); Water Quality Control Department (Wastewater System Division); and Research Center for Land and Construction Management (Research Coordinator for Land Management and Disaster Prevention). Practical case studies will be implemented in the future with local governments in model areas.

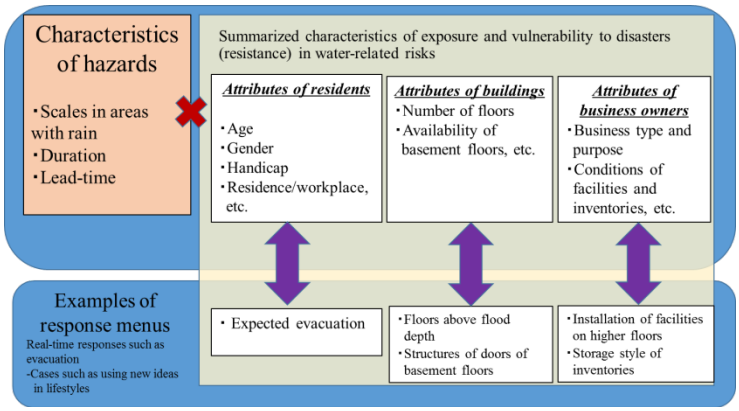


Fig-1. Interpretation of risks from hazards based on various attributes in cities and concept of presenting menus of responses to the risks

Manuscript for individual articles (one-page manuscript)

Creation of Annual Record of Sediment Discharge in Mountainous Watershed

SAKURAI Wataru (Dr. Agr.), Head, UCHIDA Taro (Dr. Agr.), Senior Researcher, TANAKA Yasutaka, Researcher, IUCHI Takuma, Guest Research Engineer

Sabo Planning Division, Sabo Department

(Key words) mountainous watershed, hydrological observation of sediment discharge, bed load, suspended sediment, hydrophone, turbidimeter

1. Background

Grasp of sediment movement in mountainous watershed is important for formulation of sabo (erosion control) basic plan and consideration of comprehensive sediment management policy, as well as from the viewpoint of land monitoring. Attempts have been made to date to estimate sediment discharge from the survey results on sedimentation in erosion control dams. However, this method needs much effort and has some issues including coarseness in time resolution. Meanwhile, centering on sabo offices under direct control, hydrological observation of sediment discharge has begun to be conducted in recent years using hydrophone, which observes bed load discharge with echoes generated when bed load collides with the metal pipe installed in the river bed, or using a turbidimeter [1)] (see Photo). Accordingly, Sabo Planning Division has organized the hydrological observation data on sediment discharge observed by the sabo offices under direct control as "Annual Record of Sediment Discharge" as defined by the Technical Criteria for River Works (Survey Part).

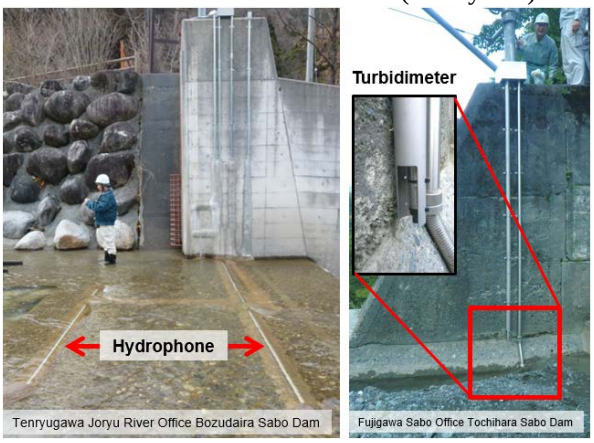


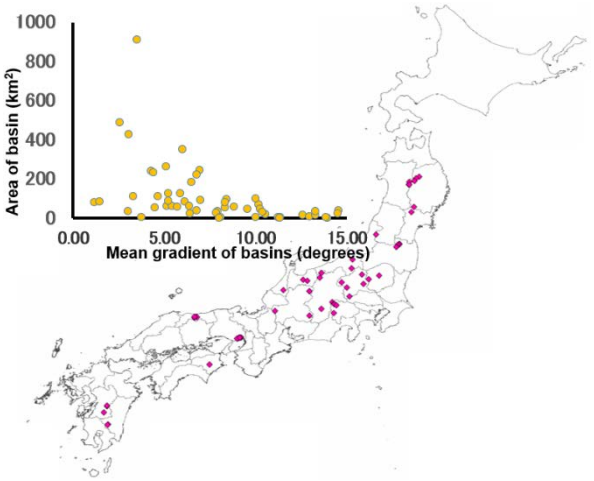
Photo: Example of sediment discharge observation facility

2. Outline of observation data

This study examined the data on the hydrological observation of sediment discharge conducted by the sabo offices under direct control at 54 locations across the country from fiscal 2009 to fiscal 2013 (see Figure). The areas of target basins range from approx. 3 to 913 km^2, and mean gradient of the basins, approx. 1.2 to 14.5 degrees.

Observation items covered by this Annual Record of Sediment Discharge are water depth, flow rate, bed load discharge, and suspended sediment. Bed load discharge was determined by converting the acoustic waveform obtained by the hydrophone into the unit-width bed load discharge using the synthesized sound pressure method provided by Suzuki et al (2010) [2)] and then multiplying the result by river width, while suspended sediment was determined by converting the turbidity measured by turbidimeter into suspended sediment concentration and then multiplying the result by flow rate. The Annual Record of Sediment Discharge has also organized data on daily and monthly sediment discharge as well as sediment discharge by flood.

Figure: Locations of sediment discharge observation



and the area and average gradient of the observed basins (Upper left)

3. Conclusion

This Annual Record of Sediment Discharge is going to be published as Technical Note of NILIM. This is expected to serve as basic data for grasping sediment movement in mountainous watershed, information on which had been limited, and to be utilized for various purposes. Meanwhile, many technical issues remain in the hydrological observation of sediment discharge in mountainous watershed. Therefore, further technical development and study are required.

[Reference]

1) TANAKA Yasutaka, UCHIDA Taro, KAMOHARA Jun-ichi, SAKURAI Wataru: "The Advances and Tasks of Recent Sediment Transport Monitoring in Mountainous River," Civil Engineering Journal, vol.57, No.7, pp. 22-25, 2015

2) SUZUKI Takuro, MIZUNO Hideaki, OSANAI Nobutomo: "Basic study on sediment rate measurement with a hydrophone on the basis of sound pressure data,"

Journal of the Japan Society of Erosion Control Engineering, 62 (5), 18-26, 2010

Manuscript for individual articles (one-page manuscript)

Study on Run-off Condition of Recent Debris Flows using LP Data

MATSUMOTO Naoki, Researcher, KUDO Tsukasa, Guest Research Engineer, UCHIDA Taro (Dr. Agr.), Senior Researcher, SAKURAI Wataru, Head
Sabo Planning Division, Sabo Department

(Key words) debris flow, run-off condition, LP data

1. Background

It is one of the most important techniques for debris flow control to forecast the scale, run-off status, and deposition range of debris flow. Accordingly, information data concerning the condition of debris flow is important for debris flow control, but accumulation of such data is not necessarily proceeding due mainly to the difficulty in obtaining detailed topographic information before occurrence of debris flow. In recent years, however, topographic changes due to run-off of debris flow can be grasped spatially and precisely using the topographic survey data based on the aerial laser profiler ("LP data") before and after disasters. Accordingly, Sabo Planning Division has been surveying the scale and run-off condition of debris flow using LP data in order to contribute to the review and revision of the technical guidelines for debris flow control planning.

2. Outline of study

(1) Scope of study

In recent years, LP data before and after the occurrence of debris flow is increasingly acquired for the mountain streams where debris flow occurred causing serious damage (see Table below). Then, Sabo Planning Division has been studying the following concerning the mountain streams that caused debris flow and for which LP data is available.

Table: Mountain streams covered

Date	Location	Number of target mountain streams
July 21, 2009	Hofu-shi, Yamaguchi	5 streams
July 27-30, 2011	Minami-Uonuma-shi, Niigata	5 streams
July 11-14, 2012	Minamiaso-mura, Aso-shi, Kumamoto	5 streams
Sep. 18, 2012	Inabe-shi, Mie	2 streams
Aug. 9, 2013	Senboku-shi, Akita	1 stream
July 9, 2014	Nagisomachi, Nagano	1 stream
Aug. 20, 2014	Hiroshima-shi, Hiroshima	2 streams
Total		21 streams

(2) Study items

Typical items under examination are as follows.

- Relations between grain size composition and shape of sedimentation in debris flow.
- Grasping the actual width and depth of erosion by debris flow.
- Analysis of the factors (rainfall, topography, catchment area) that affect the amount of sediment run-off.
- Estimation of the peak rate of debris flow and analysis of the factors (rainfall, topography, catchment area) that affect the peak rate of debris flow.
- Study of effect of the conditioning method of numerical computation on the reproducibility of run-off condition.

(3) Example of study results

We measured the erosion width and depth before and after debris flow by determining the area of debris flow run-off using LP data and aerial photographs taken before and after debris flow (see Figure below). As the result, approx. 83 percent of the cases of mean erosion width were within 10-30 m, and approx. 80 of the cases of mean erosion depth were within 0.75-2.5 m. It was also shown that in survey of debris flow, sampling typical profiles appropriately is important since there is large variation even in the same mountain stream.

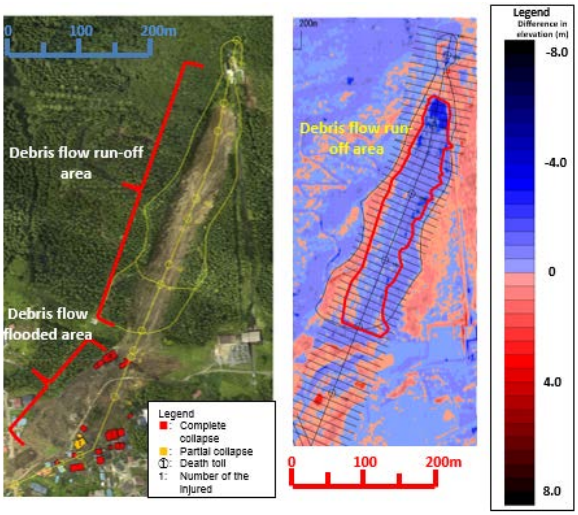


Figure: Example for measurement of the width and depth of erosion by debris flow

3. Conclusion

We intend to continue data accumulation and more detailed analysis to improve techniques for forecasting the scale and run-off condition of debris flow.

[Reference]

1) KUDO Tsukasa, UCHIDA Taro, MATSUMOTO Naoki, SAKURAI Wataru: Analysis of Eroded Width and Depth Due to Debris Flow using LiDAR Data, Civil Engineering Journal, Vol.57, No.11, pp.22-25, 2015

Relations between Sediment Disasters that Caused Serious Damage and the Precipitation System - For strengthening warning and evacuation system -

KUNITOMO Masaru, Head, KAMIYAMA Joko, Senior Researcher, IKEDA Hiroshi, Guest Research Engineer
Sabo Risk-Management Division, Sabo Department

(Key words) sediment disaster warning information, Band-shaped Heavy Rainfall, sediment disaster risk assessment

1. Introduction

The Basic Guidelines for Preventing Sediment-related Disasters (Article 3 of the Sediment Disaster Prevention Law) strongly recommend municipalities to use the sediment disaster warning information (Article 27 of the same Law) for making decisions on whether to issue evacuation orders or not when a sediment disaster is expected to occur. For such information, however, since threshold values are often set to a lower level in order to avoid so-called "third strike looking," there are many "swings and misses" as a relationship of trade-off. Consequently, there are not a few cases where announcement of such information does not lead to issuance of evacuation orders, so it is hard to say that such information is functioning effectively as disaster prevention information.

Considering such situation, it is urgently needed to evaluate appropriately the occurrence likelihood of sediment disaster and reduce "swing and miss." Therefore, this study analyzed relations between sediment-related disasters that caused serious damage and the precipitation systems that caused such disasters in reviewing such a method of evaluating sediment disaster risk.

2. Precipitation system in the event of sediment disaster

We examined the conditions of precipitation systems in the event of sediment-related disasters ("serious disasters") for 17 cases where damage to five or more persons or houses (complete collapse) except deep-seated landslides in the last ten years.

The table below shows the damage classifications with focus on the formation of precipitation systems (band-shaped heavy rainfall[1]). The figure shows the status of precipitation in the 2014 Hiroshima Disaster as a typical example of disasters caused by the formation of band-shaped heavy rainfall ("disaster caused by band-shaped heavy rainfall").

The Table shows that the number of disasters caused by band-shaped heavy rainfall is 2.4 times other disasters, and human and house damages per disaster is 3.1 and 1.9 times other disasters, respectively, which suggests that many of serious disasters are caused by band-shaped heavy rainfall with increase in damage. In addition, human damage per damaged house is 1.6 times greater than other disasters. This suggests that pre-evacuation is difficult in case of disaster caused by band-shaped heavy rainfall as compared with other disasters (e.g. typhoon). It was therefore found that assessment of the extent of probability for formation of band-shaped heavy rainfall is important in order to reduce human damage by appropriate encouragement of evacuation to residents.

3. Conclusion

Sediment Disaster Warning Information is announced after conducting risk assessment with forecast values of precipitation. However, it is pointed out that accuracy of forecast values will decline according to increase in rainfall intensity.[2] Accordingly, the Meteorological Agency is considering the evaluation of probability of formation of band-shaped heavy rainfall based on the information on environmental field.[1] Since the risk of sediment-related disaster may also be evaluated more accurately by adding the weather indicators that show the environment field where band-shaped heavy rainfall are likely to be formed to the present precipitation indicators, we intend to continue the study.

Table: Human and house damages by serious disasters

Formation of Band-shaped Heavy Rainfall	Number of subject precipitation cases	Total human damage	Total house damage	Human damage per case	House damage per case	Human damage per damaged house
① Formed	12	188	513	15.7	42.8	0.37
② Not formed	5	25	111	5.0	22.2	0.23
①/②	2.4	7.5	4.6	3.1	1.9	1.6

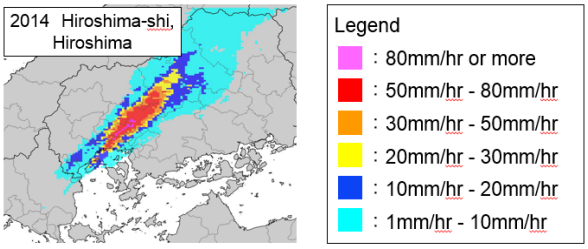


Figure: Typical example of linear precipitation system (2014 Hiroshima Disaster)

[Reference]

1) Forecast Division, Meteorological Agency: Fiscal 2014 Forecasting Technique Training Textbook, 2015
2) The Japan Society of Civil Engineers and the Japanese Geotechnical Society: Investigation Report by the 2014 Hiroshima Heavy Rain Disaster Joint Emergency Investigation Team, 2014

Emergency Observation with SAR during Development of Disaster Mission Planning Support System

KUNITOMO Masaru, Head, MATSUSHITA Kazuki, Senior Researcher, SUZUKI Yamato, Researcher, SAKAGAMI Masayuki, Guest Research Engineer
Sabo Risk-Management Division, Sabo Department

(Key words) sediment disaster, remote sensing, operations research (OR)

1. Introduction

In a large-scale earthquake or similar event, slope failures may occur across a wide area, access roads to the stricken areas may be interrupted and landslide dams may be formed. For quick recovery of stricken areas and resident evacuation, it is necessary to grasp the situation of stricken areas at an early stage without being affected by the weather, etc.

For this reason, in order to eliminate, to the extent possible, the time when no information is available immediately after occurrence of a large-scale earthquake, etc., we have undertaken the study on the method of grasping affected areas quickly and widely by combining Synthetic Aperture Radar ("SAR") loaded in an artificial satellite that enables observation even at night or in bad weather and SAR loaded in an airplane with high mobility.

2. Content of study

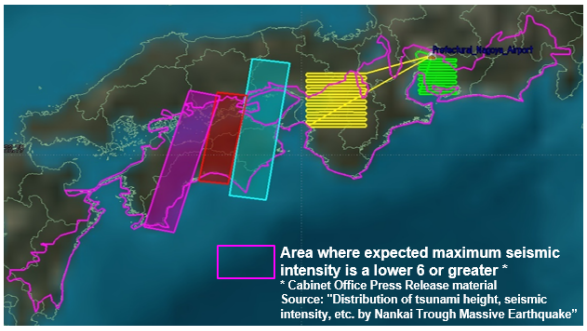
This study has developed a fundamental algorithm for formulating the fastest and most efficient observation operation plan by comprehensively analyzing operational conditions for "Sensor Platform" ("SP", i.e., artificial satellite and airplane), which is available in the event of a disaster, and environmental conditions (e.g., time, weather, available airport) in case of damage using the technique of Operations Research ("OR").[1)]

Based on this algorithm, we have also developed "Mission Planning Support System" (prototype) for computing the critical path of observation operation with "Microsoft Project" by managing various input conditions with Microsoft Excel and SP operation conditions with "Systems Tool Kit" (AGI).

As one of the examples for development, the Figure shows observation planning assuming the occurrence of Nankai Trough Massive Earthquake. This example provides the area that can be observed within 12 hours of the occurrence of a disaster under the conditions where maximum use of SP expected available is possible (assuming the occurrence of the disaster on December 22, 2015, at 1:00). Even these conditions, SP is not sufficient to observe all the areas where expected maximum seismic intensity is a lower 6 or greater. It was therefore found that increase of resources needs to be considered.

3. Conclusion

The algorithm and the planning support system developed by this study are just prototype version. In the future, in order to deduce more efficient observation routes, formulate efficient initial survey plans, and grasp necessary resources (SP etc.), we intend to upgrade the algorithm by utilizing the Theory of Search, which has been used in the OR field, for finding the object efficiently, etc. and to improve the planning support system for more practicability.



No.	Satellite / airplane	Observation beam	Observation start time (UTC)	Scheduled observation end time (UTC)	Legend
1	Satellite A	mode1	2015/12/22 2:50	2015/12/22 2:50	
2	Satellite B	mode2	2015/12/22 8:54	2015/12/22 8:55	
3	Satellite C	mode1	2015/12/22 9:37	2015/12/22 9:37	
4	Airplane A	mode2	2015/12/22 2:45	2015/12/22 6:43	
5	Airplane B	mode2	2015/12/22 2:17	2015/12/22 7:40	

Figure: Example for observation planning assuming the occurrence of Nankai Trough Massive Earthquake

[Reference]

1) IIDA Koji, "Science of Fighting in the Information Age, Revised ver. Introduction to Military OR," Sankeisha, 2004

A Case of Utilizing Results

Attempted wise use of roads by using ETC2.0 probe

Hiroshi Makino, Head
Hideyuki Kanoshima, Senior Researcher
Daisuke Watanabe, Researcher
Tomoaki Mizutani, Researcher
Intelligent Transport Systems Division, Road Traffic Department

(Key words) ETC2.0, probe information, ITS, disaster

1. Introduction

The Ministry of Land, Infrastructure, Transport and Tourism has been installing roadside units (radio antennas for road-to-vehicle communication) on nationwide expressways and general roads since 2011. Road traffic information and so on is provided to in-vehicle devices supporting ETC2.0 by using these roadside units, and ETC2.0 probe information such as the running history is collected.

Accordingly, at the NILIM, we are conducting research to utilize ETC2.0 probe information to analyze the effect of new service routes and grasp the road conditions when a disaster occurs.

In this article, as an example of how the ETC2.0 probe information was utilized, we will show the analysis results for vehicle traffic paths when roads were closed because of heavy rain from a typhoon, along with a function of the ETC2.0 probe information system to display a traffic record assuming that the system is used during a disaster.

2. Analysis of influence of typhoon on road traffic paths

Because of the heavy rain caused by typhoon No. 12 in August 2014, the route between Kawanoe JCT and Susaki Higashi IC on the Kochi Expressway was closed for approximately 61 h from August 2nd to August 5th. We analyzed the ETC2.0 probe information and obtained the vehicle traffic paths for the normal and closed times, as shown in Figure 1 and Figure 2, respectively. A comparison and analysis of the data confirmed that national highway Route 194 was used as an alternative to the Kochi Expressway and Route 32 during the heavy rain.

Figure 1 Normal time

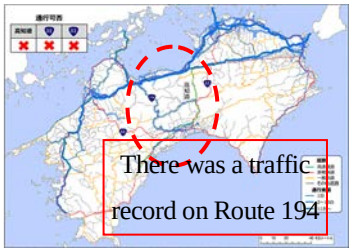


Figure 2 When roads were closed

3. Comparison between new and old systems and discussion of how to utilize system during disaster

The ETC2.0 probe system was updated in February 2015, and a function was added to successively display the traffic records obtained 3 h before on the same day.

The new system can immediately display the traffic record of vehicles 3 h from the time of a disaster (Figure 3). Thus, it is possible to predict where roads are closed because of the disaster.

However, this result is just reference information that shows that vehicles passed a certain place at that time, and we still need to confirm whether there is actual traffic by using another method.

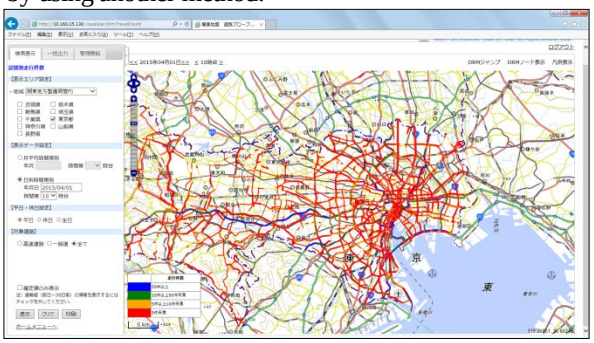


Figure 3 Display of a traffic record

4. Concluding remarks

In this article, we showed that we can grasp vehicle traffic paths during a disaster by using ETC2.0 probe information.

Thus, we can see that it is possible to grasp more detailed road conditions if roadside units are installed on roads where we need to confirm vehicle traffic situations, such as a mountain pass zone, a zone with traffic restriction due to rain, and a zone that is subject to the influence of snow.

Study on design methods to meet performance requirements of underground structures

Toshiaki Mabuchi, Head
Hideaki Nishida, Senior Researcher
Shigeru Takagi, Senior Researcher
Jun Nishifuji, Researcher
Foundation, Tunnel and Substructures Division, Road Structures Department

(Key words) underground structures, performance requirement, culvert, retaining wall, seismic performance

1. Overview

The Ministry of Land, Infrastructure, Transport and Tourism is progressing with the formulation of design criteria that meet the performance requirements of roads. Technical criteria for road earthworks were introduced in FY2014, and clarified the performance requirements for road earthworks. At the NILIM, we are maintaining the technical conditions that meet the performance requirements for road earthworks. This research will examine the design conditions and methods required for designs that meet the performance requirements for underground structures (culverts, retaining walls, sheds, etc.).

2. Examination contents

(1) Examination of design method for box culverts

A box culvert placed in an embankment (we call it a culvert in the following) is designed using a conventional design method for a relatively small culvert according to a guideline[1]. In this design method, the verification of the effect of seismic motion can be omitted based on past accumulated experience. On the other hand, the structural damage conditions to satisfy the performance requirements for the underground structures were diverse, ranging from minor damage that is not a hindrance to traffic (performance level 1) to a condition where damage makes it necessary to close the road, but the hindrance is not critical (performance lever 3), as shown in Figure 1.

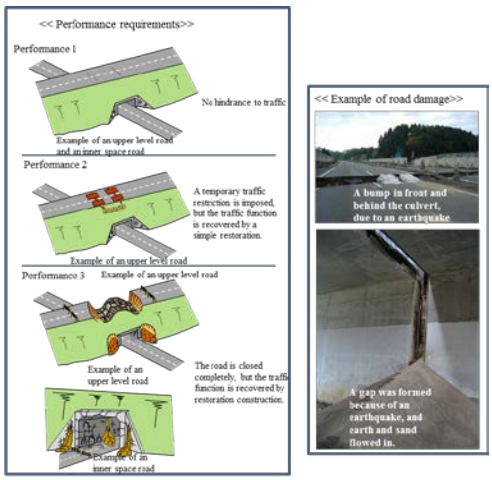


Figure 1 Relationship between performance requirements for culvert and damage

Therefore, it was necessary to clarify the design conditions and methods that can meet such performance requirements for underground structures.

In this study, we assumed that seismic motion (Level2 class) affects a culvert placed in an embankment. Then, to clarify by obtain an applicable range for the safety allowance and a design condition for the culvert itself, we evaluated the seismic response deformation of the embankment, and the propagation of strain in the culvert and soil around ….. , earthquake resisting for along with the interaction between them (Figure 2).

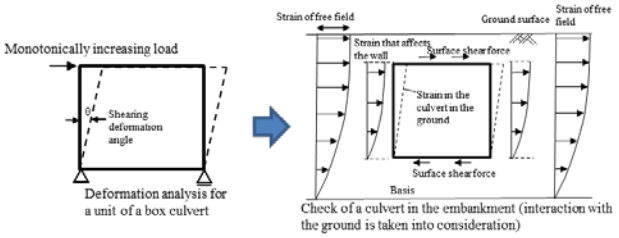


Figure 2 Schematic of deformation caused by interaction between culvert and embankment

Additionally, we examined the influences of various characteristics of box culverts (size, form, overburden, etc.) on the shearing deformation by seismic motion (Figure 3).

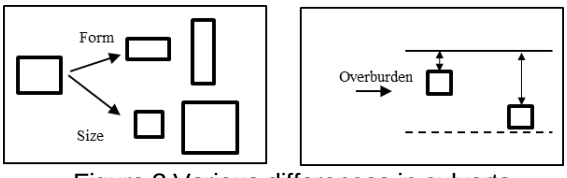


Figure 3 Various differences in culverts

(2) Examination of design methods for retaining walls and sheds

Similarly, to examine the design conditions while considering the performance requirements against seismic motion for a retaining wall, which is a structure that bears the earth pressure on its back under normal conditions, and a shed placed on the road along the slope that has a high risk of falling rocks, we are now

examining the influences on the stability of structures and the safety of components against an external force based on various regulations such as the Guideline of road civil engineering and construction of retaining walls, Specifications for highway bridges, and Handbook of measures for falling rocks.

3. Future plans

We plan to examine the design conditions during an earthquake that meet the performance requirements of civil engineering structures within the applicable range of the present guideline. In addition, we plan to examine the design conditions for earthquake cases and summarize examination results that can be useful for the design conditions of new types of underground structures that are outside of the applicable ranges of the guidelines, which are expected to increase in number in the future.

---

1) Guideline of road civil engineering and construction of culverts (March 2010, Japan Road Association) (in Japanese)

Development of function sustaining technologies for buildings used for disaster management

OKUDA Yasuo (Ph.D. in engineering), Research Managing Coordinator for Advanced Building Technology
ISHIHARA Akihiko, Research Coordinator for Disaster Mitigation of Building
GO Yuichiro, Head, Standards and Accreditation System Division
IWATA Yoshihiro(Ph.D. in engineering), Head Senior Researcher, Standards and Accreditation System Division
KABEYAZAWA Toshikazu (Ph.D. in engineering), Senior Researcher, Standards and Accreditation System Division
HIRAMITSU Atsuo, Head, Environment and Equipment Standards Division
WAKIYAMA Yoshio(Ph.D. in engineering), Senior Researcher, Evaluation System Division
Building Department

(Keywords) The Great East Japan Earthquake, disaster management base, tsunami, tornado, sustained use

1. Introduction

Learning from the damage caused by the tsunamis and earthquakes in the Great East Japan Earthquake and tornadoes that occurred in recent years, the four-year comprehensive technological development project titled the Development of Function Sustaining Technologies for Buildings used for Disaster Management started in FY 2013. Technologies are being developed in this project so that buildings to be used as the base for emergency responses will sustain their functions immediately after being hit by a disaster. This project aims to propose design technologies and evaluation methods to sustain the functions of buildings used for disaster management to prepare for the Nankai Trough Earthquake and massive earthquakes directly hitting Tokyo, which are expected to occur in the near future.

2. Development of earthquake resistant technologies

Teams in charge of the development of non-resonant ceiling materials are developing suspended ceilings that can withstand greater seismic motion based on conventional suspended ceiling construction methods. In FY 2015, the teams created examples of trial designs for ceilings based on experiments conducted in FY 2014. The teams also worked on guidelines (draft) for ceiling designs in buildings used for disaster management. The teams also tested damage control designs using walls in an actual-scale building in FY 2015. The tested building was a 1 by 2 span, about 19-meter-high, five-story building made of reinforced concrete.

Photo 1. Damage test using an actual-scale five-story building

The developed design used the walls (wing walls, hanging walls, retaining walls) around openings that were separated from pillars because of complicated computations in conventional structural designs. The test demonstrated that the developed design could increase the strength and rigidity of frames, reduce deformation during a massive earthquake, and reduce the damage to sections that are difficult to repair, such as joints of beams and pillars and non-structural members, at low cost.

3. Development of tsunami management technologies

Hydraulic tests were conducted in FY 2015 to develop low-resistant tsunami evacuation buildings that will effectively withstand tsunamis. Tsunamis in various conditions and constant flows were applied on a low-resistant building model (1/100 scale) constructed with specifically designed shapes and pillar arrangements, and experimental data on the tsunami loads were obtained. The study found that the low-resistant buildings effectively reduced loads of tsunami force and buoyancy of water.

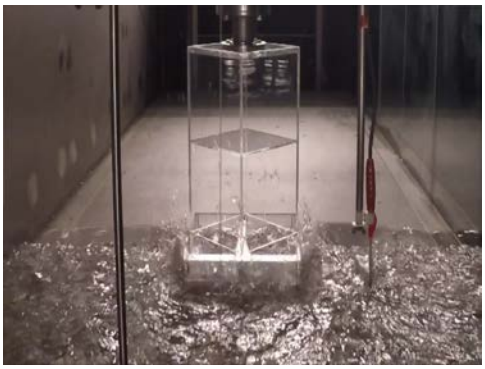


Photo 2. Hydraulic test using a low-resistant building model

4. Conclusion

Besides the studies above, the teams are also examining how facilities can sustain their functions when all lifelines are disconnected. The teams are going to prepare a designing guideline for buildings used for disaster management in FY 2016.

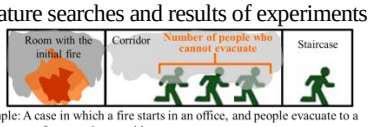
Method to calculate evacuation safety performance in a building fire

HAYASHI Yoshihiko (Ph.D. in Engineering), Head
SUZUKI Junichi (Ph.D. in Engineering), Senior Researcher
Fire Standards Division, Building Department

(Keywords) Evacuation Risk, evacuation safety performance

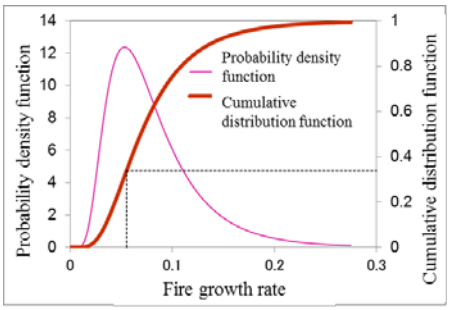
1. Introduction

The number of casualties is used as an index of building evacuation safety performance. The number of casualties can be obtained based on smoke spread predictions (unsteady two-layer zone model BRI2002) and evacuation predictions[1] (Fig. 1). Yet, the result varies greatly depending on fire scenarios, such as many casualties when the fire spreads rapidly and sprinklers and smoke exhaust systems are not activated. The result also varies depending on the time required for people in a building to start evacuating and how fast they walk. Thus, the research team developed a method to calculate the expected value (evacuation risk) from the number of casualties and the probability of onset with the expectation of all types of fire scenarios rather than setting a specific scenario. The calculation requires the probability density distribution of the fire growth rate and the probability of facilities to function. The study found these data through literature searches and results of experiments (Fig. 2).



Example: A case in which a fire starts in an office, and people evacuate to a staircase, a safe zone, via a corridor
In this example, the number of people who cannot evacuate (number of people exposed to smoke) is three.

Fig. 1 Number of casualties



*The fire growth rate is the parameter to determine the size of a fire.
The probability density function is required to compute the probability of the onset of any fire.

Fig. 2 Probability density distribution of fire growth rate

2. Examples of using calculation method of evacuation risk [2)]

When a fire occurs from Office 1 on a floor that is smaller than 3,000 m^2 (Fig. 3), people in the room evacuate to the corridor from the door that is farthest from the fire. People in rooms without a fire will start evacuating later but have access to all the doors (Fig.-3). Smoke from the room where the fire occurred spreads to the adjacent rooms via the corridor. Some people cannot evacuate if sprinklers do not work, depending on the fire scenarios, and the evacuation risk in this case becomes 0.013 (See the table.). The table shows the evacuation risks when the fire occurs from Offices 2 to 4. The total risk on the floor is 0.019 based on the risk in each room and the fire occurrence rate. (In proportion to floor area, the total fire occurrence rate is 1 because the occurrence of fire is the presumption of the risk calculation.) For example, the evacuation risk at a given floor decreases from 0.019 to 0.011 when the reliability for facilities to function improves (sprinkler: from 0.96 to 0.98, smoke exhaust system: from 0.9 to 0.95). The overall risk can be reduced by improving the reliability of facilities to function even when the ratio of people who are slow to evacuate increases, and the evacuation risk increases because of a slower walking speed or other conditions.

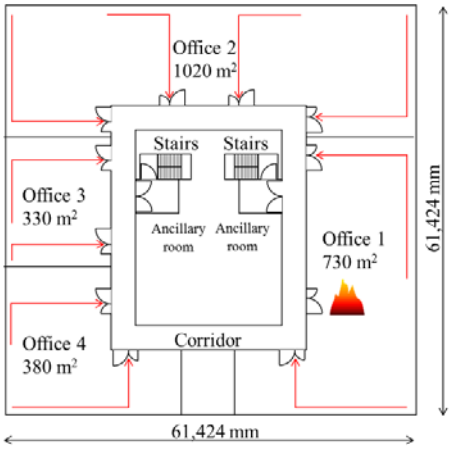


Fig.-3 Floor plan of offices used for calculation of risks

Table. Calculated Evacuation Risk

		Room of fire origin			
		Office 1	Office 2	Office 3	Office 4
SP	×	0.0114	0.0314	0.0020	0.0029
Ex	○				
SP	×	0.0016	0.0038	0.0004	0.0005
Ex	×				
Total		0.013	0.0352	0.0024	0.0034

SP: Sprinkler, Ex: Smoke exhaust system,
○: Proper activation (probability of function SP: 0.96, Ex: 0.9)
×: Failure to function; the risk 0 when the sprinkler works properly.

3. Future efforts

Fire prevention and evacuation regulations will be streamlined in the 2016-2020 General Technology Development Project. Proper standards will be set for target performances to establish regulations without producing a sense of burden. Quantitative examinations are required, and the calculation methods for the evacuation risk are expected to be useful.

1) New Building Fire Control Planning Policy by the Building Center of Japan (supervised by Japan Conference of Building Administration, Construction Supervision Division, Housing Bureau, Ministry of Construction). 1995
2) Hayashi Yoshihiko et al., Development of Risk of a fire Computation Tools for Buildings (in Japanese). Compilation of Academic Lectures, Conference of Architectural Institute of Japan. pp. 347-350, 2016

Development of earthquake resistance evaluation method for wooden houses using the information of three-dimensional CAD

NAKAGAWA Takafumi (Ph.D. in agriculture), Senior Researcher,
Material and Component Standards Division, Building Department

(Keywords) Wooden house, precut, three-dimensional CAD, earthquake resistance evaluation

1. Introduction

Eighty-five percent of new detached buildings are constructed based on the framework construction method, and 90% of those buildings are constructed using precut materials (a method to quickly assemble a house using materials that are precut in a factory). Fully automated mechanical processing using three-dimensional CAD and CAM are the mainstream tools for precutting. Design data of frameworks and joints are needed to evaluate earthquake resistance of wooden houses. The above data are created as three-dimensional data in CAD data for precutting. The data are thus highly compatible with the computation of allowable stress and stress analysis. The three-dimensional CAD data prepared for hundreds of thousands of houses every year are now being kept idle in precutting factories without being used for earthquake resistance evaluations. Figure 1 shows a standard flow of design and production of wooden houses. In actual operations today, building confirmation is given in the design phase, followed by the precutting process where structures, such as frameworks, are examined for the first time. If this flow is changed so that the three-dimensional data created in the precutting process are used for structural designs, it will streamline the process and enable the production of wooden houses with higher safety against earthquakes. This study focuses on structural drawings of CAD for wooden houses and three-dimensional CAD data created in the precutting process and examined methods to link them with earthquake resistance evaluation.

2. Linking ***wallstat*** with CEDXM

The study selected CEDXM file format, a common format of CAD for wooden houses as the target of studying three-dimensional CAD data. The study linked the data with the structural analytical software called *wallstat* (Fig. 2) that Building Research Institute of National Institute for Land and Infrastructure Management (NILIM) developed. As a result, the team released the new version of *wallstat* linked to CAD in June 2015 on the Internet. This enabled users to create analytical models through simple operations from CEDXM files created using various CAD software and run earthquake response simulations.

3. Conclusion

The outcome of this study can be downloaded from the website of NILIM. Movies are also available on YouTube (Search “wallstat” on YouTube.). The program will be improved in the future by reflecting opinions of users and the development team.

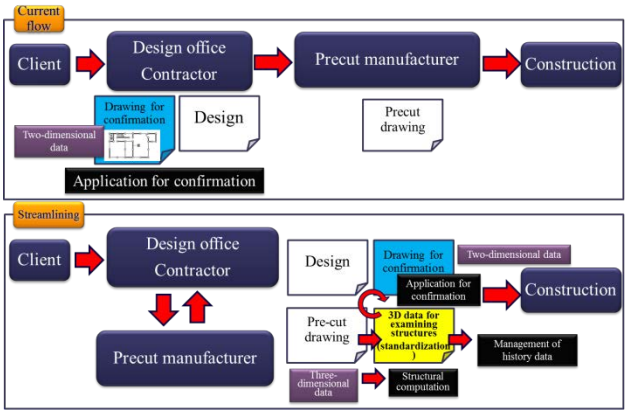


Figure 1 Production flow of a wooden house

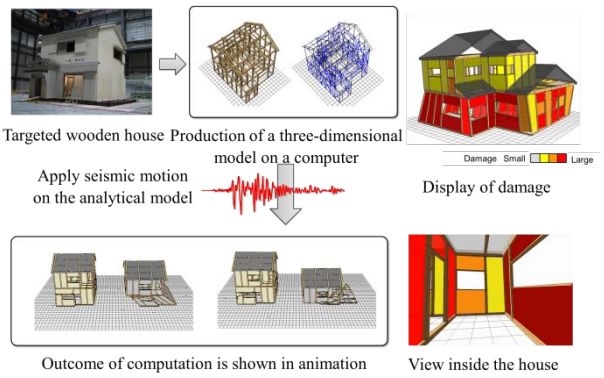


Figure 2. Overview of wallstat

☞For more information

1) Wooden house collapse analytical software, *wallstat*
http://www.nilim.go.jp/lab/idg/nakagawa/wallstat.html

Study of methods to evaluate and test external forces to verify structural performance of architectural structural members

WAKIYAMA Yoshio, Ph.D. (Engineering), Senior Researcher
INOUE Namihiko, Head
Evaluation System Division, Building Department

(Keywords) Glass screen, vibration characteristic, actual-scale vibration table test, strong-motion earthquake measurement

1. Background of the study

This study aims to develop technical references for structural performance verification by targeting non-structural members of buildings which are damaged by earthquakes, the field that have not been explored so much in past studies, and by examining methods to evaluate external forces that are generated during earthquakes. The study also aims to test structural performances of applicable members. The target of this study is the glass screen. Past studies have examined effects of forced deformation in the in-plane direction that is parallel to the glass surface. The damage probably caused by the effect of inertial force of resonance with swings in the off-plane direction that was orthogonal to the glass surface was reported in recent earthquakes. The study conducted an actual-scale vibration table test using glass screens and strong-motion earthquake measurement of a building that caused the force applied to the glass screen during an earthquake.

2. Examination of the vibration characteristics of glass screens

One test piece shown in Photo 1 was created for the actual-scale vibration table test. Types of vibrations applied in the off-plane direction included the sine wave excitation, random wave excitation to check vibration characteristics, and excitation with the wave observed during earthquakes. (Waves observed were on the ground-level floors because many reported damages were on ground-level floors of low-rise steel-frame buildings.)

The maximum excitation with observed waves was set at 250% of the north-south wave observed in Sendai by Japan Meteorological Agency during the 2011 Great East Japan Earthquake. Figure 1 is the plotting of the excitation level and maximum responses on the glass surface. The excitation level and maximum responses are mostly proportional up to about 10 mm of the maximum responses. The peak of the Fourier amplitude ratios of the responses is clearly shown at 6.1 Hz in ranges with small responses. Meanwhile, two peaks are seen for 250% excitation at 6.2 Hz and 6.6 Hz. The test indicated that the vibration characteristics on the glass surface changed with excitation levels.

3. Strong-motion earthquake measurement of low-rise steel frame building

Strong-motion earthquake measurement was conducted using a low-rise steel-frame building (one-story building with a two-story section in Ushiku, Ibaraki) to examine the vibration characteristics of a building that could generate force on the glass screens. Figure 2 shows the Fourier amplitude ratio observed during an earthquake (occurred at 14:28, May 25, 2015). The peaks in two orthogonal directions were at 3.30 Hz (0.30 seconds) and 2.77 Hz (0.36 seconds). The test found that the vibration characteristic had a natural period that was considerably greater than the natural period (0.12 seconds for a steel-frame building with the height of 4 meters) calculated using the simplified formula used for architectural designs.

4. Conclusion

The series of experiments and observations in this test were obtained targeting glass screens produced with certain specifications and low-rise steel-frame buildings. The team will apply these tests to more generalized targets in future studies.

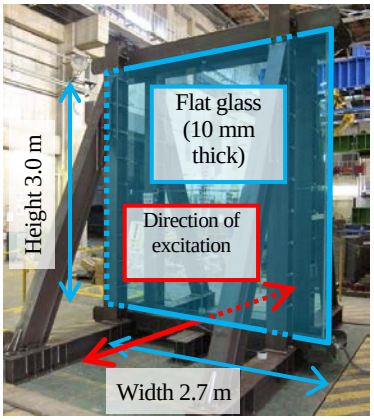


Photo 1. Test piece used for actual-scale vibration table test

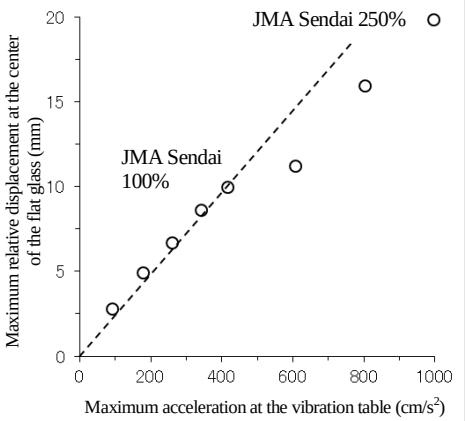


Figure 1. Relationship between excitation level and responses

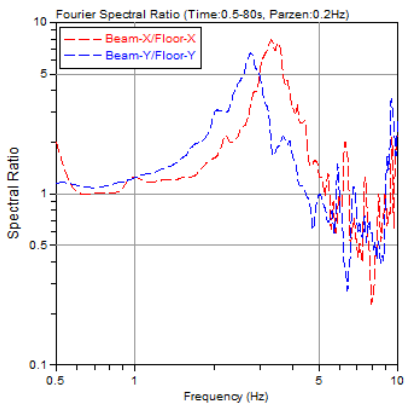


Figure 2. Responses of low-rise steel-frame building during an earthquake

Proposal on Coordination between Public Housing Construction and Provision of Welfare Services for Fukushima Nuclear Accident Evacuees in the Wake of the Great East Japan Earthquake

HASEGAW Hiroshi (Doctor of Engineering), Research Coordinator for Housing Performance
Housing Department

(Keywords) Fukushima Prefecture, nuclear accident evacuees, housing reconstruction, post-disaster public housing, coordination with welfare needs

1. Foreword

The nuclear accident at the Fukushima Daiichi Nuclear Power Plant of Tokyo Electric Power Co. (TEPCO) in the wake of the Great East Japan Earthquake forced the evacuation of a large number of residents. The construction of post-disaster public housing units is under way to provide permanent housing for planned long-term evacuees (those evacuees from Okuma-machi, Futaba-machi, Tomioka-machi, Namie-machi, and Iitate-mura among other places) within Fukushima Prefecture. The main characteristics of people who reside in post-disaster public housing are as follows: (i) They tend to be more elderly, (ii) they are relocated from temporary housing and come from wider areas, and (iii) they plan to live there for a long time but have to live with neighbors who are evacuees from other municipalities in the same housing complex or residential buildings. Therefore, it is critically important not only to address their hardware needs by making post-disaster housing units available to them, but also to address their soft welfare needs in parallel, such as providing livelihood support services and helping them establish their own new community. For this reason, in addition to providing technical assistance to the development of the post-disaster public housing supply plan, we have been studying ways to coordinate the supply of public housing and the provision of welfare services to residents.

2. Overview of Post-Disaster Public Housing Development

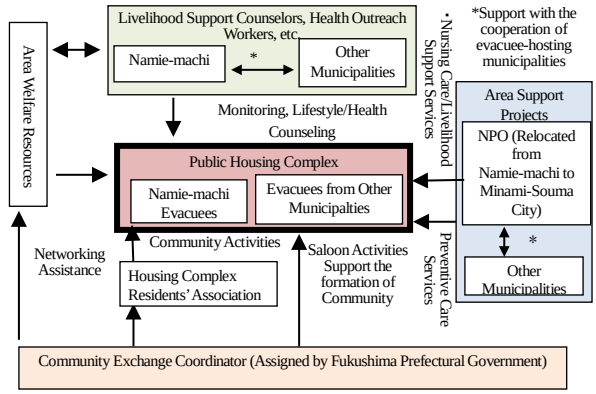
The supply of post-disaster public housing is primarily concentrated within Fukushima Prefecture, and as of the end of September 2015, a total of 4,948 public housing units plan to be supplied within Fukushima Prefecture, of which 836 public housing units have already been completed, and people have started moving in there. The number of municipal governments that supply post-disaster public housing within Fukushima Prefecture is 16, including Iwaki City (1,768 units), Minami-Souma City (928 units), Koriyama City (570 units), Fukushima City (475 units), and Nihonmatsu City (346 units).

3. Case Study of Scheme of Providing Livelihood Support Services to Namie-machi Evacuees who will Live in Post-Disaster Public Housing

All of approximately 21,000 residents of Namie-machi had to evacuate their homes and appropriately 15,000 evacuees currently reside in Fukushima Prefecture (as of the end of December 2015). A larger number of Namie-machi evacuees have expressed their desire to relocate to post disaster public housing units that are to be constructed in Minami-Souma City, Nihonmatsu City, Iwaki City, and Motomiya City among other places. Because of this, we investigated the actual availability of welfare resources and the plan to provide them in these evacuee-hosting municipalities, as well as Namie-machi, and have subsequently developed and proposed a livelihood support services provision scheme by district in which post-disaster public housing will be constructed. Two patterns of livelihood support services provision scheme—one for residents of post-disaster public housing in Minami-Souma City, and the other for those in Nihonmatsu City—are summarized in the table.

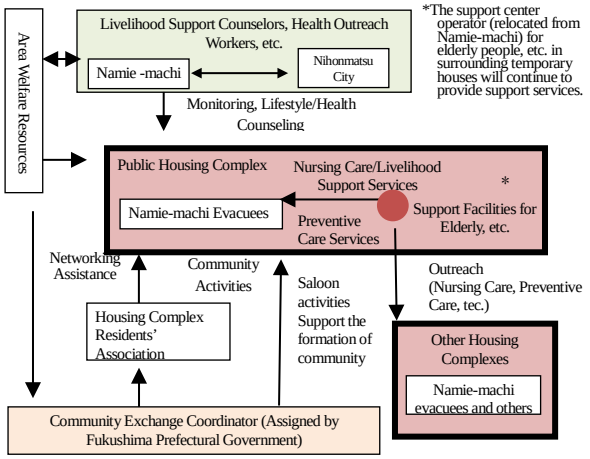
Table. Proposed Livelihood Support Services Provision Schemes for Residents of Post-Disaster Public Housing

[Public Housing Location] Minami-Souma City
[Incoming Residents] Namie-machi Evacuees and Evacuees from Other Municipalities



The NPO with its secretariat function based in Minami-Souma City will provide nursing care, preventive care and other livelihood support services to Namie-machi evacuees. It will provide such support services to evacuees from other municipalities as well (A mechanism for cooperative utilization of welfare resources of Namie-machi and other related municipalities needs to be established.) Monitoring of elderly residents and other services will be provided on their own in the case of post-disaster public housing complexes populated by Namie-machi evacuees alone. In the case of post-disaster public housing complexes populated by Namie-machi evacuees as well as evacuees from other municipalities, a mechanism for providing integrated services will be established by the relevant post-disaster public housing complexes with cooperation of the evacuee-hosting municipalities.

[Public Housing Location] Nihonmatsu City
[Incoming Residents] Namie-machi Evacuees Only



In post-disaster public housing complexes where the support center function for elderly people, etc. in temporary houses will be relocated, JIN, an NPO, will operate such support center function and provide nursing care services (such as day-care services), preventive care services and other livelihood support services. From this as a base, JIN will provide outreach support services, such as preventive care services, to residents of other post-disaster public housing in Nihonmatsu City and other surrounding municipalities. Monitoring of elderly residents will be performed in cooperation between Namie-machi and Nihonmatsu City, an evacuee hosting municipality.

Not only Namie-machi evacuees but also a large number of evacuees from other municipalities are expected to live in post-disaster public housing to be constructed in Minami-Souma City. The welfare non-profit organization (NPO), which was relocated from Namie-machi to Minami-Souma City because of the nuclear power plant accident, is expected to provide livelihood support services, such as nursing care and preventive care services. Monitoring of elderly residents will be provided by Namie-machi with the cooperation of other related municipalities. On the other hand, post-disaster public housing to be constructed in Nihonmatsu City will be mostly populated by Namie-machi evacuees. Support facilities for the elderly will be constructed in some of the post-disaster public housing complexes there, and these support facilities will cater to residents' needs in these and other surrounding public housing complexes. Monitoring of elderly residents will be provided in cooperation between Namie-machi and Nihonmatsu City.

4. Next Steps

We will further review and upgrade the proposed livelihood support services provision schemes by deepening our discussions with municipalities governing those areas whose residents had to evacuate as well as evacuee-hosting municipalities to ensure that these schemes will be successfully implemented.

Overview of Master Plan for Post-Disaster Public Housing Development in the Wake of the Great East Japan Earthquake and Background for Master Plan Development

HASEGAWA Hiroshi (Doctor of Engineering), Research Coordinator for Housing Performance, Housing Department
SATO Hideaki, Head, Housing Stock Management Division
MENO Fumitake (Doctor of Engineering), Senior Researcher, Housing Planning Division

(Keywords) The Great East Japan Earthquake, post-disaster public housing, master plan, background for master plan development

1. Foreword

Since fiscal year 2011, surveys for the promotion of post-disaster public housing supply in the wake of the Great East Japan Earthquake have been conducted under the direct control of the Housing Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) (hereinafter called "MLIT's Direct Survey"). NILIM, together with the Building Research Institute, has provided on-site technical guidance during MLIT's Direct Surveys. The pace of recovery and reconstruction from the Great East Japan Earthquake varies considerably among municipalities. By using the same formats, we summarized master plans for post-disaster public housing development for more than 150 areas that have been developed based on the results of MLIT's Direct Surveys conducted up to and including fiscal year 2013, together with the background for master plan development.

2. Overview of Master Plan for Post-Disaster Public Housing Development

Trends in the number of areas for which the master plan was developed based on the results of MLIT's Direct Surveys are shown in **Figure 1**.

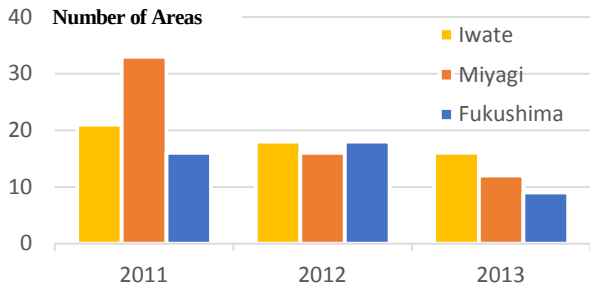


Figure 1. Number of Areas by Prefecture and by Fiscal Year for which the Master Plan Was Developed

The master plans were organized by using the following four sheets: Municipality Information Sheet, Municipality Study Background Sheet, Area Information Sheet, and Area Master Plan Study Background Sheet (for each individual area) (see **Figure 2**).

In order to clarify the background for studying the development of master plans, among other things, the status of post-disaster public housing development and other necessary information were included in the Municipality Information Sheet, and the overall background for studying the development of master plans by fiscal year was described in the Municipality Study Background Sheet. In addition, issues by fiscal year were described in detail in the Area Master Plan Study Background Sheet.

3. Background for Studying Master Plan Development

In developing the master plans for many areas, we consulted with not only municipal governments, but also relevant prefectural governments, the Urban Renaissance Agency, and consultants in charge of the area's surface maintenance projects. Main consultation subjects are as shown in **Figure 3**.

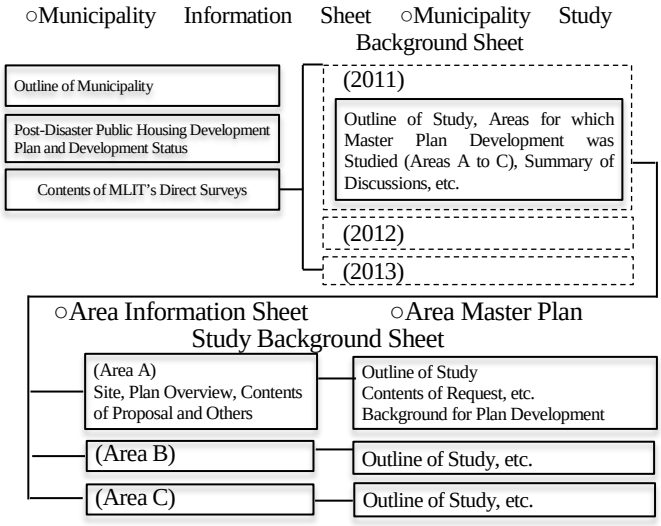


Figure 2. Composition of Sheets

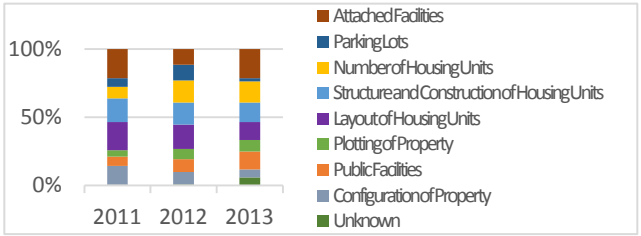


Figure 3. Main Consultation Subjects by Fiscal Year

4. Utilization of Study Results

All the necessary details of the master plan development, including the status of reconstruction of municipalities and the background for plan development, are summarized using the same formats. Municipalities are encouraged to utilize these study results for reference when developing both ex-ante and ex-post measures to support the supply of post-disaster public housing when a large-scale disaster occurs.

☞For further information, please refer to the following:
1) NILIM document No.846.
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0846.htm

Studying the Process for Reconstruction Planning for Tsunami-Stricken Cities Following the Great East Japan Earthquake

KIUCHI Nozomu (Doctor of Engineering), Head, Urban Planning Division, Urban Planning Department
MENO Fumitake (Doctor of Engineering), Senior Researcher, Housing Planning Division, Housing Department
YOSHIDA Jundo, Senior Researcher, Urban Facilities Division, Urban Planning Department

(Keywords) The Great East Japan Earthquake, reconstruction of communities, planning process

1. Foreword

Five years after the Great East Japan Earthquake ("the Earthquake"), we started to see the emergence of reconstructed urban areas in some of the cities devastated by the tsunami (seismic sea wave) triggered by the Earthquake. Following the Earthquake and the tsunami, with huge affected areas, there have been many issues that need to be addressed, such as the necessity of selecting areas for reconstruction of communities, development of new preventive measures against tsunamis, development of plans for the utilization of land in coastal regions devastated by the tsunami, and provision of accommodation for tsunami victims, among other things. These and other issues have been intricately intertwined with one another, thereby making the current reconstruction project unprecedentedly large-scale and complex in the history of post-disaster reconstruction programs. We have investigated the process for the development of the reconstruction plan based on case studies.

2. Process for Studying and Development of Reconstruction Plan

An outline of the process for the studying and development of a reconstruction plan for a certain tsunami-stricken city that took four years to complete immediately following the Earthquake and the tsunami is shown on the chart at the bottom right. A common process for the study and development of a reconstruction plan is as follows:

(1) Development of the Plan for Construction and Improvement of Sea Embankments: A prefectural government to study and determine the installation of sea embankments (seawalls) with the basic objective of defending against Level 1 (L1) tsunamis.
(2) Adoption of Method for Achieving In-Depth Defense[1]: Study methods for achieving in-depth defense of urban built-up areas and the specific location and configuration of such in-depth defense facilities by simulating level 2 (L2) tsunamis and the current tsunami event.
(3) Securing of sites for relocation housing: Study the location (upland, inland) and size of sites for relocation of residential built-up areas that cannot be fully protected with in-depth defense systems.
(4) Development of Reconstruction Plan for Tsunami-stricken Built-up Areas: Study the specific project method[2] for the reconstruction of tsunami-stricken built-up areas and the development of plans and procedures for related infrastructure development and land utilization, through discussions and coordination with residents, landowners, and leaseholders.
(5) Development of Post-Disaster Public Housing: Study plans for development, construction, and landscaping of post-disaster public housing and public buildings in tsunami-stricken built-up areas that are to be reconstructed.

3. Characteristics of Process for Studying and Development of Reconstruction Plan

Of the above reconstruction planning process from (1) to (5), planning and coordination stages of (1) through (3) are a new addition to the post-quake reconstruction planning process in the case of the Great Hanshin-Awaji Earthquake. Although an outcome from each of stages (1) through (4) should be a precondition for planning at each of the succeeding stages in an effort to draw a conclusion earlier, studies in the later stages of the process began earlier based on then available information while planning was still in progress at the preceding stages, and there was hardly any room to go through the feedback stage.

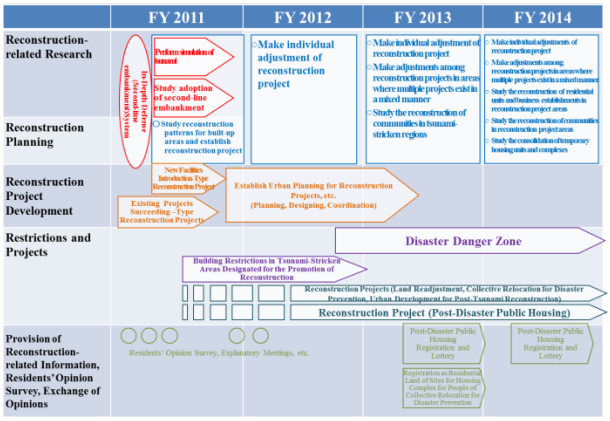


Chart. Process for Studying and Development of Reconstruction Plan for Case Study City

In addition, the development of in-depth defense systems and securing of sites for relocation housing were studied and planned on a priority basis. As a result, the studying and development of the concept of an appropriate urban structure and the population frame, which should typically be performed at first when developing an urban master plan, was pushed back to later.

4. Conclusion

We will summarize and publish our study results in the form of NILIM documents in the near future.

---

(1) The method for achieving an *in-depth defense*, which is designed to protect the life and property of people by employing multiple protection measures, is explained as follows: (a) construct sea embankments (seawalls) as the first-line embankment, (b) in order to defend against tsunamis that go over these embankments, install the second-line embankment by constructing raised roads or elevating the ground, among other things, and relocate residential houses in areas that cannot be protected with these measures to developed lands in upland or inland regions, and designate such areas as disaster danger zones and convert lands in the areas to non-residential use, and (c) in addition, further bolster a tsunami detection, warning and evacuation system and further enhance evacuation facilities.

(2) Such project methods as a land readjustment project, a project for promoting collective relocation for disaster prevention, and an urban development project for post-tsunami reconstruction are mainly applied and employed in urban areas.

Effects of Snow and Cold Weather on the Operation of Evacuation Facilities

TAKEYA Shuichi (Doctor of Engineering), Head, Urban Disaster Mitigation Division, Urban Planning Department

(Keywords) Snowfall, cold weather, evacuation facilities

1. Foreword

When a disaster strikes, many disaster victims are forced to live in evacuation facilities. If a disaster occurs during winter in snowy cold regions, it is easily assumed that things will be very much different because of the snow and cold weather than when it occurs during the summertime.

NILIM has been engaged in studying ways to further strengthen disaster prevention measures in preparation for disasters that occur during winter months. Here in this paper, I would like to present the status of our study regarding the effects of snow and cold weather on the operation of evacuation facilities.

2. Characteristics of Snowy Cold Regions

In heavy snowfall regions such as Niigata Prefecture, as winter snowfall is extremely heavy, roads tend to become impassable or the pace of traffic on roads tends to become extremely slow after a heavy snowfall due to delayed snow removal, and open space areas tend to become unusable as they are fully covered by snow. Also, in cold weather regions such as Hokkaido, it is not uncommon for the outside temperature to fall below zero degrees Celsius, and the people's lives may be in danger without heating equipment, and roads and walking areas may become icy, which results in constraining people's movement and road transport (see Photos 1 and 2).

Photo 1. Winter Conditions in Heavy Snowfall Region (Niigata Prefecture)

Photo 2. Winter Conditions in Cold Weather Regions (Hokkaido Prefecture)

3. Constraints on the Operation of Evacuation Facilities during Winter

Using as case studies schools in Hokkaido and Niigata Prefecture that will be used as evacuation facilities in the event of a disaster, we studied the effects of snow and cold weather on the operations of evacuation facilities from the standpoint of constraints on space, movement, and habitability. During the course of our study, we held workshops with the participation of experts in the relevant fields.

As a result of our study, it has been found, as shown in Table 1, that different problems may arise during winter from those that may be encountered during summer. For example, (i) the amount of usable open space will be reduced because of snowfall, thus resulting in constraining outdoor activities, (ii) icy roads may make it difficult for people to evacuate or may cause a delay in the delivery of relief supplies, and (iii) the intrusion of snow into indoor spaces may make the indoors dirty or may make it difficult to use heating equipment.

4. Conclusion

We will publish, through NILIM's website and other means, key points that need to be taken into account concerning the operation of evacuation facilities during winter, which have been identified during the course of studying ways to further strengthen disaster prevention measures during winter months.

Table 1. Examples of Challenges in Operating Evacuation Facilities during Snowfall/Cold Weather Season

Constraints	Challenges
Constraint on Space	- Lack of parking space due to snowfall or ice in open space areas, such as schoolyards - Difficult to set up a tent or prepare meals outdoors - Difficult to secure space for temporary bathrooms or baths
Constraint on Movement	- Icy roads may make it difficult for people to move to and from an evacuation center, may cause a delay in the opening of an evacuation center, or may cause accidents when moving to and from an evacuation center, among other things. - Snowfall on roads or icy roads may cause a delay in the delivery of relief supplies.
Constraint on Habitability	- The slush and snow on evacuees' shoes and/or clothes may make the living space dirty. - Unable to use heating equipment because of a stoppage of essential utilities - Dry or frigid weather may cause damage to the health of evacuees.

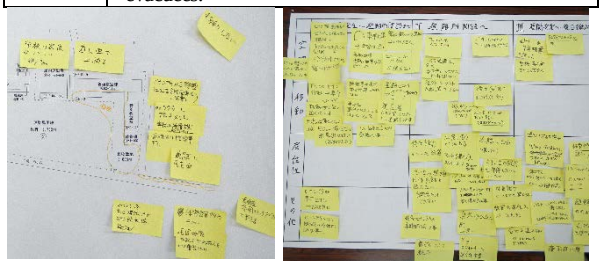


Photo 3. Study Items during Expert Workshop

Evaluation of urban fire control performance in inclined built-up areas

TAKEYA Shuichi (Dr. of Engineering), Head
Urban Disaster Mitigation Division, Urban Planning Department
ITOU Keita, Guest Research Engineer
KIUCHI Nozomu (Dr. of Engineering), Head, Urban Planning Division
KATSUMATA Wataru (Dr. of Engineering), Head, Urban Development Division
YOSHIOKA Hideki (Dr. of Engineering), Senior Researcher
Building Department Material and Component Standards Division

(Keywords) Urban fire, sloped urban areas, urban fire control performance

1. Introduction

Various fire control measures have been implemented in Japan. In recent years, Local governments are especially focusing on organizing dense urban areas that are high-risk areas of fire. Methods to evaluate fire control performances of cities have also been developed, but these activities have not examined effects of terrains.

Thus, the National Institute for Land and Infrastructure Management (NILIM) has been developing methods to evaluate fire and fire evacuation safety while taking into account the terrains and road conditions on hills. This paper introduces the progress of the examination of how slopes affect how fast fire spreads

2. Characteristics of hilly urban areas

Buildings are constructed along terrains features of hilly urban areas. Thus, characteristics of such areas include buildings constructed in step-like arrangements, retaining walls, not many roads where cars can drive on, many roads in step-like arrangements, and narrow roads. Thus, fire is expected to spread differently, and people evacuate from fire differently from flat terrain. Yet, actual differences are not clearly known.

Photo 1. Hilly urban areas

3. Characteristics of the speed of spreading fire on hills

To clarify differences in the speed of spreading fire based on inclination, the study arranged five eight-by-eight-meter buildings side by side with three-meter intervals between them and 13 of them on the vertical direction (direction of the slope). The study also set up hypothetical cities on 0 to 30% grades to estimate how fire spreads in simulated urban fire.

The simulation with a scenario that fire started from the center of the hypothetical city on 0% grade with no wind (Fig. 1) indicated that the fire arrived at the buildings at the top and the bottom of the slope 157 minutes after the start of the fire. Meanwhile, when the grade was 20% (Fig. 2), the fire arrived at buildings at the top of the slope 163 minutes after the start of fire. Based on this simulation, the fire tends to spread more slowly when there is a slope compared to when the terrain is flat. In terms of the spread of fire toward the bottom, the fire has not arrived at the two rows of buildings at the bottom. Thus, the speed of the spread of fire tends to be slower with a slope.

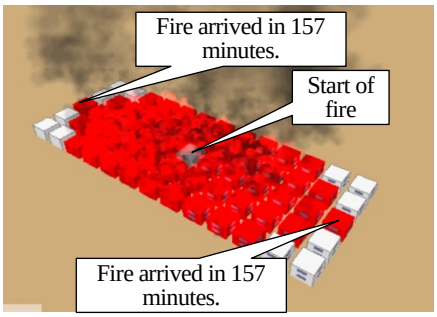


Figure 1. Spread of fire when buildings at the fire arrives at buildings at the top of the slope (0% grade)

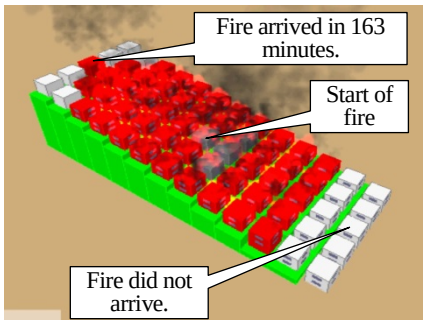


Figure 2. Spread of fire when buildings at the fire arrives at buildings at the top of the slope (20% grade)

4. Conclusion

The team is going to explore how fire spreads and the conditions of fire evacuation depending on the slopes using larger hypothetical cities to conduct case studies using actual cities.

Simple method to evaluate the effect of improving the disaster mitigation effect of redeveloping dense urban areas

KATSUMATA Wataru (Ph.D. in engineering), Head
Urban Development Division, Urban Planning Department
TAKEYA Shuichi (Ph.D. in engineering), Head
Urban Disaster Mitigation Division, Urban Planning Department

(Keywords) Dense urban areas, redevelopment of urban areas, risk of spreading fire, difficulty of evacuation, simple evaluation method

1. Introduction

The basic housing plan (nationwide plan) (cabinet decision passed on March 15, 2011) states a target to eliminate most of about 6,000 ha of dense urban areas that are especially vulnerable in disasters, such as earthquakes (hereinafter referred to as "high-risk dense urban areas," Fig. 1) by 2020. It is an urgent task to accelerate the redevelopment of dense urban areas.

This paper introduces the overview of the simple evaluation sheet to measure the effect of improving disaster mitigation effects in relation to the risk of spreading fire and the difficulty of evacuation that the National Institute for Land and Infrastructure Management (NILIM) developed to assist local governments to effectively and efficiently redevelop dense urban areas.

2. Development of the simple evaluation sheet to measure the effect of improving disaster mitigation effects

(1) Objective

High-risk dense urban areas are found based on unique criteria of individual local governments based mainly on (1) risk of spreading fire (how easily fire spreads among buildings) and (2) difficulty of evacuation (difficulty of evacuation caused by obstacles in evacuation routes caused by collapsed buildings). The evaluation uses macro disaster mitigation indexes (risk of spreading fire: ratio of fire-proofed areas, resistance against spreading fire, ratio of wooden buildings, and density of houses) that are obtained by entering data of physical properties, such as buildings and roads, of an area into computation formulas. These indexes are also used to keep track of the progress of urban redevelopment projects.

The computation formulas are complicated. Thus, it is difficult to quickly identify what kind of development should be implemented and to what extent to secure basic safety in an area and what kind of redevelopment methods are suitable and effective for a given area with restricted financial resources. The simple evaluation sheet was thus developed to enable the identification of future trends of the macro disaster mitigation indexes, including the risk of spreading fire and difficulty of evacuation in an area based on redevelopment plans for public facilities and buildings.

(2) Characteristics of the simple evaluation sheet to measure the effect of improving disaster mitigation effects

The simple evaluation sheet to measure the effect of improving disaster mitigation effects is the computation sheet based on Microsoft Excel. It has the following functions.

- Computation of macro disaster mitigation indexes at a given time in the future obtained by entering annual development plans
- Preparation of graphs showing trends of macro disaster mitigation indexes of each year based on details of development (e.g. re-construction of buildings and widening of roads)
- Computation of annual development cost and other conditions in a given year
- Preparation of graphs showing the relationship between project cost and macro disaster mitigation indexes for specific development (Fig. 2)

3. Conclusion

The simple evaluation sheet to measure the effect of improving disaster mitigation effects is going to be provided to local governments. The local governments are expected to use the sheet as a tool to manage the progress of redevelopment to eliminate high-risk dense urban areas and to find effective redevelopment methods to suit regional characteristics.

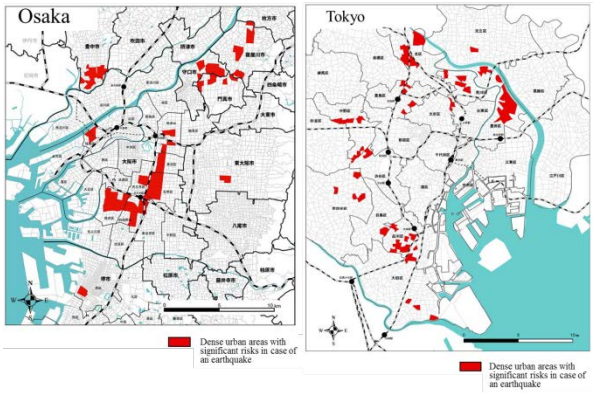


Fig. 1. Distribution of high-risk densely populated urban areas (left: Osaka, right: Tokyo)

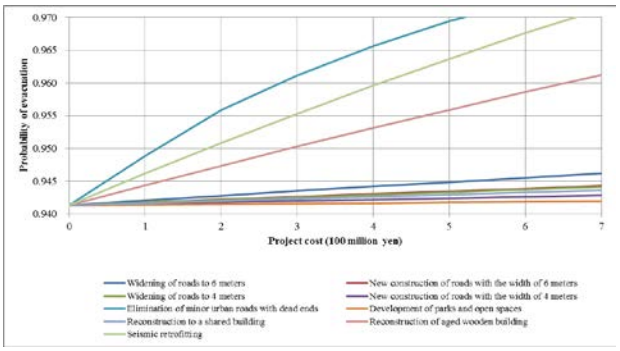


Fig. 2. An example of the relationship between the project cost by development type and the improvement of the probability of evacuation

A Case Study on Natural Disaster Prevention and Reduction by Green and Open Spaces

KURIHARA Masao, Head,
ARAGANE Keita, Researcher
Landscape and Ecology Division, Research Center for Land and Construction Management

(Keywords) The Great East Japan Earthquake, disaster-prevention park, emergency evacuation from tsunami, support for Stranded Evacuees

1. Foreword

Following the Great Hanshin-Awaji Earthquake, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) published the Guideline for Planning and Designing Disaster-Prevention Parks (Draft) (hereinafter referred to as the "Draft Guideline") in 1999, and in line with this Draft Guideline, MLIT has been promoting the construction of disaster-prevention parks, which can serve as an evacuation site, as well as a base for disaster-prevention activities, among other things, if a fire breaks out in built-up areas as a result of an earthquake.

On the other hand, new roles that disaster-prevention parks should play, as well as issues with disaster-prevention parks in performing disaster prevention and mitigation functions, have been identified as a result of recent disaster events such as the Great East Japan Earthquake. It is essential to ensure that these lessons learned will be fully incorporated when planning and designing disaster-prevention parks going forward. For the purpose of this study, we collected, through literature searches and other means, and analyzed the case examples of recent large-scale disaster events in which a disaster-prevention park's green spaces played an effective role in preventing or mitigating the impact of the disasters. Accordingly, in cooperation with MLIT's City Bureau, we revised the Draft Guideline.

2. Collection and Organization of Materials

We collected published research papers and materials published by local governments and other documents with the primary focus on the Great East Japan Earthquake. From case examples of utilization of disaster-prevention parks and their issues at the time of an earthquake, we organized information related to the green spaces of disaster-prevention parks. To collect the necessary information, in addition to ordinary literature searches, we also utilized databases such as the regional disaster prevention plan database (held by the Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications) and the NDL Great East Japan Earthquake Archive *Hinagiku* (held at the National Diet Library).

3. Revision of Draft Guideline

Based on our findings through the collection and organization of information as described in **2** above, we revised the Draft Guideline. The key point of the revision is to assign the following new roles to disaster-prevention parks, that is, to serve as an emergency evacuation site for tsunami evacuees and as a base for providing assistance to evacuees who are stranded and unable to return home at the time of a tsunami (hereinafter referred to as "stranded evacuees") (see **Photos 1** and **2**).

In terms of the function of a disaster-prevention park to serve as an emergency evacuation site for tsunami evacuees, we clarified the key points that need to be taken into account in designing disaster prevention parks to ensure prompt and safe evacuation by presenting our way of thinking on the location of disaster-prevention parks with a focus on elevation and accessibility and by defining a miniature hill that could provide emergency safe havens to tsunami evacuees as one of the disaster prevention facilities of disaster-prevention parks (see **Photo 3**).

In terms of providing support to stranded evacuees, we defined a *place of support to help stranded evacuees go home* as one class of the disaster prevention parks and presented our way of thinking on the location and facilities of such disaster prevention parks.

Photo 1. Example of Upland Providing Safe Haven for Tsunami Evacuees (Hiyoriyama Park in Ishinomaki City, Miyagi Prefecture)
Source: Geospatial Information Authority of Japan's (GSI) Website

Photo 2. Example of Accommodating Stranded Evacuees in Disaster-Prevention Park Facilities in the Wake of the Great East Japan Earthquake (Hibiya Park in Chiyoda-ku, Tokyo)
Source: The College of Midori to Mizu (Green and water) for Citizens

Photo 3. Example of Miniature Hill Created to Provide Safe Haven for Tsunami Evacuees (Central Park in Kamisu City)

4. Conclusion

The Draft Guideline is available for viewing on NILIM's website (http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0857.htm). We encourage park and community renovation-related departments and agencies of local governments, as well as construction consultants among other related parties, to fully utilize the Draft Guideline to further promote the effective development and improvement of disaster-prevention parks.

Empirical Study on B-DASH Project (Hydrogen production / energy saving water treatment / biogas collection / CO_2 recovery / reclaimed water utilization)

YAMASHITA Hiromasa, Head, TAJIMA Atsushi, Senior Researcher, SHIGEMURA Hiroyuki, Senior Researcher, MATSUMOTO Ryu, Researcher, HAMADA Tomoyuki, Researcher, OGOSHI Masashi (Dr. Eng.), Researcher, MAEDA Kotaro, Guest Research Engineer, HORII Yasuo, Guest Research Engineer

Wastewater and Sludge Management Division, Water Quality Control Department

(Key words) sewerage, energy saving, resource saving, cost reduction, greenhouse gas, innovative technology

1. Introduction

Sewerage is social capital essential to public life and, utilization of its potential, such as utilization of sewage sludge and sewage heat as energy and utilization of phosphorus as resource, is increasingly sought in addition to the measures for reducing global warming gases in order to respond to the issues of global warming and the tight supply of resources and energy.

To respond to such social request and administrative needs, new technologies are being developed but are less used in practice and many sewerage service providers are cautious about introduction. For this reason, the Sewerage and Waste Water Management Department of the Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") launched the "Breakthrough by Dynamic Approach in Sewage High Technology" (B-DASH) project in fiscal 2011, and the Water Quality Control Department of NILIM serves as an executing agency of this empirical project. The objective of B-DASH is to realize cost reduction in sewerage projects, creation of renewable energy, etc. through the verification and dissemination of excellent innovative technologies and to support the overseas development of the water business by Japanese enterprises.

2. Outline of B-DASH Project

Under B-DASH Project, the NILIM contracts out studies on innovative technologies, which are solicited to the public and adopted by expert review, to research organizations (contractors), which construct a full-scale plant in their sewage treatment facilities to verify stability of treatment, applicability of the technologies, cost reduction / energy saving effect resulting from introduction of the technologies, etc. Based on the results of such verification, the NILIM formulates guidelines for introduction of the technologies. For study results, formulation of guidelines, etc. of the research, advice and evaluation are obtained from experts.

The paper introduces the outlines of empirical studies "Technology for producing hydrogen from biogas" and "Energy-saving water treatment technology," which were both adopted in fiscal 2014 and are under verification, and "Technology for separation / collection / utilization of CO_2 contained in biogas," "Biogas collection / utilization technology," and "Recycled water application technology," which were adopted in fiscal 2015 and have started verification.

3. Outline of verification technologies adopted in fiscal 2014

(1) Technology for producing hydrogen from biogas

○Empirical study on the technology for producing hydrogen from sewage biogas raw material (Joint Research Organization of Mitsubishi Kakoki Kaisha, Ltd., Fukuoka City, Kyushu University, and Toyota Tsusho Corp.)

This study aims to establish a system for efficiently producing hydrogen from sewage biogas with combination of technologies for biogas pretreatment, hydrogen production, and hydrogen supply, and is verifying feasibility of commercialization by evaluating the performance of the hydrogen production technology in combination with the membrane separation method, quality of hydrogen to be supplied, etc. (Figure 1)

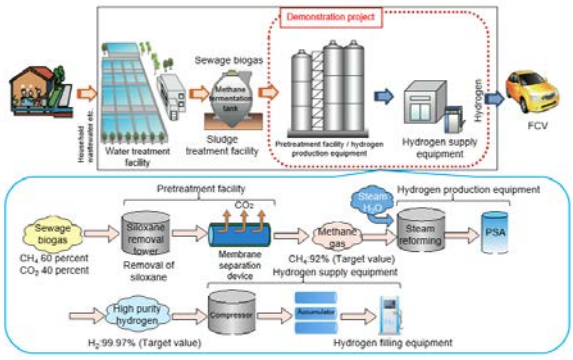


Figure 1: Hydrogen production technical flow

(2) Energy-saving water treatment technology

(i) Empirical study on the energy-saving water treatment technology using the high efficiency solid-liquid separation technology and the Dual DO control technology (Joint Research Organization of Maezawa Industries, Inc., Ishigaki Co., Ltd., Japan Sewage Works Agency and Saitama Prefecture)

This study is verifying stable nitrogen removal effect, energy saving effect from optimization of aeration air flow, etc. by removing solid matter in sewage influent with high efficiency and space saving using the high efficiency solid-liquid separation technology and by forming an aerobic zone / anoxia zone with the technology of controlling DO (dissolved oxygen) at two points in the circulating channel prepared by altering the existing channel (Figure 2).

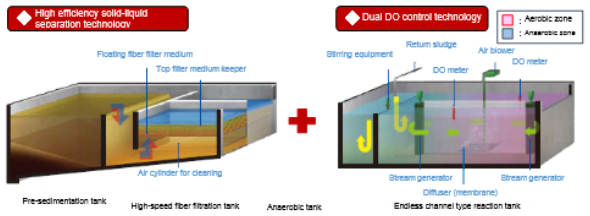


Figure 2: High efficiency solid-liquid separation technology and Dual DO control technology

(ii) Empirical study on non-aerated circular water treatment technology (Joint Research Organization of Metawater Co., Ltd., Kochi City, Kochi University, and Japan Sewage Works Agency)

This study is verifying the energy saving effect, etc. as the result of securing stable water quality and of reducing ventilation energy similar to that obtained by the conventional activated sludge process by conducting suspended solid / BOD removal using suspended carrier (pre-stage filtration facilities), BOD removal using microbe-attached carrier in the non-aerated oxygen supply system (High-speed carrier filter bed), and secure suspended solid removal (final filtration facilities) and by circulating biological treatment water (Figure 3).

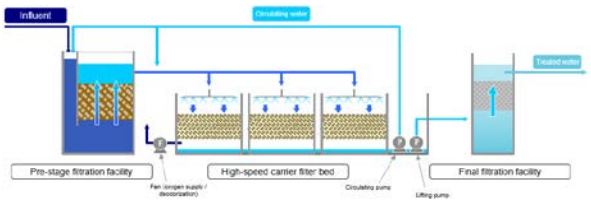


Figure 3: Non-aerated circular water treatment technology

4. Outline of verification technologies adopted in fiscal 2015

(i) Empirical study on the technology for separation / recovery of CO_2 in biogas and application to microalgae culture (Joint Research Organization of Toshiba Corp., Euglena Co., Ltd., Nikkan Tokushu K.K., Nihon Suido Consultants Co., Ltd., Japan Sewage Works Agency, and Saga City)

This study verifies the performance of CO_2 separation / recovery, performance of producing euglena, performance of removing nitrogen and phosphorus in dehydrated separated liquid, business potential of the entire system, etc. by separating / recovering CO_2 from biogas and culturing euglena using the recovered CO_2 and dehydrated separated liquid, etc.

(ii) Empirical study on the technology for efficient collection of biogas from multiple sewage treatment facilities and utilization (Joint Research Organization of JNC Engineering Co., Ltd., Adsorption Technology Industries Ltd., Kyudenko Corp., Sinko Co., Ltd., Yamaga City Gas Co., Ltd., Prefectural University of Kumamoto, Yamaga City, Otsu Town, and Mashiki Town)

This study verifies the effect of cost reduction, energy production, etc. from power generation using surplus biogas in small-scale sewage treatment facilities at three locations, which are refined and kept in storage vessels and conveyed by vehicle to one location.

(3) Empirical study on the regeneration system for sewage treatment water (Joint Research Organization of Nishihara Environment Co., Ltd., Tokyo Engineering Consultants Co., Ltd., Kyoto University, and Itoman City)

This study verifies the technology for utilizing safe, energy-saving, and economical reclaimed water by combining UF film (filtration film with the pore diameter of 0.01 μm), and ultraviolet disinfection.

2. Future development

The NILIM is going to continue to lead verification studies and formulate guidelines successively for considering introduction based on study results and promote the dissemination of guidelines.

[Reference]

http://www.nilim.go.jp/lab/ecg/index.htm

Promotion of Global Warming Countermeasures in Sewerage

YAMASHITA Hiromasa, Head, SHIGEMURA Hiroyuki, Senior Researcher, TAJIMA Atsushi, Senior Researcher, MICHINAKA Atsuko (Dr. Eng.), Researcher, ITAKURA Mai, Researcher, YAMAGUCHI Shuji, Guest Research Engineer, MAEDA Kotaro, Guest Research Engineer, HORII Yasuo, Guest Research Engineer
Wastewater and Sludge Management Division, Water Quality Control Department

(Key words) sewerage, global warming, nitrous oxide

1. Introduction

As one of the global warming countermeasures concerning sewerage, the MILIM is proceeding with the study for reducing emissions of nitrous oxide (N_2O), one of the greenhouse gases ("GHG") emitted from sewage treatment process, and on the effect of the rising air temperature attributable to global warming on sewage treatment.

2. Control of GHG emissions from wastewater treatment process

The widely adopted sewage treatment system is characterized by the generation of N_2O gas in addition to CO_2 generated from energy use since reaction of activated sludge (microorganism) is used in the system. Since it was found from the results of past studies that the amount of N_2O emitted from the conventional activated sludge process (the "conventional process") is outstanding among total N_2O emissions in water treatment process, we are studying the method of reducing N_2O emissions with focus on the conventional process. According to the results of the experiment using a pilot plant, when the aeration air flow at the first stage of treatment process is restricted, the rate of nitrogen removal improved approx. 10% and N_2O emissions reduced more than 80%. In addition, according to the results of the survey on actual amount of N_2O emissions in treatment facilities that operate the staged advanced treatment system, which removes nitrogen etc. by devising the operating method without changing the facility structure of the conventional method, the possibility of reducing N_2O emissions by the staged advanced treatment operation or nitrification control operation was demonstrated (Figure 1). Since the results of the study show that N_2O emissions can be reduced by the operation method that improves the ratio of nitrogen removal, introduction of the staged advanced treatment is expected to lead to reduction of N_2O emissions as well as quality improvement in treated water.

3. Effect of air temperature rise resulting from global warming on advanced sewage treatment

The advanced sewage treatment technology introduced in developed countries not only removes organic matter but also nutrients (phosphorus and nitrogen) using microorganisms such as phosphate-accumulating bacteria, nitrifying bacteria, and denitrifying bacteria. Since the temperature of sewage is expected to rise as global warming progresses in the future, we studied the effect of water temperature conditions on phosphorus removal and microbial communities in the sewage system. As the temperature was successively raised using a laboratory reactor, the capability of phosphorus removal was maintained from 22 to 28°C and declined at a temperature above 30°C (Fig. 2). These results suggest that if water temperature reaches the same level as in the torrid zone, activated sludge in the developed countries located in the temperate to subarctic zones may be affected by air temperature rise.

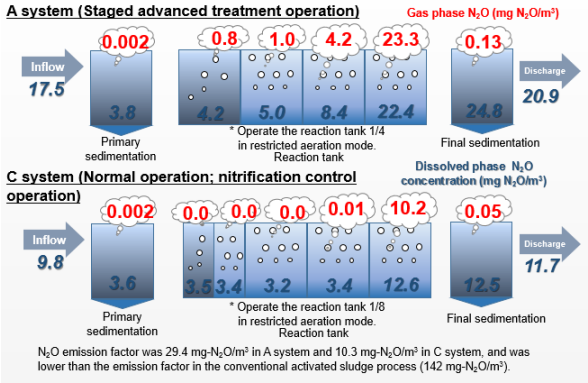


Figure 1: N_2O emissions in each operation mode

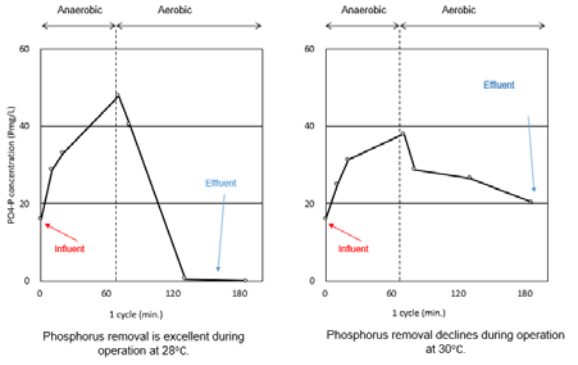


Figure 2: Fall of phosphorus removal ability due to temperature change

[Reference]

Michinaka (2015), "Journal of Japan Society on Water Environment," 38(9) pp.340-344

A Case of Utilizing Results

Formulation of Guideline for B-DASH Project (Power generation from sewage sludge biomass and solid fuelization)

TAJIMA Atsushi, Senior Researcher, HAMADA Tomoyuki, Researcher, HORII Yasuo, Guest Research Engineer, YAMASHITA Hiromasa, Head
Wastewater and Sludge Management Division, Water Quality Control Department

(Key words) sewerage, energy saving, energy creation, cost reduction, greenhouse gas, innovative technology

1. Introduction

The Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") launched the "Breakthrough by Dynamic Approach in Sewage High Technology" (B-DASH) project in fiscal 2011, and the Water Quality Control Department of NILIM serves as an executing agency of this project.

The Department formulated Technology Introduction Guidelines in September 2015 for three innovative technologies, i.e., a technology for conversion into solid fuel, adopted in fiscal 2012 and two technologies for power generation from sewage sludge biomass, adopted in fiscal 2013, based on the finding of empirical studies and opinions of local governments and experts.

2. Outline of demonstrated technologies

(1) Technology for power generation from sewage sludge biomass

This technology is a combination of (i) technology to lower water content in sludge, (ii) technology for energy-saving incineration, and (iii) technology for power generation from incineration waste heat. The technology eliminates the need for supplemental fuel for incinerators by reducing water content in sludge and enables the production of energy with power generation using waste heat in the incinerating process, which has been seldom used.

(2) Technology for sewage sludge solid fuelization using hydrothermal treatment and high temperature digestion with carrier with reduced greenhouse gas

This technology consists of three processes of hydrothermal treatment, digestion, and solid fuelization. With this technology, it is possible to control the emissions of greenhouse gas to be generated in converting residues into solid fuel by converting the organic matter hydrolyzed by hydrothermal processing into digester gas using it as supplemental fuel.

3. Composition of the guideline

Table shows the composition of the guideline formulated. Chapter 2 describes the characteristics, performance, etc. of the technology, and Chapter 3 estimates the effect of the technology when introduced in treatment facilities. If introduction of the technology is determined to be highly effective based on the results of estimation, examination should be made concerning basic planning, equipment design, etc. for introduction as described in Chapter 4. Chapter 5 describes inspection items after introduction of the technology, operation management method, etc.

Table: Composition of Guideline

Chapter 1. General Provisions	Objective, scope of application, definitions of terms
Chapter 2. Outline of the Technology	Characteristics of the technologies, conditions of application, evaluation results
Chapter 3. Examination for Introduction	Introduction examination method, examples for examination of introduction effect
Chapter 4. Planning and Design	Introduction plan, design
Chapter 5. Maintenance	Inspection items, operation management method
Reference Data	Verification results, case study, etc.

4. Utilization of findings and future development

In order to introduce this guideline to local governments, sewerage-related companies, etc., the NILIM held a guideline presentation seminar in Tokyo Big Sight in July 2015, attended by about 100 persons (Photo 1). We continue to introduce the guideline actively through such presentation seminars, etc. to promote utilization of sewage energy by disseminating the technologies.

Photo 1: Guideline Presentation Hall

[Reference]
1) Technical Note of NILIM, No. 859
Guideline for introducing an innovative energy conversion system through total optimization of sludge dehydration, combustion and electricity generation (Draft)
2) Technical Note of NILIM, No. 860
Guideline for introducing an electricity generation system from sewage biomass source (Draft)
3) Technical Note of NILIM, No. 870
Guideline for introducing a technology for sewage sludge solid fuelization using hydrothermal processing with reduced greenhouse gas and high temperature digestion with carrier.
http://www.nilim.go.jp/lab/ecg/bdash/bdash.htm

Promotion of Water Treatment Technology Considering Energy Optimization and Risk Control

SHIGEMURA Hiroyuki, Senior Researcher, TAJIMA Atsushi, Senior Researcher, HAMADA Tomoyuki, Researcher, ITAKURA Mai, Researcher
Wastewater and Sludge Management Division, Water Quality Control Department

(Key words) energy consumption, hygienic risk

1. Introduction

Sewerage greatly contributes to maintenance of good water environment, removing organic matter, nutrient salt, and harmful microorganisms in sewage. Meanwhile it has been recognized that sewerage service by local governments generates greenhouse gas much more than other services and reduction of greenhouse gas is therefore urgently required and that the sewerage service is facing issues resulting from new demand from society, such as utilization of sewerage resources. This Division has been conducting researches and studies from various viewpoints in order to respond to such new social demand expected for sewage service.

2. Examination of energy optimization in air blowing system

Air blowing system accounts for the most amount of power consumption in sewage treatment facilities, and power saving is a major issue for them. As a specific means for power saving, a technology for controlling air blow rate by grasping required air blow rate by sensor is mentioned. However, specific effect of power saving is not clear since power consumption at a reduced air blow rate varies according to models of air blowers, etc. This study identified the relations between "air blow rate" and "power consumption" by conducting hearings from manufacturers about typical air blowers. Based on the results of this study, we estimated power consumption according to air blow rate control conditions based on results of estimation in model facilities in order to clarify the effect of power saving by the air blow rate control technology.

As an example of the study results, the Table shows the results under the conditions (Case 1: Intake valve, Case 2: Inlet vane) where the air blow rate control method of the cast-iron multi-stage turbo blower (Air blow rate: 107 m^3 / min (6,420 m^3/h), pressure 5,800 mgAq). As compared with the power consumption per unit blow rate during operation at the blow rate equal to 60% of the rate in rated operation, Case 1 increased 21% and Case 2 increased 16.5%, which suggests that the increase rate of inlet vane was lower.

Using these results, we estimated power consumption in the model treatment facilities. As the result of applying the air blow rate control technology, power consumption reduced 23-35% as compared with consumption during operation in constant air blow.

Table: Relations between air blow and power consumption by an air blower control mechanism

		Case1	Case2
Rated	Air blow rate (m^3/h)	6,420	6,420
	Power consumption (kwh)	137	133
	Power consumption per A unit air blow rate	0.0214	0.0207
80% of air blow rate	Air blow rate (m^3/h)	5,136	5,136
	Power consumption (kwh)	119	113
	Power consumption per B unit air blow rate	0.0231	0.0220
	B/A	107.9%	106.2%
60% of air blow rate	Air blow rate (m^3/h)	3,852	3,852
	Power consumption (kwh)	100	93
	Power consumption per C unit air blow rate	0.0259	0.0241
	C/A	121.0%	116.5%

3. Evaluation of hygienic risk control technology for treated water / recycled water

Since recycling of sewage treatment water has been proceeding at home and abroad, it is urgently required to study the risk of using recycled water and performance evaluation of treatment technology. In this study, we first conducted a questionnaire survey on the use of recycled water and organized the recycling methods introduced according to purpose of use in order to consider appropriate treatment method in water use, recycled water use, etc. in the discharge points of sewage treatment water from the viewpoints of hygienic risk (annual infection risk), cost, and energy consumption. Figure shows an example of this survey.

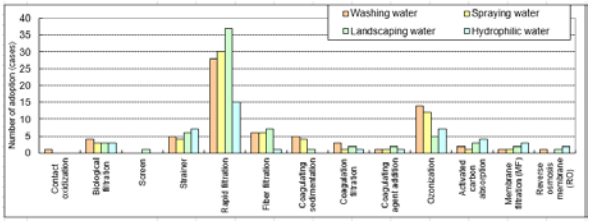


Figure: Number of recycling treatment methods adopted according to purpose of use

The number of rapid filtration method was the largest in each purpose of use and ozonization method was the second largest, except for landscaping water. For landscaping water, which is not directly used by humans, treatment methods that require much power consumption, such as ozonization method, would not be adopted. In contrast, membrane filter method and reverse osmosis membrane method, by which high water quality can be obtained, are relatively adopted as hydrophilic water, which is directly used by humans, although the number of adoption is small.

Dam Flood Control Operation with Maximum Utilization of Existing Dam Functions

INOMATA Hironori, Senior Researcher, KAWASAKI Masao, Head
Water Cycle Division, River Department

(Key words) disaster prevention operation for extraordinary floods

1. Introduction

If a dam causes a flood exceeding the planned scale, operation will be conducted in accordance with the predetermined procedure of disaster prevention operation for extraordinary floods. In many of the cases where such disaster prevention operation for extraordinary floods was conducted in accordance with the current procedure, the reservoir level was maintained below the maximum water level in case of a flood. Meanwhile, however, there are many cases where flood control ends without using the flood control capacity sufficiently. In response to the recent concern about the increasing frequency and growing intensity of large-scale floods, implementation of the disaster prevention operation for extraordinary floods is expected to reduce downstream damage by using the flood control capacity as much as possible. Under such circumstances, a number of methods for disaster prevention operation for extraordinary floods have been proposed, and some of them are considered more effective in reducing discharge from the dam than the operation in accordance with the current procedure. The NILIM has been organizing the concepts of the horizontal review for a number of methods of disaster prevention operation for extraordinary floods as well as characteristics of each method through simulations in a number of case study dams. As part of such activities, this paper briefly describes some methods of disaster prevention operation for extraordinary floods and introduces examples of calculation for case study dams.

2. Various methods of disaster prevention operation for extraordinary floods and examples of calculation

(i) Minimum-required discharge method

A method of operation based on a table prepared with specification of the volume of minimum discharge required (minimum-required discharge) at present to ensure discharge at the designed maximum water level even in case of rapid increase in any inflow or inflow from the reservoir level.

(ii) Method of successively reviewing discharge curve

A method aiming to use the flood control capacity as much as possible by reviewing discharge curve successively every 60 minutes so that the inflow at that point may be discharged at the maximum water level in case of a flood when the inflow is decreasing after reaching the peak.

(iii) VR method

A method aiming to use up the flood control capacity at the end of flood control by estimating the total inflow during flood reduction and determining whether to increase or decrease discharge based on the total inflow thus estimated and the level of vacant capacity at that point.

(iv) Marginal operation method

A method aiming to keep the rising rate of downstream water level under the target value by calculating a variable called "marginal inflow" analytically and starting discharge when the inflow exceeds the marginal inflow.

The Figure shows the results of calculation by applying the foregoing methods of disaster prevention operation for extraordinary floods. It suggests that all of the methods result in more effective operation using the flood control capacity than the operation in the present procedure.

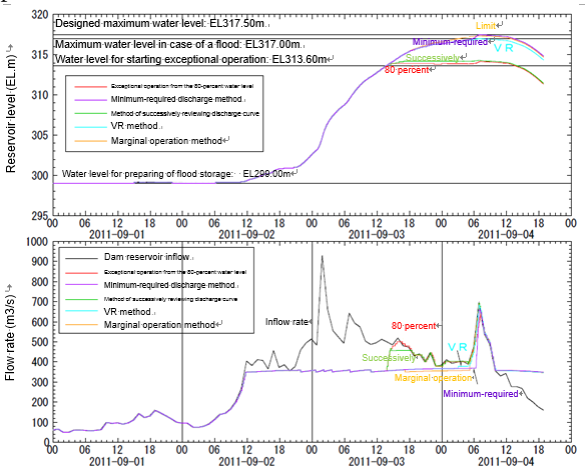


Figure 1: Examples of calculation in various methods of disaster prevention operation for extraordinary floods

3. Conclusion

In order to introduce the above-mentioned methods of disaster prevention operation for extraordinary floods into existing dams, it is also necessary to evaluate characteristics in management, such as ease of operation, in addition to flood control effect. We aim to introduce these methods into practical operation by preparing a guide describing considerations for introduction.

Examination of running quality of vehicles due to differences in apron structure of roundabout

Naoyuki Kawamoto, Researcher
Katsuaki Imada, Researcher
Yasushi Kimura, Researcher
Tomoya Ueno, Guest Research Engineer
Susumu Takamiya (Ph.D.), Head
Road Division, Road Traffic Department

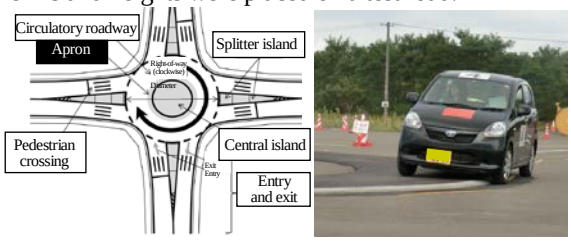
(Key words) roundabout, apron, driving experiment, passenger vehicle, large vehicle

1. Introduction

In August 2014, the document "Desirable roundabout structures"[1)] was issued by the Road Bureau, Ministry of Land, Infrastructure, Transport and Tourism, and the basic concept for the installation of a roundabout, which is a type of circular road crossing, was shown.

The apron (see figure), which is placed between the circulatory roadway and the central island, is a structure peculiar to a roundabout. A large vehicle is allowed to drive over this apron because it is difficult to drive only on the circulatory roadway, but it is not desirable for a passenger vehicle to drive over it because it may cause high vehicle's speed. Thus, it is desirable to find an appropriate structure for an apron that fulfills this function.

At the NILIM, we examine and study roundabouts, and in this article, we provide an overview of a driving experiment (photo) where aprons with various structural forms and heights were placed on a test road.



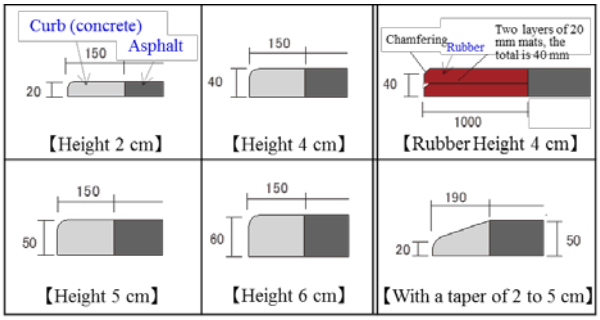
(Left) Figure Standard drawing of roundabout
(Right) Photo Snapshot of driving experiment

2. Overview of driving experiment

The participants drove passenger vehicles and large vehicles on an apron placed on a test road, and we obtained data about vehicle behavior (velocity, shock, etc.). We also conducted a questionnaire survey that asked the participants about the drivability, safety, and so on. We studied six cases of aprons, as listed in the table.

3. Results of experiment

An evaluation of the tolerance (whether or not a participant wanted to drive on the apron), as reported in the questionnaire, showed that the tolerance was particularly bad when the height of an apron was 5 cm or 6 cm, and the tolerance difference between the heights of 4 cm and 5 cm was larger than the other differences. In addition, the shock became larger when the apron became higher, for both passenger vehicles and large vehicles. Therefore, we can say that making the height of an apron 5 cm or higher was effective at discouraging passenger vehicles from driving over an apron. On the other hand, considering the drivability of large vehicles, an apron with a taper ranging from 2–5 cm could be used.



* The values in the plots in the table are shown in millimeter units.

Table Cases of aprons

4. Summary

We expect that the knowledge obtained in this study will be used by road administrators who are considering the installation of an apron with a step structure. In the future, we would like to examine an appropriate structure for an apron, considering the results of investigations about vehicle behavior before and after the installation of an apron with a step structure on actual roads.

☞Detailed information:

1) Website of Ministry of Land, Infrastructure, Transport and Tourism:
http://www.mlit.go.jp/road/sign/kijyun/pdf/20140901tuutsi.pdf (in Japanese)

Development of probe data utilization method for traffic safety countermeasures

Yuta Ozaki, Researcher
Susumu Takamya (Ph. D.), Head
Road Division, Road Traffic Department

(Key words) ETC2.0, probe data, traffic safety countermeasure

1. Introduction

To effectively and efficiently implement traffic safety countermeasures, it is necessary to properly identify hazardous spots or areas, accurately analyze accident factors, and properly plan and implement countermeasures based on these. In addition, it is necessary to evaluate the effect in an early stage, and implement any additional countermeasures in the early stage, as needed.

On the other hand, using the ETC2.0 service, the Ministry of Land, Infrastructure, Transport and Tourism has been collecting and accumulating probe data such as the moving paths (in the following, we call this "ETC2.0 probe information") from vehicles equipped with special devices.

In the Road Division, we are examining a method to use ETC2.0 probe information for a traffic safety countermeasure.

2. Identification of area containing community road with high risk of danger

Here, we introduce a research trend for a method to identify the areas with a high risk of danger from areas containing community roads, using the ETC2.0 probe information.

The ETC2.0 probe information contains data on the traveling routes of vehicles (traveling route data) collected as point data. Figure 1 shows the distribution of the traveling route data collected in the region surrounded by the purple frame.

On community roads, traffic safety issues are due to vehicles passing through the area, and vehicles traveling at a fast speed. Here, we divided the region surrounded by the purple frame in Figure 1 into several areas separated by boundaries formed by roads in which there are multiple roadways separated from a sidewalk, and we counted the number of vehicles that passed through each area (see Figure 2). A large amount of traffic passed through the area surrounded by the blue circle in Figure 2. In this way, using the ETC2.0 probe information makes it possible to grasp the traffic situation for vehicles passing through an area, which is a traffic safety issue on a community road. We can identify the areas with a high risk of danger using such information.

3. Future issues

Using the ETC2.0 probe information makes it possible to grasp the traffic situation for vehicles passing through a area, as well as the speeds of such vehicles and the occurrence of sudden braking. In addition, the probe information could be used for various purposes such as to identify hazardous spots on arterial roads and evaluate the effect. In the future, we plan to conduct research to develop these methods.

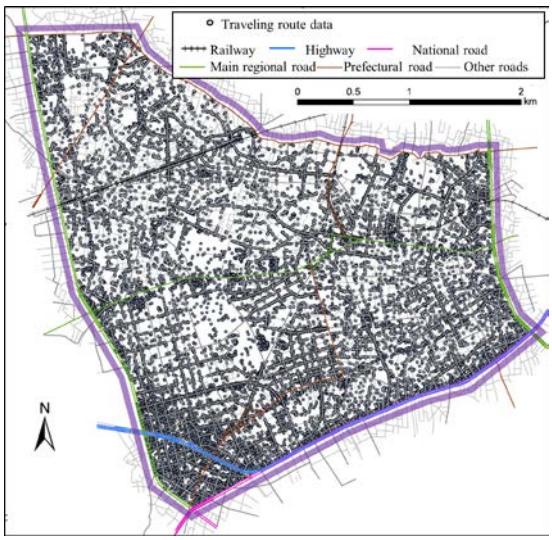


Figure 1 Distribution of traveling route data

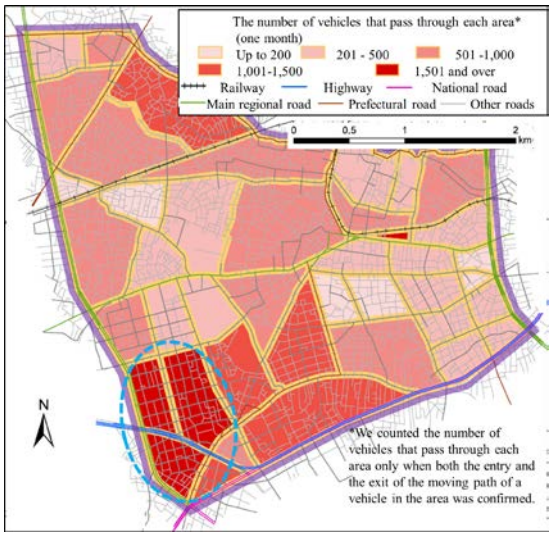


Figure 2 Number of vehicles that pass through each district

Development of a data cleansing method for probe travel speed data

Toshikazu Matsushima, Guest Research Engineer
Hiroyoshi Hashimoto (Ph.D. (Engineering)), Senior Researcher
Susumu Takamiya (Ph.D.), Head
Road Division, Road Traffic Department

(Key words) probe data, travel speed, data cleansing, ETC2.0 probe data

1. Introduction

A large amount of probe data obtained from automobile navigation systems and other sources are currently being collected and used to analyze traffic conditions. The probe data for travel speeds, which are processed to determine the travel speed of each link, contain peculiar high-speed and low-speed data as a result of individual driving preferences and stopping or parking a vehicle on a roadside. Therefore, to accurately analyze the data, it is necessary to remove such peculiar data.

2. Overview and characteristic of data cleansing method

One characteristic of the data cleansing method that we are developing is that it focuses on the differences in the amounts of time required by individual cars to pass the section. The data obtained stopped or parked vehicles, as shown in Figure 1, are unsuitable for a traffic condition analysis, and we need to remove such data. However, we cannot distinguish such vehicles from low-speed running vehicles caught in a traffic jam, if we just use the travel speeds of individual vehicles. Thus, we focused on the fact that stopped or parked vehicles required significantly larger amounts of time to pass the section than other vehicles, whereas vehicles moving slowly as the result of a traffic jam passed the section in smaller amounts of time that were not very different from those of other vehicles. We considered a vehicle to be peculiar and subject to removal if the difference between the actual amount of time required and the minimum required time during the same time period was larger than a certain threshold time.

3. Discussion of trial result of data cleansing

We used the data cleansing method for the travel speed data classified by DRM links and the upper or lower directions, from ETC2.0 probe data (from April to June in 2015, nationwide data), by setting the threshold time corresponding to the delay from the minimum required time to 600 s. The number of subject vehicles was approximately 274 million vehicle-links in total, and the number of removed vehicles was approximately 0.7 million vehicle-links in total. Thus, the percentage of removed vehicles was approximately 0.32%. We conducted a comparison that focused on individual vehicles in the same time period. As a result, we confirmed that the data that were supposed to be peculiar running data such as for stopping or parking on the roadside were removed.

4. Closing remarks

When using a large amount of data, it is important to perform data cleansing that agrees with the purpose of an analysis. In the future, we will further examine a data cleansing method and consider generalized measures such as creating a manual.

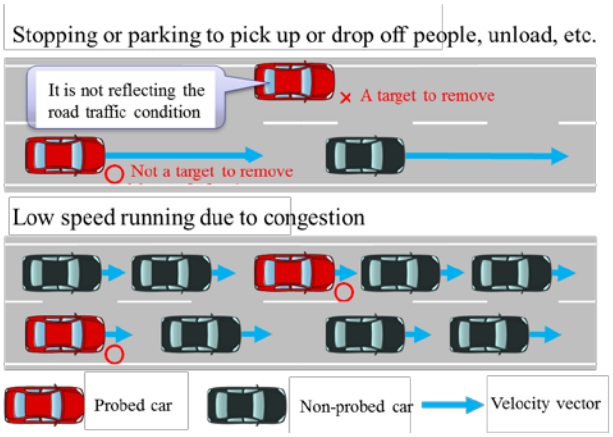


Figure 1 Example of running data subject to removal

Table 1 Overview of data cleansing

Item	Content
(1) Removing data based on threshold values	Data are removed when the speed is less than 1 km/h, or the speed is 150 km/h or more.
(2) Removing data based on a road traffic situation in the same time period	Samples are removed when they are 600 s or more later than the minimum required time in the same time period. Note that the lower limit of the minimum required time is determined by the required time for the speed of 80 km/h when a vehicle is running on a highway, and that for the speed of 30 km/h when running on a local road.

Table 2 Amount of data before data cleansing

Speed rank\DRM link length	Less than 500 m	500 m and over, less than1000 m	1000 m and over, less than 2000 m	2000 m and over, less than 3000 m	3000 m and over	Total
Less than 1 km/h	101,128	1,730	28	0	0	102,886
1 km/h and over, less than 10 km/h	11,992,068	381,337	61,583	7,295	1,913	12,444,196
10 km/h and over, less than 20 km/h	21,784,312	1,393,434	182,147	21,286	8,499	23,389,678
20 km/h and over, less than 40 km/h	39,880,142	5,829,960	1,169,011	105,362	47,875	47,032,350
40 km/h and over, less than 60 km/h	63,059,274	8,611,434	2,945,802	497,285	206,778	75,320,573
60 km/h and over, less than 80 km/h	36,702,063	7,951,405	4,152,835	1,162,003	861,972	50,830,278
80 km/h and over, less than 100 km/h	23,351,446	7,013,708	5,187,359	2,015,993	1,852,373	39,420,879
100 km/h and over, less than 120 km/h	10,918,100	3,441,007	2,727,682	1,246,404	1,332,974	19,666,167
120 km/h and over, less than 150 km/h	3,262,987	600,510	427,468	180,034	189,023	4,660,022
150 km/h and over	601,744	44,377	17,343	5,410	4,609	673,483
Total	211,853,264	35,268,902	16,871,258	5,241,072	4,506,016	273,540,512

(vehicle-links)

Table 3 Percentage of vehicles removed in data

Speed rank\DRM link length	Less than 500 m	500 m and over, less than1000 m	1000 m and over, less than 2000 m	2000 m and over, less than 3000 m	3000 m and over	Total
Less than 1 km/h	100.00%	100.00%	100.00%	-	-	100.00%
1 km/h and over, less than 10 km/h	0.25%	10.10%	29.09%	71.17%	80.71%	0.75%
10 km/h and over, less than 20 km/h	0.00%	0.00%	0.01%	6.14%	38.98%	0.02%
20 km/h and over, less than 40 km/h	0.00%	0.00%	0.00%	0.00%	0.81%	0.00%
40 km/h and over, less than 60 km/h	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
60 km/h and over, less than 80 km/h	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
80 km/h and over, less than 100 km/h	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
100 km/h and over, less than 120 km/h	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
120 km/h and over, less than 150 km/h	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
150 km/h and over	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Total	0.35%	0.24%	0.21%	0.23%	0.22%	0.32%

Large

Legend, Percentage

*Percentage of removed vehicles (%) = the amount of data subject to removal / the amount of data before the data cleansing

cleansing

Development of a method to analyze congestion factors using probe data

Yoshihiro Tanaka, Researcher
Hiroyoshi Hashimoto (Ph.D. (Engineering)), Senior Researcher
Susumu Takamiya (Ph.D.), Head
Road Division, Road Traffic Department

(Key words) probe data, traffic congestion, traffic facilitation

1. Introduction

In the "Effort to wisely use roads, mainly expressways" (July 2015), which is an interim report of the Arterial Highways Workshop, Road Subcommittee, the Panel on Infrastructure Development, the following efforts are outlined to realize smooth traffic: utilizing information and communication technology (ICT), establishing a method to analyze congestion factors, grasping bottleneck places and their causes, and implementing appropriate measures. In this article, we present an overview of a method to analyze congestion factors using probe data, which is under development at the NILIM.

2. Method to analyze congestion factors using probe data

As a method to analyze congestion factors, we are developing a method in which the direction of a speed decrease is identified using probe data, and congestion factors are narrowed down by combining them with other data such as the volume of traffic. We conducted a congestion factor analysis at Intersection A in Ibaraki Prefecture. We confirmed that traffic congestion becomes serious in the northern direction, on straight roads, and in the morning, based on probe data and the volume of traffic classified by travel directions, and we analyzed the congestion factors. As a result, in this intersection, compared with the main road in the east-west direction, we found that when more time is assigned to green lights, the subsidiary road in the north-south direction has more traffic in the morning. Therefore, we can say that an inconsistency between the signal indication and traffic condition is one of the factors (Figure).

3. Concluding remark

In the future, we plan to compile a manual for data analysis, which will be used to establish an effective measure for traffic congestion.

[Travel speed classified by travel directions] (Probe data)

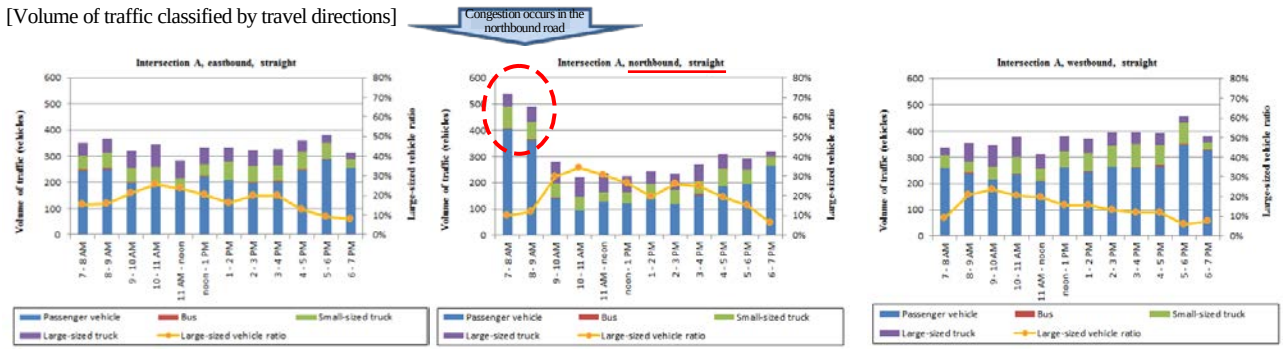
(km/h)

Intersection A		Daytime							Holiday						
		Night	Morning		Afternoon		Evening		Night	Morning		Afternoon		Evening	
Southbound	Turn left	29.1	27.1	93%	24.8	85%	20.6	71%	29.4	28.2	96%	22.4	76%	21.9	74%
	Straight	29.5	18.5	62%	21.2	72%	17.2	58%	27.7	23.7	86%	22.8	82%	21.6	78%
	Turn right	20.8	26.3	127%	28.7	138%	21.3	103%	38.2	16.9	44%	24.2	63%	25.3	66%
Westbound	Turn left	15.0	22.9	152%	22.9	152%	18.1	121%	18.9	36.0	191%	19.1	101%	19.0	101%
	Straight	24.9	18.1	73%	19.7	79%	18.2	73%	20.0	15.4	77%	16.0	80%	13.7	69%
	Turn right	18.0	13.9	77%	18.3	101%	10.9	60%	19.1	13.2	69%	16.4	86%	13.7	72%
Northbound	Turn left	20.1	10.9	54%	10.8	54%	21.9	109%	17.9	22.9	128%	15.2	85%	10.2	57%
	Straight	23.9	7.7	32%	16.0	67%	13.3	56%	15.4	19.9	130%	17.2	112%	15.1	98%
	Turn right	14.4	12.1	84%	14.2	98%	12.3	85%	37.5	10.2	27%	16.1	43%	10.9	29%
Eastbound	Turn left	29.7	24.5	82%	26.4	89%	19.7	66%	27.0	36.3	134%	25.3	94%	19.0	71%
	Straight	27.3	22.7	83%	17.9	65%	17.3	63%	23.7	25.0	106%	17.0	72%	19.5	82%
	Turn right	22.6	16.1	72%	16.0	71%	13.5	60%	19.8	33.7	170%	15.9	81%	14.6	74%

*In Morning, Afternoon, and Evening
the left column represents travel speed (km/h)
the right column represents the ratio to the values of Night (%)

Travel speed	Ratio to the values of Night
:10 km/h and less	:50% and less
:20 km/h and less	:75% and less

[Volume of traffic classified by travel directions]



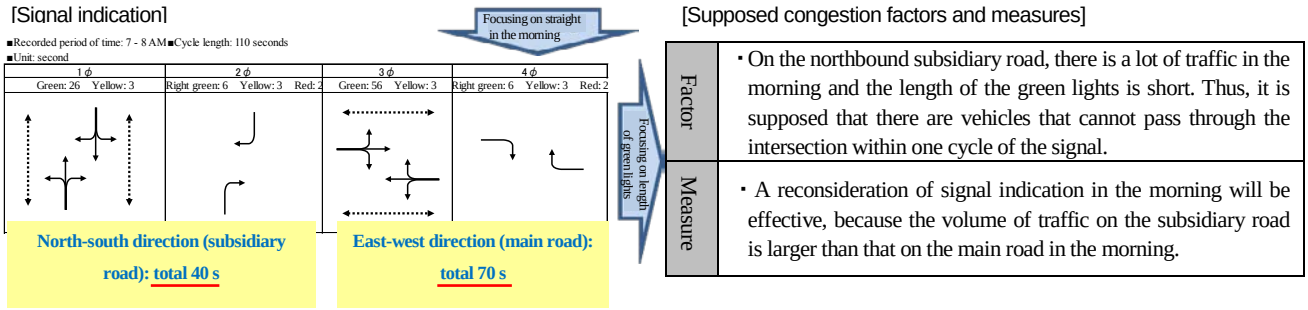


Figure Trial result of analysis of congestion factors

Development of methods for estimating carbon dioxide emissions from vehicles utilizing vehicle travel data

Ryuji Inoue, Head
Yosuke Nagahama, Researcher
Road Environment Division, Road Traffic Department

(Key words) road improvement, vehicle, carbon dioxide, vehicle travel data

1. Introduction

The 21st annual Conference of Parties to the United Nations Framework Convention on Climate Change was held in Paris from November 30th to December 13th in 2015, and a legal framework for measures to combat global warming was adopted and will go into effect after 2020.

In the "Intended Nationally Determined Contributions" submitted by Japan for COP 21, the reduction target for greenhouse gases in FY2030 is cut to 26.0% compared to the emissions in 2013, and the target for the transportation sector is to reduce 62 million tons carbon dioxide by improving fuel efficiency, popularizing next-generation vehicles, and implementing other measures of the transportation sector (promoting measures to improve traffic flow, promoting the use of public transportation, and so on). Because improving the speed of vehicles by easing traffic congestion will lead to the reduction of fuel consumption, road improvements and appropriate route selections will contribute to the reduction of carbon dioxide emissions. However, a study on how to quantitatively grasp their effects is still under way.

We are attempting to develop methods for estimating carbon dioxide emissions from vehicles utilizing vehicle travel data.

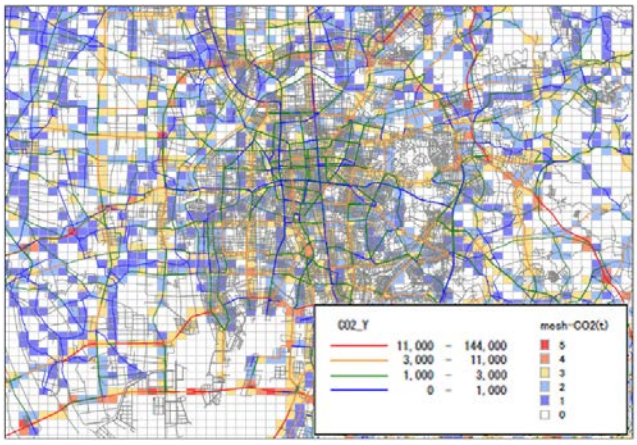


Figure 1 Areal distribution of carbon dioxide emissions based on probe data and road traffic data (500-m mesh)

2. Grasping carbon dioxide emissions by utilizing vehicle travel data

Figure 1 shows an aerial distribution of carbon dioxide emissions based on probe data and road traffic data. It makes it easier to grasp areas where a large amount of carbon dioxide is discharged, along with the variation in emissions before and after implementing traffic control measures, and we expect that this can be used to evaluate the effects of measures.

Figure 2 shows the relationship between the average travel speed and instantaneous fuel consumption classified by the travel conditions, which was produced using the on-board diagnostics (OBD) of vehicles. Considering the fact that it is necessary to press the accelerator when traveling uphill, and a large amount of fuel is consumed as a result of traffic congestion because of the increase in the number of acceleration/deceleration and idling periods, it is supposed that carbon dioxide emissions will increase as a result.

3. Future development

In the future, we plan to examine a method to assess the carbon dioxide generation suppression effects of traffic control measures utilizing ETC 2.0 probe data, and will examine concrete utilization plans by road administrators for methods to estimate the carbon dioxide emissions from vehicles.

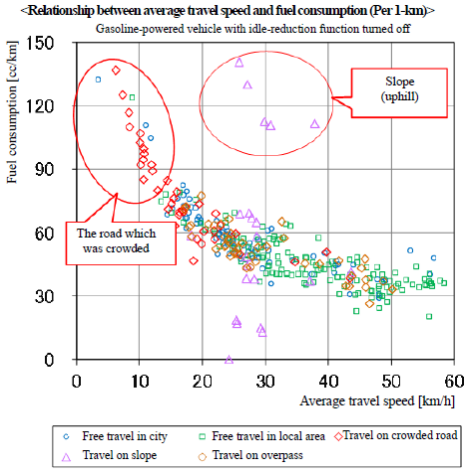


Figure 2 Relationship between average travel speed and instantaneous fuel consumption, classified by travel conditions, based on OBD data.

Implementing a pilot program for ETC2.0 vehicle operation management support service

Hiroshi Makino, Head
Naoko Matsuda, Senior Researcher
Gaku Ohtake, Research Engineer
Yukio Shikatani, Guest Research Engineer
Intelligent Transport Systems Division, Road Traffic Department

(Key words) ETC2.0, distribution support, pilot program, to use wisely

1. Introduction

Today, distribution companies face many issues, including the high price of diesel fuel and the aging of drivers. To deal with these issues, it is desirable to have effective operations and management, support safe driving, improve fuel efficiency, and optimize labor management. In our laboratory, we conduct research and development for a distribution support service that utilizes ETC2.0 probe data collected from intelligent transport systems (ITS) spots and other sources. In this article, we introduce a pilot program for the ETC2.0 vehicle operation management support service, which has been conducted since fiscal year FY2015.

2. Overview of pilot program

As part of wise distribution management utilizing IT, which is promoted as the "effort to wisely use roads" by the Ministry of Land, Infrastructure, Transport and Tourism, this pilot program has the purpose of analyzing and evaluating the effectiveness, feasibility, and social benefits of services provided by companies for vehicle operation management, including making the operation and management of vehicles more efficient and ensuring the safety of drivers. We are also attempting to smoothly develop measures (see Figure).

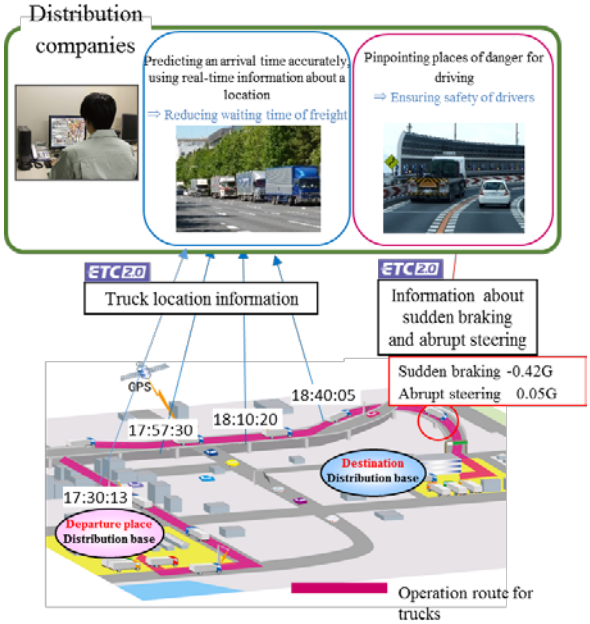


Figure Overview of pilot program

In ETC2.0, using high-speed and large-capacity communication between an ETC2.0 in-vehicle device and a roadside unit, we can collect ETC2.0 probe data, including the traveling history and activity log of each vehicle. In this pilot program, the ETC2.0 probe data collected from the vehicle of each participant, which can be used to identify an individual vehicle (in the following, we call these the identification probe data), are delivered to a system managed by the program participants. The program participants then process and analyze the delivered identification probe data, which are used to make the physical distribution more efficient such as by reducing the waiting time of freight and ensuring the safety of drivers.

The first-term participants in this pilot program were recruited and private companies were chosen in November 2015, and the program was started.

The following is an overview of the provided service and examples of the uses of the identification probe data by the program participants.

○ The traveling history data are analyzed, and the congestion frequency is obtained, classified by the distribution routes, days and hours. Then, operation plans are reviewed based on these.

○ The traffic line data are analyzed, such as the places where tourists using rental cars stop and the length of their stay, and sightseeing information is provided to tourists to make sightseeing by rental car more satisfying, based on the attributes of each tourist.

○ Places with danger are identified, which assists with the safety education of drivers.

3. Concluding remarks

We plan to recruit the second-term participants for the pilot program. In addition, by evaluating and analyzing the service, and examining its system, we would like to use these for an actual operation.

Topics

Simplification of passage permission for oversize/overmass vehicles equipped with ETC2.0

Hiroshi Makino, Head
Shoichi Suzuki, Senior Researcher
Takahiro Tsukiji, Researcher
Yukio Shikatani, Guest Research Engineer
Intelligent Transport Systems Division, Road Traffic Department

(Key words) oversize/overmass vehicle, passage permission, ETC2.0

1. Introduction

Taking measures to deal with the aging of road facilities is an urgent issue. In particular, it is assumed that vehicles that weigh more than a specific value have a significant influence on the degradation of road facilities. Thus, it is desirable to regulate the passage of such vehicles. On the other hand, because the shortage of drivers has become serious, there is a desire to make physical distribution more efficient and save manpower by increasing the size of vehicles and decreasing the burdens of freight companies[1)]. In our division, we are examining the travel routes for oversize/overmass vehicles utilizing ETC2.0 and weigh-in-motion (WIM) data, with the goal of developing a method to grasp their situations. In this article, as an effort to use roads wisely, we explain an attempt to simplify passage permission for oversize/overmass vehicles, using intelligent transport systems (ITS) technology, to simultaneously optimize physical distribution and adjust the passage of oversize/overmass vehicles.

2. Technology to monitor passage of oversize/overmass vehicles using ETC2.0

In ETC2.0, using high-speed and large-capacity communication between an ETC2.0 on-board unit and a roadside unit, we can collect probe data, including the travel route record of each vehicle. In addition, after obtaining the consent of a freight company, we can collect probe data that include information to identify an individual vehicle.

Utilizing ETC 2.0, road administrators can confirm the travel route of an oversize/overmass vehicle equipped with an ETC2.0 on-board unit. In addition, by combining the weight measurement data obtained from WIM all over the country for oversize/overmass vehicles and the travel routes obtained by ETC2.0, we can confirm the weight of a running vehicle equipped with ETC2.0 (Figure 1).

Using this technology, we can confirm the passage on a permitted route and the conditions for a vehicle that weighs more than the general weight limit determined by the cabinet order on vehicle restrictions, such as an oversize/overmass vehicle whose total weight is 20 tons or more.

3. Simplification of passage permission for oversize/overmass vehicles

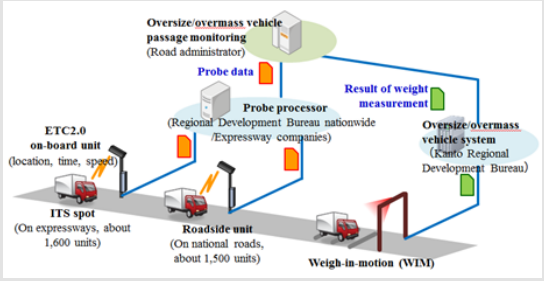
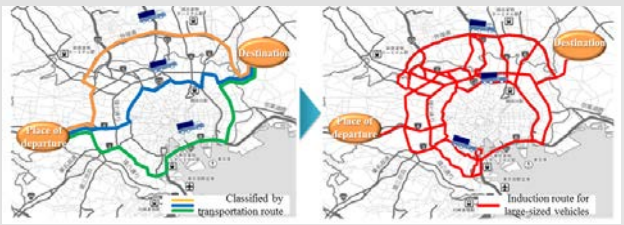


Figure 1 ETC2.0 oversize/overmass vehicle passage monitoring

The Ministry of Land, Infrastructure, Transport and Tourism is considering the introduction of a system to simplify passage permission for oversize/overmass vehicles equipped with ETC2.0 (in the following, we call this “gold permission”). Previously, to obtain passage permission for an oversize/overmass vehicle, an application for each transportation route was required. However, in the gold permission system, if a vehicle is equipped with an ETC2.0 on-board unit, a user policy and so on are agreed upon, and the vehicle information is



registered, permission is given and a travel route can, in principle, be freely chosen from about 34,000 km of induction routes nationwide for large-sized vehicles (Figure 2). We think that the implementation of this system will make transportation more efficient and smoother because a route can be flexibly chosen by considering road traffic information and so on, while it

will simultaneously regulate the passage of oversize/overmass vehicles.

Figure 2 Simplification of passage permission for oversize/overmass vehicles

4. Concluding remarks

The gold permission system began to be used in 2016, considering Public Comments collected by the Ministry of Land, Infrastructure, Transport and Tourism. At the NILIM, we will attempt to develop a technology that can support a system to establish a win-win relation for the passage of oversize/overmass vehicles between freight companies and road administrators, to promote efforts to use roads wisely in the future.

[Reference]

1) Press release of Ministry of Land, Infrastructure, Transport and Tourism: Basic directions and so on for physical distribution policies in the future (report) (in Japanese)
http://www.mlit.go.jp/common/001114704.pdf

Joint public-private research for the realization of next-generation C-ITS

Hiroshi Makino, Head
Toshio Ogiso, Senior Researcher
Gaku Ohtake, Researcher
Masaki Hiro, Guest Research Engineer
Intelligent Transport Systems Division, Road Traffic Department

(Key words) C-ITS, to use wisely, safe driving support

1. Introduction

A cooperative intelligent transportation system (C-ITS) is a system that integrates vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and infrastructure-to-infrastructure (I2I) communication; information is mutually exchanged between vehicles, roadside units, the center, and individual terminals by making communication methods and data formats consistent; and such information is shared in various applications such as for safety, the management of roads and traffic, the management of distribution, environments, and collecting and providing information.

2. Contents of joint public-private research

In this joint public-private research, out of the information that belongs to individual vehicles and road administrators, we are examining information that can be mutually utilized and concrete methods for information exchange. We are also studying and developing a next-generation C-ITS, which can make road management more efficient and less expensive, while simultaneously realizing safe and comfortable automated driving and so on (Figure 1).

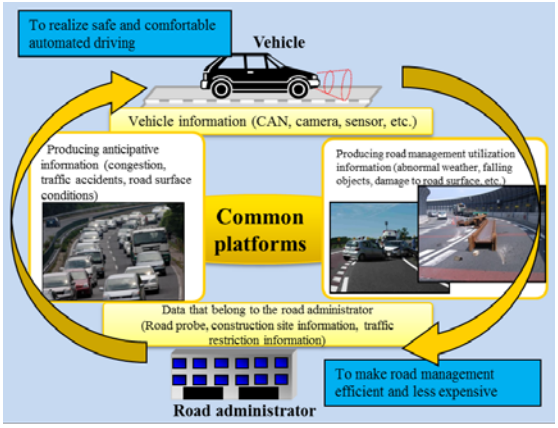


Figure 1 Schematic of next-generation C-ITS

3. Research items and participants

In this joint public-private research, the examination is proceeding with the following three Working Groups with 17 private companies consisting of road administrators, auto manufacturers, and electrical manufacturers (Figure 2).

1) Working group for advanced road management

We are examining a concrete service that makes road management more efficient and less expensive, by providing various types of sensor information from vehicles to roadside units, and grasping the road traffic situations and road conditions.

2) Working group for safe driving support

We are examining a concrete service to support safe and smooth automated driving and so on, by integrating information collected by roadside units, and providing anticipative information to vehicles.

3) Working Group for C-ITS common platforms

We are working on the development, tests, technical standards, and technical specification for cross-cutting platforms (maps, communication technology, etc.) that are common to a service for sophisticated road management, and a service to support driving.

Figure 2 Participants

4. Schedule

To realize the service as quickly as possible, we plan to conduct a driving experiment on a test course at the NILIM by FY2016. For the required research and development of the service, we are organizing the

technical issues, and will study and develop common fundamental technologies.

Topics

Action for international standardization of ETC2.0 service

Hiroshi Makino, Head
Shoichi Suzuki, Senior Researcher
Daisuke Watanabe, Researcher
Tomoaki Mizutani, Guest Research Engineer
Intelligent Transport Systems Division, Road Traffic Department

(Key words) ETC2.0, smart use of road, international standardization, overseas expansion

1. Introduction

The World Trade Organization (WTO) obliges member countries to make individual standards such as the national standard in each country consistent with the international standard. In addition, there is an increasingly active transition from a de facto standard (a standard based on an established fact), which has already had a major impact on the market, to a de jure standard (a standard determined by an official institution), and international standardization has become very important. In particular, when new technology is introduced in the market, the early establishment of its international standard specification makes it possible to prevent market turmoil in the early stage.

In Japan, in the past, a market share has been obtained by making efforts during the manufacturing process to meet the international standard established by other countries. However, in the future, to effectively outpace the market competition during this period of internationalization, it is desirable to promote technology development and standardization proposals at the same time. Therefore, NILIM will attend ISO/TC204, which is a meeting for international standardization, and make a proposal for the international standardization of Japanese ITS technology, particularly the ETC2.0 service, in cooperation with various relevant organizations.

2. Action for international standardization

ETC2.0 service is expected to be used in various fields in the future, such as for the dynamic provision of information to drivers and measures to remedy traffic congestion using the travel information of each vehicle, in addition to conventional electronic toll collection (see Figure 1). NILIM created a draft for the international standardization of this service, and we are working on international standardization and making a proposal to ISO/TC204, in collaboration with domestic parties. For example, for standardization and procedures, we discuss at WG5 (Working Group 5: Fee and toll collection) where electronic toll collection is dealt with as for probe data for heavy vehicles equipped with ETC2.0 and a traffic monitoring service using WIM (see Figure 2),

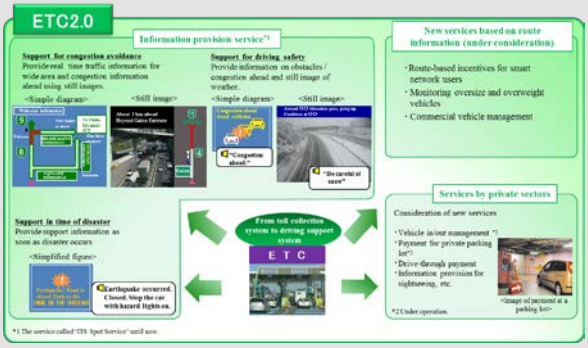


Figure 1 Overview of ETC2.0 service

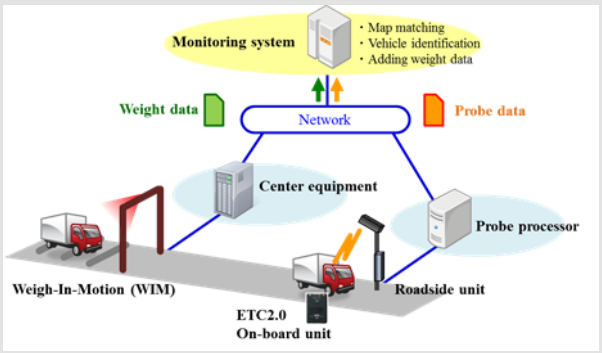


Figure 2 Monitoring system for heavy vehicles equipped with ETC2.0

and WG7 (Working Group 7: General fleet management and commercial /freight) is discussing commercial vehicle operation management.

3. Concluding remarks

The standardization of Japanese ITS technology has already been conducted; however, we need to cooperate in Japan on the international standardization of an ETC2.0 service that will start in the future.

[Reference]

1) Public Interest Incorporated Association, Society of Automotive Engineers of Japan, Standardization of ITS 2015 (in Japanese)
http://www.jsae.or.jp/01info/its/2015_bro_j.pdf

Development of light distribution measurement tool using digital single-lens reflex camera for high quality visual environment designs

YAMAGUCHI Hideki (Ph.D. in Engineering), Senior Researcher,
Equipment Standards Division, Building Department

(Keywords) Light and visual environment, visual comfort, energy efficient, evaluation tool

1. Introduction

Development and promulgation of energy-efficient design methods are important today because the energy efficiency of buildings is expected to be further improved. The comfort of the indoor environment must also be ensured at the same time. Expected environmental performances vary for purposes of building spaces, especially, for the light and visual environment. Measurement and forecasting of light distribution in building spaces are required to create high quality visual environment designs that provide both comfort and energy efficiency.

This paper introduces the development of a light distribution measurement tool that uses a commercially available digital single-lens reflex camera. It also discusses how the tool can be used to evaluate the visual environment.

2. Overview of the light distribution measurement tool

The Equipment Standards Division is developing tools to measure light distribution without depending on camera types. This requires a calibration method that is compatible with any camera, which is also being developed in the Equipment Standards Division. Light distribution (distributions of luminance and colors) can be obtained using any camera when the obtained calibration data are imported to the measurement software (Fig. 1).

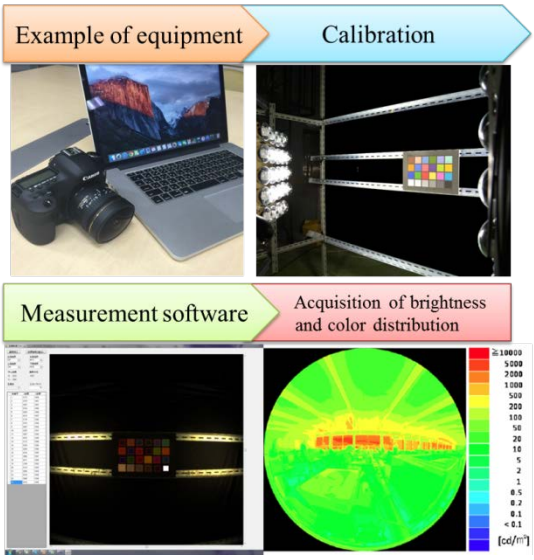


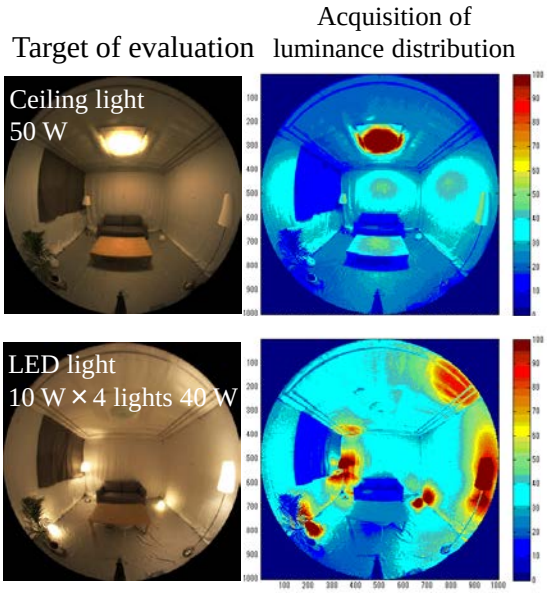
Figure 1 Overview of the light distribution measurement tool

3. Use of the light distribution measurement tool for the evaluation of the visual environment

This tool enables the production of luminance distribution to express differences in the brightness of a space and the brightness on a desk in two lighted environments shown below as examples (Fig. 2). It is expected to become useful as an evaluation tool to produce high quality visual environment designs.

4. For the release and utilization of the outcomes

The developed measurement tool is going to be released through documents from the National Institute for Land and Infrastructure Management or through other channels. The team is going to further explore methods to convert obtained light distribution data into visual environment evaluation indexes.



	One ceiling light	Four LED lights
Sense of brightness as a space	△	○
Brightness on a desk	○	△
Power consumption	△	○

Figure 2 Examples of the use of the tool to evaluate the visual environment

Topics

Long-term Preservation and Use of Recorded Data

Hideyuki KOBAYASHI (Ph.D. Eng.), Researcher
Housing Planning Division, Housing Department

(Keywords) Long-term Preservation, Digital Data, Metafile Compiler

1. Cold Data

The lifespan of records of structures longer than that of the recorded structures is essential in order to support maintenance, alterations, and transactions. However, the lifespan of digital recording media is shorter than the structures, and the rapid obsolescence of recording formats has been an obstacle until today.

We propose a simple and permanent language to describe the steps in decoding preserved legacy data (grammar and key words). In the saving phase, a format defining file (metafile) written in this language will be attached to the 3D data file of structures and preserved as an attachment. Thus, data files in any format are preserved unchanged, except the attached metafile.

2. Programming Uses

The core of the systems of use is a simple compiler that converts metafiles into an executive function that can decode the 3D data and define the geometry of the structures by calling library functions. The definition of the language and the source codes of the compiler is filed permanently.

In addition to the current four examples, templates of library functions called from the metafile will be coded to execute the needed actions in future. One example shown in the photo is an AR application on a tablet that re-visualizes settlements lost in a tsunami in the original location (the vacant ruins are a memorial park today), using GPS and orientation sensors to superimpose rendered 3D data into a captured image on the site.

3. Future Scenario of Use

Technologies and uses of recorded 3D data varies from design, planning, and simulation to manufacturing and decoration of buildings today, suggesting more innovative values in future. In our current studies, records of old or empty structures are used for security control and will further serve as a memory of communities and families after demolition.

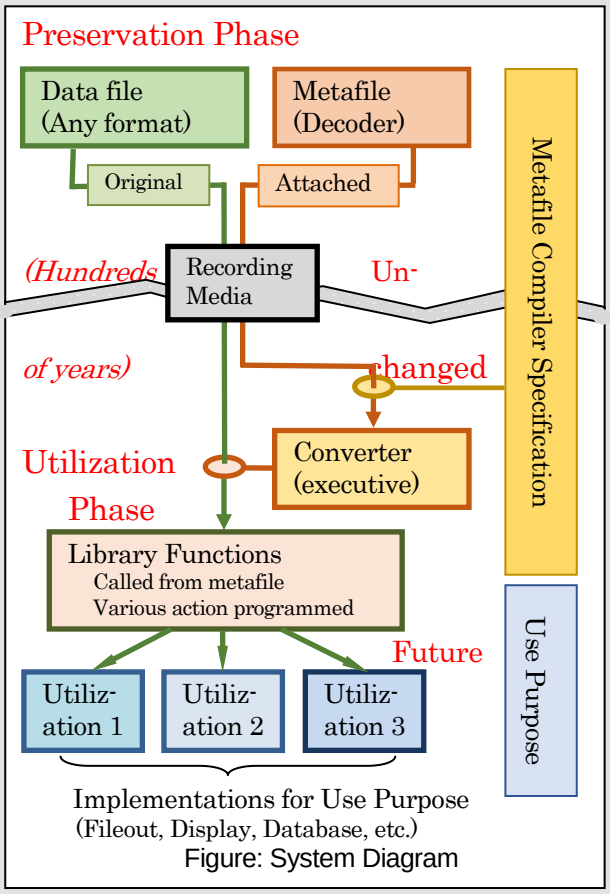


Figure: System Diagram

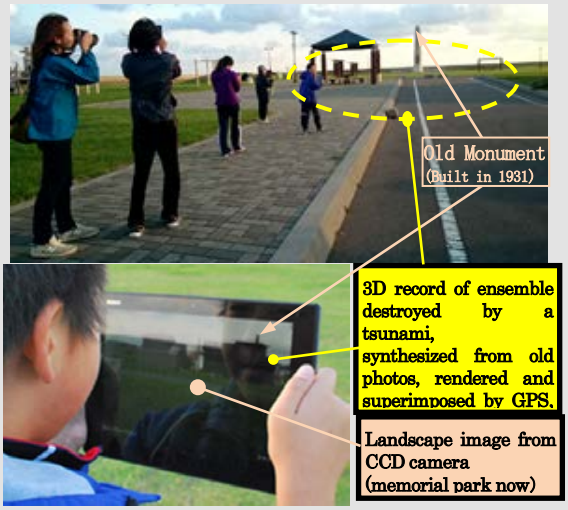


Photo: Pupils on Okushiri Island studying the disaster that occurred in 1993. (Oct. 2014.10)

[Sources]

1) Research Report of NILIM (being prepared)
http://sim.nilim.go.jp/MCS/phi

Development of method to evaluate energy conservation effects of architectural ideas in houses

AKAMINE Yoshihiko (Ph.D. in engineering), Senior Researcher
MIURA Hisashi (Ph.D. in engineering), Senior Researcher
Building Environment Division, Housing Department

(Keywords) Energy conservation, ground heat, ventilation, use of underfloor space

1. Introduction

The amount of primary energy consumption is one of the indexes of the housing and building energy conservation standards. The National Institute for Land and Infrastructure Management (NILIM) is developing methods to evaluate the amount of energy consumption in cooperation with the Building Research Institute. This paper introduces the research and development of methods to evaluate ventilation systems which use ground heat in houses as an architectural idea which matches with regional climates. See the Outline of the Architectural Institute of Japan Conference[1] for details.

2. Overview of the system and demonstration of the effect of reducing energy consumed by heating and cooling

The temperature in the underfloor space of a house with insulated foundation becomes higher than the outdoor temperature in winter and lower in summer because of the ground heat. Thus, energy for heating and cooling is expected to be reduced by taking the outdoor air in via the underfloor space because the outdoor air is preheated by the ground heat. This paper refers to such system as the underfloor-based ventilation system (Fig. 1). The test demonstrated that the energy could be cut by 8.4% for heating and 12.9% for cooling (see Table).

3. Overview of the evaluation method

The energy conservation effect of this system depends on the amount of heat that pre-heats the outdoor air sent into a room and the amount of heat that is lost from a room to the underfloor space. These can be easily found when the underfloor temperature is known. Yet, the underfloor temperature varies depending on the ground temperature. Thus, the team created a new formula to estimate the ground temperature[1] and developed a method to evaluate the energy conservation effect of heating and cooling.

4. Reflection of the method to energy evaluations based on energy conservation standards

The evaluation method was reflected in the computation program[2] that was based on energy conservation standards (October 2014). Figure 2 shows the computation outcome of a building where the test was conducted. While the reduction rates may vary because the test was conducted during a limited period, the trend observed in the test was mostly constant.

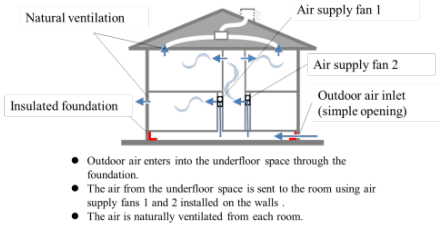


Fig. 1 Overview of the underfloor-based ventilation system

Table Effect of reducing energy for heating and cooling (test result)

	Winter		Summer	
	Type 3 ventilation	Use of underfloor space	Type 3 ventilation	Use of underfloor space
Daily average outdoor temperature (℃)	2.2	2.4	26.4	27.3
Power consumption (kWh)	11.9	10.9	4.2	3.7
Power consumption reduction rate	8.4%		12.9%	

Measured in the test house (total floor area 148.9 m^2) in Higashi Oumi, Shiga, Japan
<Type 3 ventilation> Air supply: natural air supply, Ventilation: Ventilation using fans
<Underfloor-based> Air supply: Air supply using fans, Ventilation: natural ventilation
Measurement period (2013)
Winter: Type 3 ventilation: 2/21-23, Underfloor-based: 2/9-11
Summer: Type 3 ventilation:8/23-25, Underfloor-based: 8/29~31
The power consumption is the total of air conditioners in LDK (living-dining room and kitchen) and bedrooms.

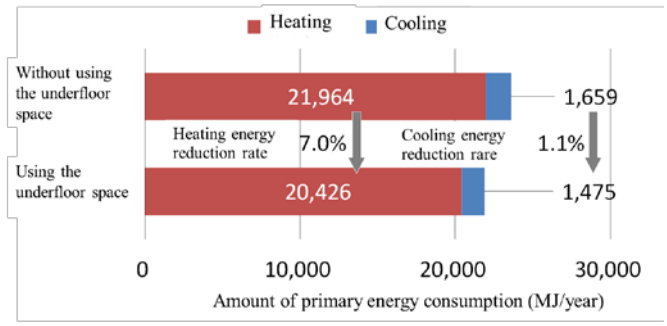


Figure 2. Result of the computation of the energy conservation for heating and cooling in this program

---

☞Detailed information

1) Akamine et al. Study of effects to reduce the load of ventilation-style air conditioning using underfloor spaces of houses with insulated foundations (part 1 and part 2) (in Japanese). The Outline of Architectural Institute of Japan Conference. 2014. pp.635-638
2) Energy conservation evaluation program for houses and dwelling units (in Japanese) (Ver. 1.15)http://house.app.lowenergy.jp/

Attempt to develop road structure data for travel support service

Koichi Shigetaka, Head
Daisuke Toriumi, Researcher
Daisuke Ishida, Guest Research Engineer
Takafumi Asada, Guest Research Engineer
Maintenance Information Technology Division, Research Center for Land and Construction Management

(Key words) road base map information, travel support service, road structure data

1. Introduction

To realize a secure, safe, and comfortable travel support service, we need a map that expresses the detailed road space (in the following, we call this "road structure data"). As used here, the term road structure data does not refer to a map that would be recognized by people, but rather a map that can easily be recognized by an in-vehicle device and software associated with a travel support service, and which is sufficiently accurate and updated. To develop the road structure data, the use of road-based map information, which is a large-scale road map, is expected.

At the NILIM, we conducted collaborative research to establish a development procedure for the road structure data required for a travel support service, where road-based map information was utilized[1)].

2. Devising development procedure for road structure data

In this collaborative research, we defined the requirements of the road structure data for a travel support service on expressways. Then, we drew up a requirement definition document for a map that contributes to the travel support service (draft) (in the following, we call this the "requirement definition document"). For the specification of the road structure data that satisfies the requirement definition document, we wrote up a product specification of the road structure data for the travel support service (draft) (in the following, we call this the "product specification"). In addition, as a development procedure for the road structure data in accordance with the product specification, we created a development guideline for the road structure data for the travel support service (draft) (in the following, we call this the "development guideline").

3. Trial production of road structure data and usability assessment

In this collaborative research, we created a trial product of the road structure data for an expressway with a length of 440 km, following the development guideline (see Figure). We found that we could develop road structure data with sufficient accuracy in relation to the center line of each lane and its curvature, using road-based map information, without actually measuring the roads, if we complemented the data with point group coordinate data combined with the existing resources of electrical maps.

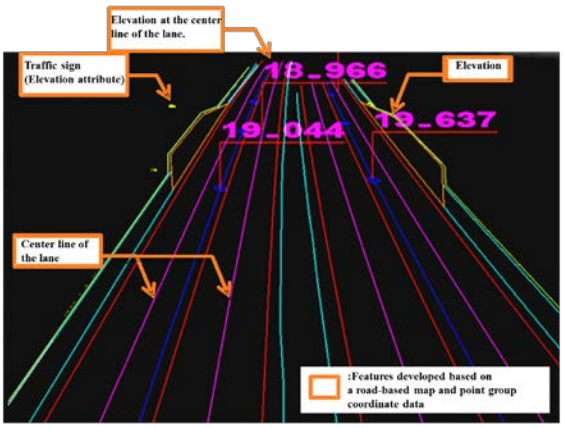


Figure Image of trial product of road structure data

Next, we conducted a driving experiment using the trial product of the road structure data for Hanshin Expressway and Sagami Jukan Expressway, and we found that the curvature of the roads included in the road structure data, and features such as the road signs and dividing lines were useful to control the speed and estimate the vehicle location.

4. Concluding remark

Future issues include establishing methods to update the road structure data, expand its application area (application to general roads), and develop, update, and manage the data continuously.

☞Detailed information:

1) Technical note in NILIM No.848 (in Japanese)
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0848.htm

Efficiency Increase in Sewage Treatment Systems under the Condition of a Falling Population

YAMASHITA Hiromasa, Head, SHIGEMURA Hiroyuki, Senior Researcher, HAMADA Tomoyuki, Researcher, MATSUMOTO Ryo, Researcher, YAMAGUCHI Shuji, Guest Research Engineer
Wastewater and Sludge Management Division, Water Quality Control Department

(Key words) sewage treatment system, depopulation

1. Introduction

Sewage treatment systems include sewerage, agricultural community effluent, human waste treatment facilities, etc. Local governments have adopted the sewage treatment system according to the characteristics of their regions, and the country's percentage of population connected to public sewerage (end of FY2014) reached 89.5%. Meanwhile, the overall population of Japan, which was increasing until around 2010, has been declining, and is expected to fall from the present level of about 130 million to about 87 million in 2060 according to the median value estimate by the National Institute of Population and Social Security Research [1] (see Figure 1).

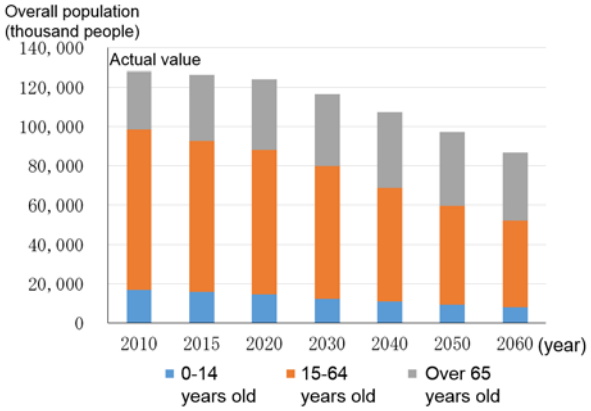


Figure 1: Population Estimate [1]

Since sewage treatment systems have the issue of decline in the operating ratio and profitability of treatment facilities due to the decrease in the required performance of facilities and usage fee as a result of reduced amount of sewage treatment in accordance with population decrease and to the increase in the cost of reconstruction / renewal of aged facilities, etc., the NILIM has been studying the efficiency increase of sewage treatment system under the condition of a falling population.

2. Efficiency increase in sewage treatment system

To increase efficiency in sewage treatment systems, the following three main methods are considered. (i) Scale down existing facilities to the level of required ability. (ii) Utilize the capability of existing facilities and conduct intensive treatment of sewage and sludge in a single sewage treatment system including those from other areas to close the facilities in other areas (e.g., Treatment Facility B in the example of sewage collection and the sludge treatment facility in Treatment Facility B in the example of sludge collection in Figure 2). (iii) Implement the method ii) above for different sewage treatment systems and close the systems merged.

In order to carry out the foregoing methods for efficiency increase in sewage treatment systems, it is essential to consider multiple aspects including reconstruction / renewal plan utilizing existing facilities, cost, energy, and long-term estimate of future population and is necessary to provide the concept of planning with technical consistency and establish an assessment method. In addition, sewerage is likely to be chosen as the center of concentration since its scale is larger than other sewage treatment systems, so it is necessary to clarify input conditions for collecting human waste, sludge, etc. into sewerage as well as technical issues for receiving them and response policy.

The NILIM has been organizing the data on cost and energy focused on the operating ratio of facilities, which would be necessary in studying various issues, and going to study technical issues in receiving human waste, sludge, etc. and response policy and establish an assessment method, etc.

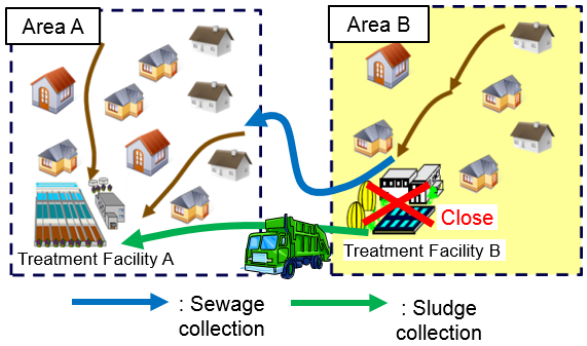


Figure 2: Example of efficiency increase in sewage treatment system

3. Future development

The NILIM promotes maintenance and efficiency increase of sewage treatment systems under the condition of a falling population by preparing technical material for local governments to study / evaluate an efficient sewage treatment system for their regions.

[Reference] 1) National Institute of Population and Social Security Research: Population Projections for Japan (estimated in January 2012), March 2012

A Case of Utilizing Results

Utilization of CommonMP for River Management Practices

KIKUMORI Yoshito (Dr. Eng.), Senior Researcher, KAWASAKI Masao, Head, OTANI Amane, Researcher
Water Cycle Division, River Department
FUKUHAMA Masaya, Research Coordinator for Water Environment
River Department

(Key words) general-purpose platform, hydraulic / hydrologic analysis, element model, extension tool, parallel computing

1. Introduction

CommonMP [1] is infrastructure software for hydraulic / hydrologic analysis that can operate the analytic model (element model) for hydraulic / hydrologic analysis including rainfall run-off and flood analysis, the graph drawing tool (extension tool) for analysis results, etc. Various functions can be added to CommonMP by adding element models and extension tools. This software has been developed since fiscal 2007 and mostly completed, entering into a stage of full application to river management practices. As examples for application of CommonMP to river management practices, this paper introduces addition of the function to create a profile of river discharge capacity and to forecast inflow into a dam reservoir.

2. Example for application to river management practices

The profile of river discharge capacity (Figure 1) shows the flood discharge capacity of the channel profile at each milepost and is often used in river management practices for considering priorities in channel development, etc. Therefore, we have added the function to output discharge capacity profiles to CommonMP. Consequently, the effect of river maintenance can be immediately reflected in the discharge capacity profile by editing the channel profile with GIS attached to CommonMP, which is expected to contribute to efficiency increase in operation, etc.

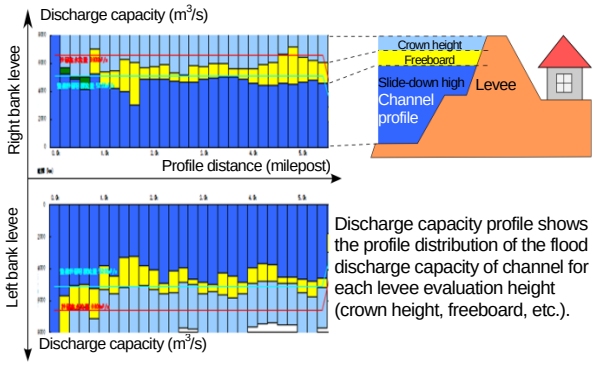


Figure 1: Discharge capacity profile

High-accuracy prediction in inflow to the dam reservoir is essential for smooth and advanced operation of the dam in the event of a flood. Accordingly, we have installed the function to predict dam inflow in CommonMP by applying the particle filter method [2] ahead of others, which has been studied and developed for flood prediction and expected to be introduced (Figure 2). Since the particle filter method requires high computing power, we have added the function for parallel computing to CommonMP to ensure a certain level of predictability and obtain a practical computing speed.

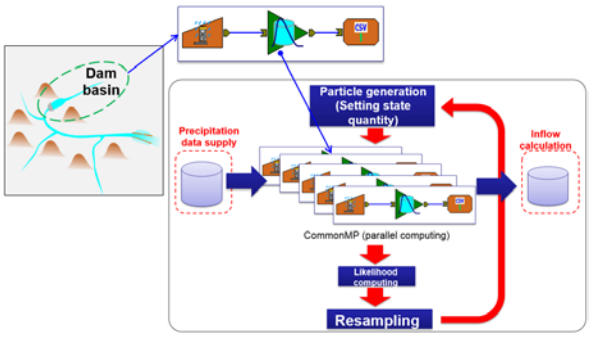


Figure 2: Inflow prediction by particle filter method

3. Future development

The NILIM has been actively holding CommonMP training seminars for the personnel of Regional Development Bureaus since fiscal 2013. We are going to disseminate the functions thus developed through such training seminars, etc. We continue to support upgrading and efficiency increase in river management practices by enhancing the efficiency of conventional methods and promoting the introduction of new technologies to on-site fields with utilization of CommonMP.

☞See the following for details.

1) CommonMP website: http://framework.nilim.go.jp
2) Yasuhito TACHIAKAWA et al: Development of a Real-time River Stage Forecasting Method Using a Particle Filter, JSCE Collection of Papers B1 (Hydraulic engineering), Vol.67, No.4 I_511-I_516, 2011

Technical Development for Displacement Monitoring in Multiple Dams included in the Same Data of Satellite SAR

SATO Hiroyuki, Senior Researcher, ONODERA Aoi, Researcher, SASAKI Takashi (Dr. Eng.), Head
Large-scale Hydraulic Structure Division, River Department

(Key words) dam life extension, maintenance, monitoring

1. Introduction

In order to address the aging of infrastructure and frequent occurrence of disasters in recent years, development is sought for efficient and effective technologies for monitoring infrastructure. The Japanese Government's Council for Science Technology and Innovation has established the Cross-ministerial Strategic Innovation Promotion Program ("SIP") to promote technical development for the maintenance / renewal management of infrastructure. To address one of the individual issues identified by the SIP, i.e., "Development of a displacement monitoring methodology that detects deterioration in the ground and structures widely at an early stage using satellite SAR," the NILIM has been working for development of efficient and effective monitoring technologies using satellite SAR mainly for dams.

2. Outline of the study

Since satellite SAR can observe changes in the ground surface widely by the radar loaded in an artificial satellite (Figure 1), it is possible to measure displacements in multiple dams at one time that are included in the same observation data. Moreover, since satellite SAR uses reflection of the radar, it can obtain observation data without installing observation instruments on the ground. Since satellite SAR can also measure areawide changes on the ground with a high space resolution of approx. 1 to 10 m, it is possible to detect even a minor sign of deterioration that may be overlooked in conventional surveys or inspection patrols.

We have so far conducted technical development for measuring deformation with high accuracy in five rock-fill dams in Okinawa using the observation data of satellite SAR "Daichi" (Figure 2). As the result of measuring displacements in these five dams for about 4 years using satellite SAR and comparing the results with the displacement data obtained by survey and GPS, mean error was approx. 5 mm.

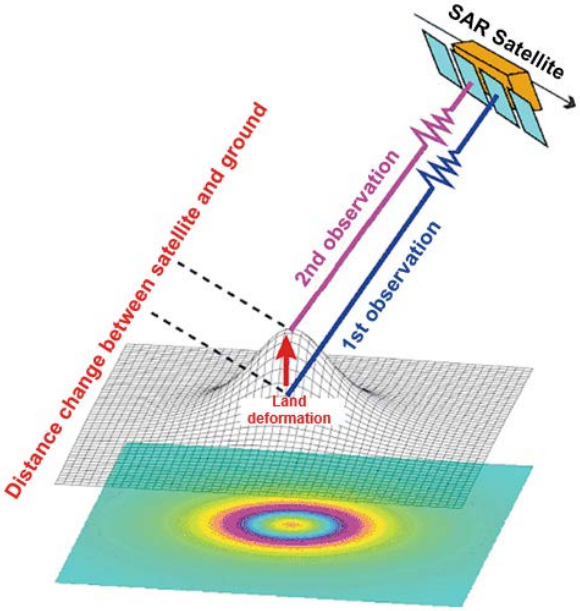


Figure 1: Concept of displacement measurement by satellite SAR[1)]

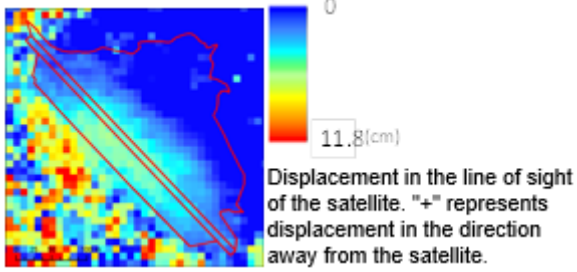


Figure 2: Example for displacement measurement by satellite SAR

3. Future schedule

We continue to improve the accuracy of displacement measurement and conduct technical development for efficient and effective monitoring of displacements in dams utilizing the advantages of both areal data by satellite SAR and point data by survey etc. through combination, and attempt to test our technologies mainly in the dams under direct control aiming for practical use.

[Reference]

1) Geospatial Information Authority: Interferometric SAR homepage http://vldb.gsi.go.jp/sokuchi/sar/

Establishment of efficient and effective environmental conservation measures for road projects

Ryuji Inoue, Head
Nodoka Oshiro, Senior Researcher,
Masamichi Takimoto, Researcher
Yuuki Mitsutani, Researcher
Keiichi Hasegawa, Guest Research Engineer
Road Environment Division, Road Traffic Department

Masao Kurihara, Head
Yusuke Ueno, Researcher
Landscape and Ecology Division, Research Center for Land and Construction Management

(Key words) natural environment, road project, preservation measure

1. Introduction

Various environmental conservation methods have been used for the conservation of rare animals and plants, as well as ecological systems, during road projects. However, their results and details have not been published so that information about the location of rare species can be kept undisclosed to prevent illegal poaching and/or removal. Therefore, at NILIM, we collect and analyze cases of environmental conservation measures (ECMs). We clarify highly effective preservation measures, with the goal of establishing more effective preservation technology by performing verification tests.

2. Evaluation of environment conservation measures for plants

If it is difficult to avoid environmental changes in a rare plant's habitat during a road project, plants will often be transplanted for the conservation of individuals as an ECM. We organized the survival rates by location after the transplanting of each species. Our results suggested that perennial plants, which live for multiple years, had good survival rates, whereas relatives of golden orchids (Cephalanthera), which are often transplanted, had low survival rates and were decreasing yearly (Figure 1).

On the other hand, we identified some cases involving the successful implementation of golden orchid (Cephalanthera) transplantation. In these successful cases, the transplantation location was chosen by considering trees that are associated with mycorrhizal fungi. Thus, we examined some transplanting methods in the field by reference to these successful cases, and attempted to establish a method for transplantation and conservation.

3. Screening for transplantation/translocation sites using species distribution models (SDMs)

The transplantation/translocation sites of plants and small animals (e.g., amphibians) during road projects as ECMs are selected based on whether the environment of the candidate site is qualitatively similar to the original habitat. Recently, SDMs have attracted attention because they can predict and evaluate a habitat quality and potential statistically using the relationship between the species distribution and environmental factors (e.g., vegetation and landforms) (Figure 2). Thus, we examined an effective method for screening the candidate sites for

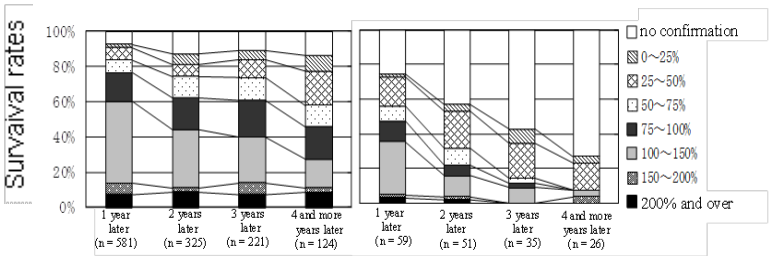


Figure 1 Transition of survival rates after transplantation: Left: perennial plants except for orchids (Orchidaceae), Right: relative of golden orchids (Cephalanthera).

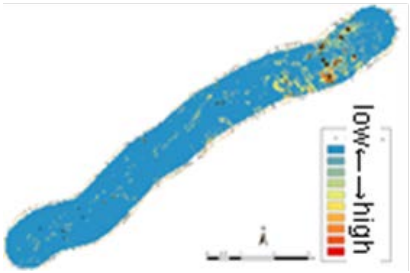


Figure 2 Estimated habitat quality of Japanese brown frog using SDM.

transplantation/translocation using SDMs.

4. Utilization of results

Based on these results, we published a technical note of the NILIM in the spring of 2016. This technical note included much useful information for road administrators, such as case studies of environmental conservation measures for fauna and flora, a conservation method for raptors based on scientific knowledge, and planning/evaluation technology of road crossing structures for mammals (e.g., overpass, underpass, and safety guard).

☞Detailed information:

1) Keiichi Hasegawa, Nodoka Oshiro, Mayumi Kanda, Ryuji Inoue, and Yusuke Ueno, “A study on the current status and effectiveness of transplantation in road projects, with a focus on Orchidaceae”, Proceedings of Annual Meeting of Environmental Systems Research, Vol.42, pp.177-184, 2014. (in Japanese)

2) Nodoka Oshiro, Keiichi Hasegawa, Yusuke Ueno, and Ryuji Inoue, “Comparison of species distribution models for screening transplantation sites”, Proceedings of Annual Meeting of Environmental Systems Research, Vol.43, pp.153-158, 2015. (in Japanese)

Research for road network operation method using intelligent transportation system

Hiroshi Makino, Head
Naoko Matsuda, Senior Researcher
Sachiyo Fukuyama (Ph.D. (Engineering)), Researcher
Hitoshi Yoshimura, Guest Research Engineer
Intelligent Transport Systems Division, Road Traffic Department

(Keywords) road network, road operation, ETC2.0

1. Introduction

Under a network of expressways such as the three ring roads, the need for "smart road use" has been pointed out, in which the functions of a road network are fully demonstrated through operational improvements, to deal with social losses such as traffic congestion and accidents, under financially and spatially limited conditions. At the NILIM, we conduct research and development on utilization measures for intelligent transportation system (ITS) technology to realize the efficient operation of road networks. In this article, we report major issues that need to be examined, and the direction of the research.

2. Issues to examine for road networks

To realize a smooth road operation that deals with traffic conditions that change hourly, it is important to carry out a plan-do-check-act (PDCA) cycle, where we quickly grasp the occurrence of a problem, and take an effective measure. For that purpose, it is necessary to establish a means to grasp road traffic conditions at all times, along with a way to implement operational measures. In our Division, we are addressing these two issues. ETC2.0 has a mechanism to provide combinations of basic functions that are required for the operation of a road network, such as toll collection, probe data collection, and the provision of information. Using this technology, we aim to establish a method for road operation where various data and ITS technologies are used complementarily.

3. Method to grasp road traffic conditions

At present, on expressways, we grasp the road traffic conditions from observation results obtained by vehicle detectors. A vehicle detector is a device used to observe the volume of traffic and speed at the installation point of the device. Considering the cost of installation and operation management, the area where traffic conditions are grasped with high accuracy using only a detector is limited. In contrast, ETC2.0 uses a technique to uplink the travel record accumulated in a vehicle when the vehicle passes through a roadside unit, which allows us to obtain a continuous running trajectory of each individual vehicle. However, it can only measure vehicles equipped with an ETC2.0 in-vehicle device, which makes it difficult to grasp the volume of traffic. Using this mutually complementary information makes it possible to generate highly accurate traffic information, and we are developing a method to monitor the traffic conditions of a road network using these two types of data complementarily.

4. Approach to implement operational measures

There are two major operational measures: one has the goal of leveling the demand across the entire network, and the other has the goal of smoothing the traffic flow at a bottleneck. The former facilitates a change in a user's route by providing information about traffic congestion and enforcing a congestion charge, whereas the latter enforces dynamic control of the speed and lane use to suppress the occurrence of traffic congestion. Concrete

examples of these measures are shown in the figure. Most of these examples have never before been implemented in Japan, and there is an issue about how to implement them. Therefore, we plan to mainly address the issues of how to provide information that is safely recognized and understood by drivers (a method, timing and so on), which is commonly important in each measure, and a way to implement each measure and evaluate its effectiveness. In addition, in a road network, the collaboration of multiple road administrators is an important issue, and we plan to examine measures in cooperation with expressway companies.

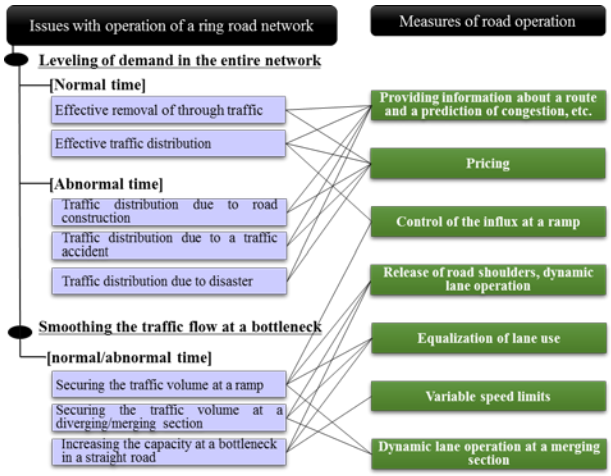


Figure Issues for road network operation and examples of measures

Research on project execution systems through public-private partnerships

Tomohiro Ogawa, Head
Masaki Ohno, Researcher
Kazumasa Kondo, Guest Research Engineer
Tomo-o Tenma, Guest Research Engineer
Shinya Yamaji, Guest Research Engineer
Yasuo Morita, Former Head
Construction Management Division, Research Center for Land and Construction Management

(Key words) Act for Promoting Quality Assurance in Public Works, various bid and contract systems, project execution through public-private partnerships

1. Introduction

The "Act for Promoting Quality Assurance in Public Works" (Law No. 56, 2014) went into force and became effective in June 2014. Article 14 newly stipulated that "The government can select a proper system among those defined in this section and other various ones, or combine them, according to the nature of the public works and actual situations of the region related to that order, when selecting a bid and contract system."

In this document, we introduce various bid and contract systems, as well as research activities concerning project execution systems through public-private partnerships.

2. Various bid and contract systems

Concerning the bid and contract systems for public works directly ordered by the Ministry of Land, Infrastructure, Transport and Tourism, the "design-bid-build system" is commonly used to separate orders for design and construction work. The other systems are as follows:

・"Design-build system including design and construction work" and "Construction work with detailed design system"

・"Early Contractor Involvement (ECI) system" where the quantity and specifications of the construction work are fixed through technical advice of contractors in the design phase, before contracting construction work

・"Construction work with maintenance and management operation system," where the construction work and initial maintenance and management operations are integrally contracted

In addition, there are ordering systems corresponding to ordering units of construction work as follows:

・"Comprehensive ordering system" to order multiple types of operations and construction work in a single contract

・"Multiple-year contract system" to order work spread over multiple fiscal years

Governments can use the systems supporting them (CM and Project promotion PPP system) to manage order-related work when necessary.

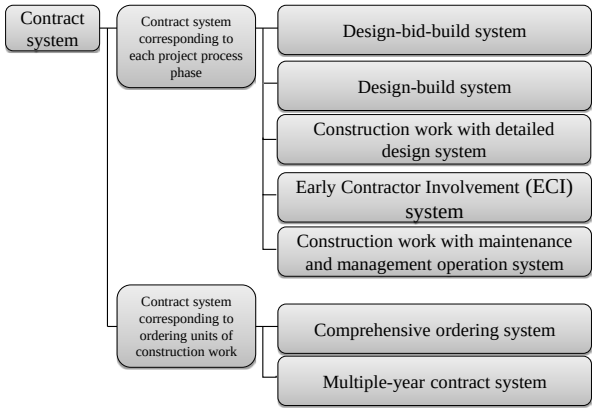


Figure　Major contract systems

3. Research on project execution through public-private partnerships

To utilize the various above-mentioned bid and contract systems, we are following ongoing trial cases to determine the effects and problems of the new bid and contract systems. In addition, in the case of the systems that are no longer utilized, we are considering an introduction method based on project characteristics, such as through a round-table conference for a future ideal construction production and management system, allowing government responsibility (Chairman: Kazumasa Ozawa, professor of School of Engineering, The University of Tokyo).

We will continue to research ways to allow government to select appropriate bid and contract systems, and incorporate the results into the revised guideline as needed.

☞Detailed information:
Web site of Construction Management Division
http://www.nilim.go.jp/lab/peg/index.htm

Utilization of Qualification for Park Administrators to improve their professional abilities and certify park administrators

KURIHARA Masao, Head
ARAGANE Keita, Researcher
Landscape and Ecology Division, Research Center for Land and Construction Management

(Keywords) Urban parks, qualification systems

1. Foreword

The number of officials in many local governments has been steadily decreasing because of escalating fiscal constraints and administrative reforms, among other reasons. The shortage or complete absence of local government officials with specialized knowledge and technical skills in the maintenance, management, and operation of urban parks has become increasingly more conspicuous and has become a more serious problem for smaller local governments.

For this reason, while holding on to the principle that the maintenance, management, and operation of urban parks shall be performed by local government officials, it is also necessary to promote the establishment of a system in which local governments can maintain, manage, and operate urban parks with the support of private sector personnel who have specialized knowledge and technical skills in related fields, depending on the situation.

The purpose of this study is to prepare technical materials that can be used as a reference when local governments decide to utilize qualified personnel in the private sector for the purpose of helping maintain, manage, and operate urban parks. Accordingly, we surveyed the status and effects of the utilization by local governments of private sector qualified personnel in the maintenance, management, and operation of urban parks.

2. Overview of Survey

With regard to private sector qualifications in the maintenance, management, and operation of urban parks (see Table 1), we collected available information by researching websites, making inquiries into the relevant host organizations, and organized information concerning related qualification systems (contents and levels of required technical skills, track records of each qualification being used as criteria for eligibility for participation in tenders, among other things).

With regard to the status and effects of the utilization by local governments of private sector qualified personnel in the maintenance, management, and operation of urban parks as listed in Table 1, we conducted a questionnaire survey for local governments (see Table 2), and the results of the questionnaire survey are as shown in Figure 1.

3. Next Steps

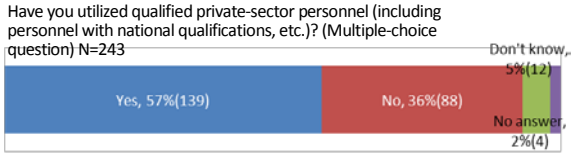
We plan to prepare technical materials that can be used by local governments as a reference when they decide to utilize private sector qualified personnel in the maintenance, management, and operation of urban parks by summarizing the effects of the utilization of such private-sector qualified personnel and procedures for placing orders for public works with them, among other things, based on the results of the questionnaire survey in 2 above. The technical materials are provisionally titled “Explanatory Materials on New Tools for Urban Park Management.”

Table 1. List of Private Sector Qualifications Surveyed

NO	Name of Qualification	NO	Name of Qualification
1	Professional Engineer	26	Garden Designer
2	Registered Civil Engineering Consulting Manager (RCCM)	27	Garden Coordinator
3	Registered Landscape Architect (RLA)	28	Green Advisor
4	Rooftop Gardening Coordinator	29	Horticultural Welfare Care Worker
5	Interior Planner	30	Park Facilities and Products Safety Manager
6	Welfare and Residential Environment Coordinator	31	Park Facilities and Products Maintenance Engineer
7	Forest Engineer	32	Park Administrator
8	Landscape Gardening Work Operation and Management Engineer	33	Certified Park Professional (CPP) and Certified International Park Professional (CIPP)
9	Landscape Gardener	34	Recreation Coordinator
10	Registered Key Landscape Gardening Technician	35	Event Director
11	Garden Manager	36	Test for Technical Ability of Service and Receiving Visitors
12	Garden Designer	37	Service Care Fitter
13	Slope Construction Manager	38	Test for Ability of Biological Classification
14	Sports Facilities Construction Engineer	39	Vegetation Manager
15	Registered Key Sports Facilities Technician	40	Biotope Planner and Builder
16	Tree Doctor	41	Biotope Adviser
17	Pine Tree Preservation Expert	42	Environmental Restoration Doctor
18	Street Tree Pruner	43	Nature Restoration Promoter
19	Street Tree Consultant	44	Environmental Technology Instructor
20	Turf Grass Manager	45	Green Saver Certification Test
21	Tree Planting Soil Consultant	46	Forest Instructor
22	Pesticide Management Adviser	47	Project Wild
23	Excellent Technician/ Supreme Technician (Master)	48	Nature Observation Instructor
24	Environmental Afforestation Tree Identification Certification	49	Secondary Forest Natural Environment Improvement Manager
25	Exterior Planner	50	Biomass Utilization Advisor

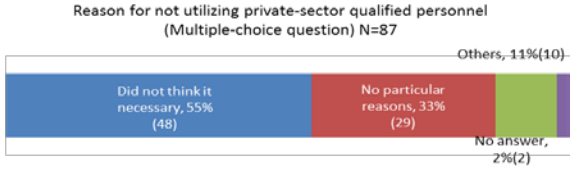
Table 2. Overview of Questionnaire Survey

Local Governments Surveyed	Officials in charge of parks at 322 local governments (i.e. 47 prefectures, 268 cities with population of 100,000 or more, and 7 special wards with population of 500,000 or more)
Survey Questions	Utilization of private sector qualified personnel, names of qualifications that they held and how they were utilized, benefits of utilizing them, reason for not utilizing them, etc.
Number of Respondents	75.1% (243/322)



Benefits of utilizing private-sector qualified personnel (Free answer)

Ensure the safety and quality of park facilities, enhance the quality of public services, obtain the understanding of local residents, etc.



Development of bird survey techniques using advanced equipment and technologies

Yusuke Ueno (Ph.D. (Fisheries Science)), Researcher
Masao Kurihara, Head
Landscape and Ecology Division,
Research Center for Land and Construction Management

(Key words) bird survey, monitoring, environmental conservation measures, bird sound analysis

1. Introduction

Various animal surveying techniques using advanced equipment and technologies have been proposed in the field of mammalogy and/or behavioral ecology, etc. The NILIM has the goal of establishing effective and efficient environmental conservation measures for wild animals, along with the development of efficient survey techniques using their advanced technologies in various public works.

2. Bird survey techniques using advanced equipment and technologies

In this section, we introduce the current development status for bird survey techniques. In the past, bird surveys (especially for raptors) have been conducted by experienced investigators. They searched for the target species and observed their behaviors in the field. These investigations required large amounts of manpower and time, and might be impossible in some cases because of landform and/or vegetation. Therefore, we test the effectiveness of systems to find and follow raptors using three pieces of advanced equipment: infrared thermal cameras (2 models: one was developed for general purposes, and another was developed for animal research), marine radar, and a tracking device equipped with a compact GPS. In addition, we try to develop an analysis program that uses bird calls recorded by IC recorders to detect the existence and reproductive behavior of a target species automatically based on voice analysis technology.

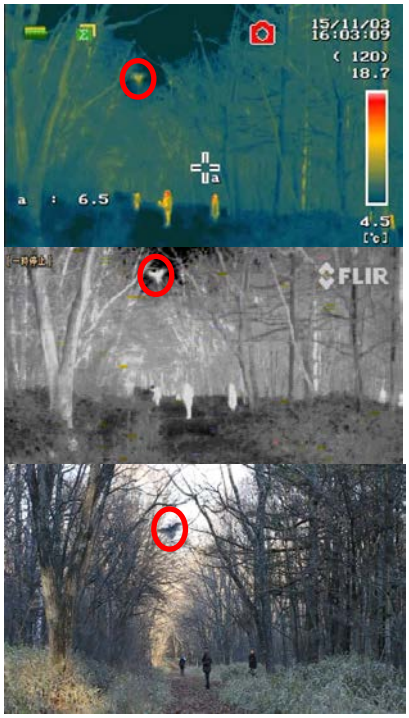


Figure 1: Photographs of goshawk perching on branch. From the top, with the infrared thermal camera (for general purposes), infrared thermal camera (for animal research), and video camera. The distance to the goshawk is approx. 50 m.

3. Future direction

We are preparing a technical note, which is based on these results, and will release it on the NILIM website in spring, 2016.

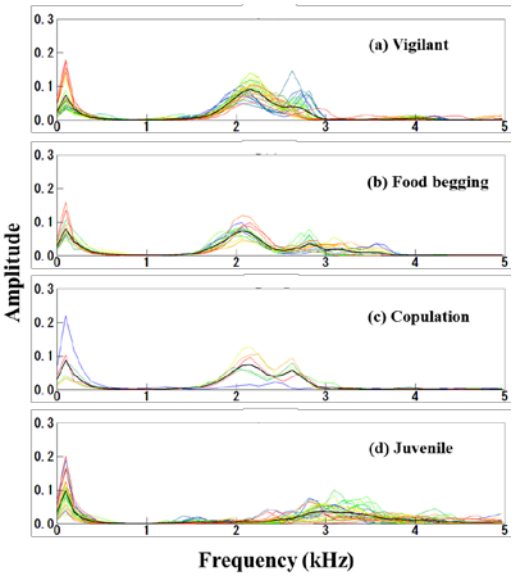


Figure 2: Characteristics of goshawk's call. Each colored line shows a bird call waveform sample (simultaneous calls), and each black bold line shows their average. We are attempting to develop an auto detection program based on statistical analysis, using the differences in the waveforms and call characteristics.

☞Detailed information:

1) Web site of Landscape and Ecology Division
http://www.nilim.go.jp/lab/ddg/

Promotion of research in environmental field

Tsutomu Uchida, Research Coordinator for Wastewater System Restoration
Masaya Fukuhama, Research Coordinator for Water Environment
Osamu Okamoto, Research Coordinator for Coastal and Marine Disaster Prevention
Ryuji Inoue, Road Environment Division Head
Yasunobu Ashie, Building Environment Division Head
Masao Kurihara, Landscape and Ecology Division Head
Secretary of the Environment Research Committee

(Keywords) environment, energy, global warming, CO2, habitat, land use, residential environment, waste

1. Introduction

The departments and center of the NILIM are promoting activities related to the environment, along with research on land management. The Environment Research Committee is promoting information sharing and external information transmission in all environmental research fields, conducted by NILIM, and is also helping to promote cross-cutting surveys and studies.

Total environment	[Environment Research Committee] Overview and progress of environmental research in the context of land management
Energy **Renewable energy**	[Water Quality Control Department] Effective use of sewage heat (B-DASH Project) [Water Quality Control Department] Use of hydrogen energy, produced by sewage bio-gas [Building Department] Utilization technology of low-carbon hydrogen energy [Research Center for Land and Construction Management] Research on utilization of energy, produced by plant waste materials in urban areas
Energy **Energy-saving, heat**	[Water Quality Control Department] How much energy consumption for treated water usage systems can we reduce? [Road Traffic Department] Consideration on effective energy utilization of road facilities [Building Department] Development of energy consumption performance forecast tool, inducing energy-saving design of buildings [Building Department] Actual energy consumption conditions of nonresidential architectures, and countermeasures for energy saving [Housing Department] Creation of evaluation method for housing performance, based on the revised energy-saving standard [Housing Department] Program for energy-saving standard, as a house design tool [Housing Department] Heat island countermeasures analysis system [Urban Planning Department] Three-dimensional data of green space in urban areas, and effect of environmental improvement of green space [Port and Harbor Department] Basic analysis on energy-saving transportation of domestic marine unit load
CO2 emission and fixation quantities	[Road Traffic Department] The volume of carbon dioxide emissions in the road traffic field, derived from automobile performance data [Road Traffic Department] Understanding the quantity of carbon dioxide fixed by concrete structures [Research Center for Land and Construction Management] How much CO2 do trees around us fix? [Airport Department] Calculation of the volume of carbon dioxide emissions from airports, and estimation of reduction effects
Climate change adaptation	[River Department] Deepening our understanding of flood systems, and climate change adaptation [River Department] Reduction of flood damages with the existing dams [River Department] Practical environmental management of rivers [Sabo Department] Changes to prepare for climate change–Soil avalanche and countermeasures [Coastal, Marine and Disaster Prevention Department] What is the long-term change in the average water level along Japan' s coasts?
Habitat	[River Department] Effect of river environmental improvement by middle-scale flash discharge of dams [Research Center for Land and Construction Management] Evaluation of living environment of creatures in wide areas with GIS and proper habitat models, and mapping trial [Coastal, Marine and Disaster Prevention Department] Patterns based on habitat usage characteristics of enclosed bay fish, and consideration of habitat design [Coastal, Marine and Disaster Prevention Department] Making the popular Bay of Tokyo into a bountiful sea
Land use and residential environment	[Building Department] From a structure to "save lives" to a structure "allowing long-term use" [Urban Planning Department] Technology development to support sustainable cities, corresponding to population decline, aging, etc. [Research Center for Land and Construction Management] Natural environment of cities, supporting future society–Afforesting planning technology, corresponding to population decline and urban restructuring
Waste	[Coastal, Marine and Disaster Prevention Department] Linear response features of coasts against the amount of new ocean debris

(Based on the titles of posters, etc. presented at the Symposium on Environmental Research)

Figure: Environmental studies conducted by NILIM

2. Research in environmental field

NILIM has conducted a broad array of environmental studies. Recently, it is promoting research on policy issues related to energy, global warming, habitats, land use, residential environments, and waste (see figure).

3. Research promotion

The Environment Research Committee is working on demonstrations of the environmental studies conducted by NILIM, based on their individual characteristics. In November, the Symposium on Environmental Research was held. It had the theme "Earth and lives in 2050 - Environmental technologies and global tasks," and representatives from thirteen environmental research institutes, including national institutes, independent administrative agencies, and national university corporations, gathered in a hall. NILIM presented lectures and released posters during the symposium (see photo).

In addition, in order to exchange information about environmental research, extend the network of researchers, and promote the research more effectively, we are preparing numerous exchange meetings for the researchers. In FY2015, we exchanged opinions from the "Perspective of environmental research in the land, infrastructure, and transportation administrations" and the "Use of hydrogen energy," and promoted mutual exchanges among researchers working in the

environmental research field.

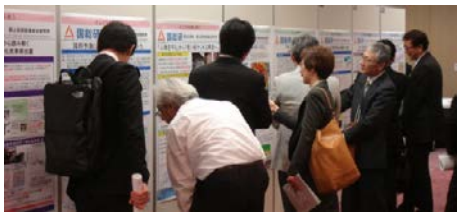


Photo: Exhibit of NILIM studies at Symposium on Environmental Research

Additionally, we are preparing a list of environmental researchers' names, and showing information on the web site.

4. Future deployment

Comprehensive studies in the environmental research field may individually progress to make direct contributions to actual operations, as a result of synergistic effects with the extension of the economic base and disaster prevention and reduction. The Environmental Research Committee is seeking out and promoting a future ideal research system related to the environmental field, and is also widely dispensing information about the latest environmental research results from NILIM to other researchers, administrative organs, and the public.

☞Detailed information:

Web site of Environment Research Committee

http://www.nilim.go.jp/english/org/e_committee/eecommittee.htm

Realization of Environmental Management for Riverine Estuaries

NAKAMURA Keigo (Dr. Eng.), Senior Researcher, SUZUKI Hiroyuki, Researcher, MAEDA Yoshiyuki (Dr. Agr.), Guest Research Engineer, KAI Takashi, Guest Research Engineer, HATTORI Atsushi (Dr. Eng.), Head, River Division, River Department

(Key words) ground level relative to tidal oscillation, Census of Rivers and Riparian Areas, river environment

1. Little known riverine estuaries

Riverine estuaries constitute a complicated environment where salt water and fresh water meet but serve as an important environment where various organisms live. However, the number of studies on riverine estuaries is very small as compared with rivers. For environmental management of riverine estuaries, it is necessary to identify perspective on their environment, which is different from that of rivers, and to clarify the physical environment of habitat that should be preserved.[1] This paper introduces the concepts and studies for realizing such issues.

2. Perspective on riverine estuaries beyond river system

Environmental management of rivers is generally discussed based on such units as basin or water system, but it is important for riverine estuaries to consider biological relations beyond river system, such as inside of the bay. For example, crabs have a habit of returning to the riverine estuary where they were born or to the coastal area around the same estuary after they drifted as larva and spread widely in the sea. As peripheral river areas to focus on, the nine areas in the riverine estuaries as shown in Figure 1 are under consideration as the authors' proposal. Amendment of 2) These areas were determined by considering the results of analyzing the data of the Census of Rivers and Riparian Areas, ocean currents, geographical conditions of inland seas and inside bays in riverine estuaries, etc. Target areas are roughly divided into the Japan Sea and Pacific Ocean sides, and are also divided according to inner bays such as Tokyo Bay and Ise Bay. By observing riverine estuaries according to these areas, results of observation can be utilized, such as restoration of tidal flat aiming at the state of tidal flat remaining in the same area, or assumption of organisms that can be revived.

3. Quantification of the habitat of organisms in riverine estuaries

Although topographic alteration, such as by river improvement, affects the habitat of organisms in riverine estuaries, quantitative relationship between them is not clarified. Therefore, the authors clarified the elevation difference preferred by main organisms in riverine estuaries using the results of the benthos survey in the Census of Rivers and Riparian Areas. [3] (Example shown in Figure 2) "Elevation difference" used herein represents the ground level relative to tide, using "Ground level relative to tidal oscillation" where high tide is 1 and low tide is 0.

By considering river improvement profiles using this relationship, minimization of the effect on the organisms that should be preserved, etc. can be expected.

4. For realizing environmental management of riverine estuaries

Using the relationship between organisms and elevation difference identified in this paper, it would be possible to grasp the characteristics of areas / river systems and changes in habitats, e.g. by tracking historical changes in the distribution of elevation difference used by organisms for each area / water system, and results could be used effectively for formulating policies on preservation and restoration. Furthermore, it would be necessary to study as well factors that define habitat of organisms other than elevation difference.

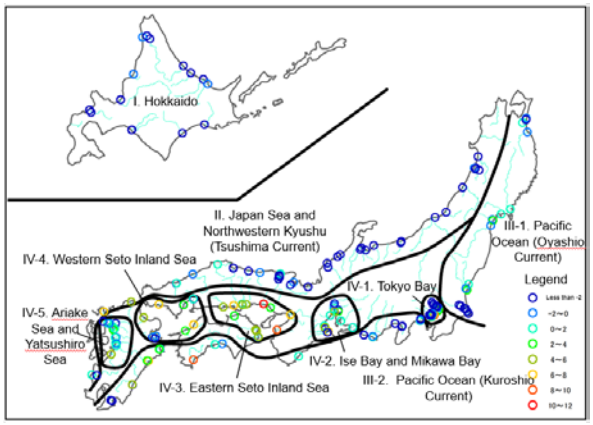


Figure 1: Nine areas of riverine estuaries (Values represent the indicators of diversity)

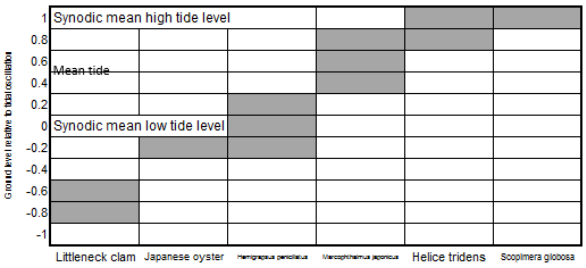


Figure 2: Preference of ground level relative to tidal oscillation

[Reference]

1) Nakamura et al. (2015): Toward Practical River Environmental Management: Concepts and Practice, Journal "Rivers", October issue, No.831, pp.50-54, 2) Nakamura et al. (2015): "An Attempt of Geographical Distribution Evaluation of Biodiversity in Riverine Estuaries based on the Census of Rivers and Riparian Areas," Collection of Presentations in the 19th Ecology and Civil Engineering Society Conference, p.36, 3) Maeda et al. (2015): Relationship between the Appearance of Benthos in Riverine Estuaries in the Country and Ground Elevation Preferred based on the Census of Rivers and Riparian Areas, same as above, p.35

Consideration of arrow feather road markings, indicating traffic space for bicycle users

Yasushi Kimura, Researcher
Katsuaki Imada, Researcher
Naoyuki Kawamoto, Researcher
Tomoya Ueno, Guest Research Engineer
Susumu Takamiya (Ph.D.), Head
Road Division, Road Traffic Department

(Key words) cycleway space, shared use road, road marking

1. Introduction

In a case where cycleway space is prepared for a "shared use road," where bicycles and cars share a roadway, the "Guideline for the preparation of a safe and comfortable environment for bicycle users" (announced jointly by the Road Bureau of Ministry of Land, Infrastructure, Transport and Tourism, and the Traffic Bureau of the National Police Agency in November 2014) stipulates that road markings indicating a cycleway should be prepared as needed, to show the traffic space for bicycle users and call this space to a car driver's attention. The guideline introduces arrow feather road markings as an example, but specifies no concrete dimensions and installation procedures such as an installation interval. Therefore, each road manager individually considers how to prepare road markings.

The NILIM is developing a method to design a cycleway space that considers the operational characteristics of cars and bicycles. In this document, we introduce the result of a driving test that we conducted to consider the recommended dimensions and installation intervals of the arrow feather road markings prepared for shared use roads.

2. Outline of driving test

Various dimensions and installation interval patterns were prepared, including four types of arrow feather widths (40 cm, 60 cm, 80 cm, and 100 cm) and four of arrow feather installation interval patterns (5 m, 10 m, 20 m, and 30 m), for a total of 16 (4 × 4) combinations. We temporarily prepared the arrow feather road markings of each pattern at an NILIM site, and constructed test roads.

In the driving test, a bicycle rider and car driver drove on each test road separately and together (the car passed the bicycle). At that time, we watched the driving conditions through a video camera, and conducted measurements. After the test, we sent out questionnaires to the test subjects to ascertain the visibility of the arrow feather road markings, and their feeling of insecurity and drivability while moving side by side.

Figure: Illustration of test road

Photo: Test scene

3. Test result

Based on the questionnaires, the widths of 80 cm and 100 cm, and the installation intervals of 5 m and 10 m, were appreciated for their high visibility. From the perspective of a feeling of insecurity in bicycle users and drivability in car drivers while moving side by side, the widths of 80 cm and 100 cm received comparably high evaluation marks. However, when the width of the arrow feathers was 100 cm, the car drivers reported a feeling of pressure because the width was too large compared to the roadway width. While watching the driving condition in the test, we found that the bicycles tended to run over the roadway center when driving alone in the road with arrow feathers that were 40 cm or 60 cm wide. Even in this case, when the cars passed the bicycles, they maintained a constant distance from the bicycles, and passed safely.

As previously mentioned, considering the visibility and feeling of insecurity of bicycle users, and the drivability of car drivers, the recommended arrow feather width is around 80 cm, and the recommended installation interval is around 5 m or 10 m.

4. Closing remarks

We will continue to consider methods to design an ideal cycleway space to promote the preparation of safe and comfortable cycleway spaces in various regions.

Traffic safety measures for residential roads by vehicle speed reduction

Sachiko Ohashi (Dr. Engineering), Senior Researcher
Haruka Kawase, Research Engineer
Naoyuki Kawamoto, Researcher
Susumu Takamiya (Ph.D), Head
Road Division, Road Traffic Department

(Key words) residential road, School routes, traffic safety

1. Development of traffic safety measures for residential roads

As arterial roads are being developed, we are getting to the stage where we can transfer motor traffic to such arterial roads and make the residential roads into a space for pedestrians. In this situation, with the goal of substantially reducing the traffic fatalities among pedestrians and cyclists, which are currently at the worst levels in the advanced countries, the standardization of new road specifications for pedestrian and bicycle safety and the construction of a system for administrative measures have been promoted.

2. Research on standardization of new residential road specifications

To standardize new specifications, the NILIM is collecting and organizing technical knowledge as evidence of it. In particular, since high-speed vehicles cause more serious accidents, we are focusing on controlling vehicle speeds by installing humps, narrow areas, and chicanes on roads, and are considering appropriate installation methods and effective shapes for these.

(1) Examination of shapes with driving experiment

We placed humps and chicanes on a test road simulating a residential road, and conducted a driving experiment to consider the most effective shapes.

Photo 1: Driving test on hump

Photo 2: Driving test on chicane

In the experiment, we prepared two types of humps with different heights, and studied the driving speed, noise, vibration, and driver's attitude (Photo 1). We also prepared three types of chicanes with different bending levels and studied the driving speed and attitude (Photo 2). Based on these results, we are analyzing the effects of different shapes, and setting appropriate shapes.

(2) Examination of measures with demonstration experiment

To promote measures, we conducted a demonstration experiment for the measure operation method on elementary-school-commuting roads, in cooperation with Tsukuba City. We extracted dangerous points based on the information of users and various traffic data, and developed and executed a measure. We confirmed effects such as a vehicle speed reduction on the road with installed chicanes and humps (Photo 3, Figure).

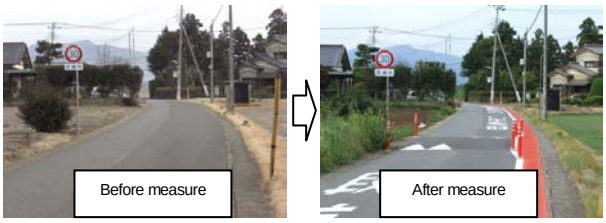


Photo 3: Narrowed hump installation zone

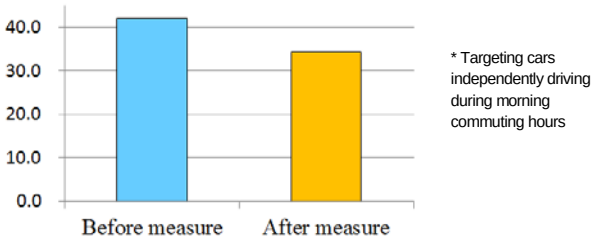


Figure: Speed change in installation zone

3. Future deployment

These research results will be used as basic knowledge for the determination of technical standards concerning new residential road specifications, which the Ministry of Land, Infrastructure, Transport and Tourism is currently

promoting.

☞Detailed information:

1) Web site of Road Division

http://www.nilim.go.jp/lab/gbg/index.htm

Effective energy use measures in road field

Ryuji Inoue, Head
Hiroshi Yoshinaga, Senior Researcher
Keiko Ohkouchi, Researcher
Road Environment Division, Road Traffic Department

(Key words) road, energy saving, heat application

1. Introduction

Recently, institutional reform and technical innovation have been rapidly occurring in the energy field. In 2016, the retail power business is being liberalized, along with power system innovation.

In addition, demonstrative businesses have been deployed in various regions to effectively use electricity and heat by controlling the demands using an IT network connecting houses, buildings, factories, and traffic systems, called a Smart Community. In the road field, according to the revision of the Road Act Enforcement Ordinance in July 2013, the road occupancy charge was reduced by approximately 90%, and the active introduction of renewable energy into road spaces is expected.

The Road Environment Division is considering effective energy use measures in the road field. We estimated the demand for electric power for roads, and considered energy collaboration between the roads and peripheral regions, based on the estimation result. In this document, we introduce the results of this consideration.

2. Current status of power consumption in road field

In order to determine the electric power demand of directly controlled national roads across the country, we researched samples of electric power consumption and estimated the nationwide power consumption. The total estimated power consumption was approx. 581 GWh, which has the breakdown shown in Figure 1. We found the following two characteristics in the electric power demand:

- Almost 80% of the electric power demand was for road illumination, tunnel facilities, and snow melting systems. The road illumination was activated during the nighttime, the snow melting systems were activated in winter, and the drainage facilities were activated on rainy days. Therefore, the electric power demand significantly varied according to season and time.
- In some regions, the annual electric power demand for the snow melting systems was more than 50%, although there was a demand for heat to melt snow, and some snow melting systems with renewable energy such as ground heat were proposed and adopted.

3. Possibility of collaboration between road field and regions

Generally, if customers use electric power anytime they want, power stations must be reinforced to supply electric power at the peak time, which is a problem. Therefore, various regions are promoting Smart Community activities, where the customers intelligently use batteries, share electric power, and optimize the balance of the regional energy demand corresponding to variations in the electric power demand. We considered the effective use of excess energy in regions where energy (electricity and heat) is consumed for the road field by collaboration with the peripheral regions, through the application of this system (Figure 2). The problems to be solved are sharing the facility costs and a discussion about wider energy management. We will continue to monitor new technological trends and consider their effective use for the energy consumed in road facilities.

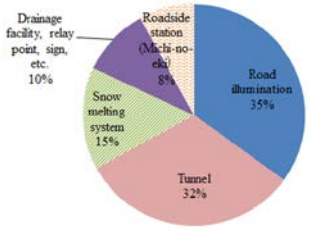


Figure 1: Breakdown of estimated electric power demand by directly controlled national roads

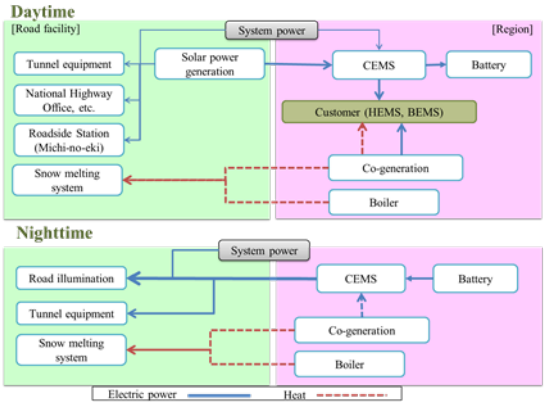


Figure 2: Energy usage plan in road field

☞Detailed information:

1) Keiko Ohkouchi, Ryuji Inoue, Hiroshi Yoshinaga: "Consideration on effective energy utilization of road facilities" (Lectures of the 43rd Environmental system research paper rollout, pp.33-37, 2015) (in Japanese)

Topics

Development of introduction and evaluation methods for promoting further utility pole removal

Ryuji Inoue, Head
Nodoka Oshiro, Senior Researcher
Yuki Mitsutani, Researcher
Road Environment Division, Road Traffic Department
Toshiaki Mabuchi, Head
Hideaki Nishida, Senior Researcher
Minoru Abe, Senior Researcher
Foundation, Tunnel and Substructures Division, Road Structures Department

(Key words) utility pole removal, underground installation, cost reduction

1. Introduction

With the goal of improving disaster prevention properties of roads, ensuring safe and pleasant traffic spaces, creating beautiful scenery, and tourism development, we have promoted the removal of utility poles from roads by placing electrical power lines underground. The NILIM is conducting verification tests to solve technical problems, leading to cost reductions, while simultaneously researching policies and technical trends abroad, in order to promote the removal of utility poles from road. In this document, we introduce an outline of these activities.

2. Low cost utility pole removal methods

We are considering various technical problems to reduce the cost for the introduction of buried electric cables. To verify the impact on road functions and electric supply and communication functions when electric cables and others are placed inside pavement at shallower levels than the conventional cases, we conducted accelerated loading tests, and checked for cable damage (see Photo 1). The results were incorporated into the intermediate report of the "State of Deliberations by the Low Cost Utility Pole Removal Methods Technology Study Committee"[1)], which was released in December 2015. We are continuing to research problems that occur during construction, including the development of a confirmation method for buried objects.

3. Evaluation indicator of utility pole removal corresponding to policy purpose

Because there are a large variety of effects produced by utility pole removal, we have to evaluate these effects quantitatively in relation to the policy purpose. As the first step, we set individual evaluation indicators for three policy purposes: the improvement of disaster prevention, formation of landscapes and tourism development, and ensuring safe and comfortable traffic spaces. We are considering how to evaluate the achievement level.

4. Research on cost reduction technology and policy abroad

Internationally, both developed countries of Western Europe and America (see Photo 2) and major cities in Asia have promoted utility pole removal. Previously in Japan, Cable Box (CAB) system lines and utility ducts have been adopted. In foreign cities, the install-without-pipe/duct method has been adopted. We are researching the current activities and technologies for cost reductions in those cities, such as the cable burying criteria (install-without-pipe/duct, install depth, etc.) and burying techniques (digging, laying, burying, backfill, etc.).

5. Closing remarks

In order to promote the utility pole removal, we will continue to conduct activities to establish technologies to reduce costs and a project effect evaluation method in the future.

[Reference]

1) State of Deliberations by the Low Cost Utility Pole Removal Methods Technology Study Committee, http://www.nilim.go.jp/lab/ucg/koho/index.html

Photo 1: Checking damage to underground cables

Photo 2: underground cables in London

Forecasting the Number of Future Households Requiring Special Assistance in Securing Housing

HASEGAWA Hiroshi (Doctor of Engineering), Research Coordinator for Housing Performance, Housing Department

(Keywords) The Households Requiring Special Assistance in Securing Housing, public housing, extremely low annual household income, forecasting method

1. Foreword

With the rapid aging and decline of the population in Japan, it has become an important task to ensure the provision of stable accommodation for people who require special assistance in securing housing, such as elderly or low-income people (hereinafter referred to as the "Households Requiring Special Assistance in Securing Housing"). In addition to an adequate supply and management of public rental properties, such as public housing, it is essential to bolster the housing safety net system through the effective utilization of a recently increasing number of empty private-sector rental properties, etc.

For this reason, under the three-year program starting from fiscal year 2015, we have been engaged in the development of technologies for the strategic management of housing functions that have a vital role in ensuring the provision of stable accommodation in communities. As part of this initiative, we have successfully developed the method for forecasting the number of the Households Requiring Special Assistance in Securing Housing.

2. Framework of Method for Forecasting the Number of Households Requiring Special Assistance in Securing Housing

We have defined the Households Requiring Special Assistance in Securing Housing as households who qualify for public housing assistance and with an extremely low annual household income (households whose annual household incomes are not sufficient to cover rent payments required to rent at an appropriate rent burden rate a private sector housing unit that meets the minimum living space requirements). The key features of the forecasting method developed by us are as follows: (i) the number of Households Requiring Special Assistance in Securing Housing can be forecasted chronologically every five years during the period from 2015 through 2040 to make it possible to study the management of public housing stock and the utilization of private-sector rental housing from a mid- and long-term perspective, and (ii) the number of Households Requiring Special Assistance in Securing Housing can be forecasted not only for the municipality as a whole but also for smaller district levels, such as junior high school districts, to make it possible to study the appropriate provision of public housing and the utilization of private-sector housing stock in collaboration with community renovation initiatives. The basic algorithm of this forecasting method is as shown in Figure 1.

3. Case Study Using Data on Specific Local Governments

We developed this forecasting method by making a case study using data on specific local governments to verify the viability of methods for generating data necessary for forecasting at municipal levels, among other things. As an example, the forecasted number of Households Requiring Special Assistance in Securing Housing by junior high school district for a certain local government as of 2030 is shown in Figure 2.

4. Next Steps

We are planning to create and publish a programmed version of this forecasting method, together with its instruction manual, for easier use by local government officials.

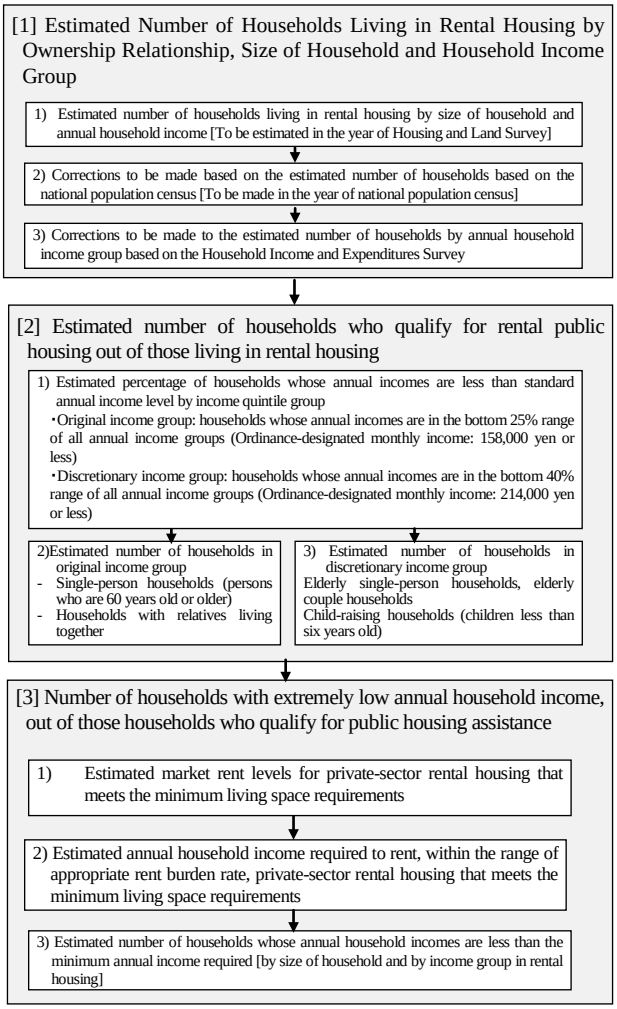


Figure 1. Basic Algorithm of Method for Forecasting the Number of Households Requiring Special Assistance in Securing Housing

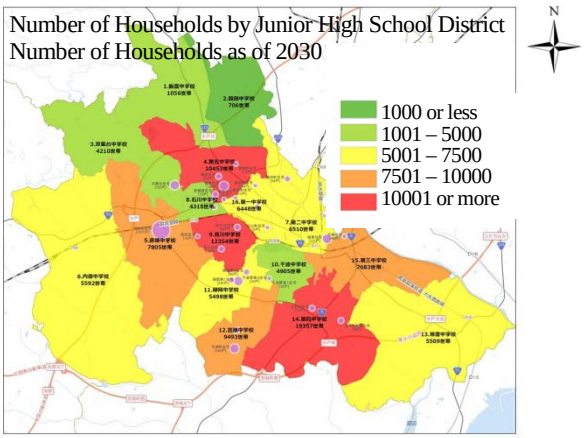


Figure 2. Example of Forecasted Number of Households Requiring Special Assistance in Securing Housing (as of 2030 and by junior high school district)

Clarifying Key Factors that Determine the Housing Satisfaction Levels of the Younger Generation and Child-Rearing Generation

HASEGAWA Hiroshi (Ph.D. in engineering), Research Coordinator for Housing Performance
Housing Department

(Keywords) Younger generation, child rearing generation, Housing Satisfaction Level, priority improvement items

1. Foreword

The objective of the Basic Plans for Housing (National Plan for 2011 to 2020) is to ensure stable and quality housing for all citizens. To achieve the objective, it is essential to focus on the implementation of effective housing policies. Under the three-year plan starting from fiscal year 2014, we have been engaged in attempting to clarify the determinants of the level of people's satisfaction with the quality of housing (hereinafter referred to as the "Housing Satisfaction Level") by generations and by household attributes. In fiscal year 2015, we extracted important and high priority determinants of the Housing Satisfaction Level through analysis using a statistical survey targeted at younger generation and child-rearing generation primarily in their 20s to 30s.

2. Extraction of Important and High Priority Determinants for the Improvement of Housing Satisfaction Levels through Customer Satisfaction (CS) Portfolio Analysis

In the Comprehensive Housing Survey conducted by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), levels of satisfaction (four levels from *satisfied* to *extremely dissatisfied*) and levels of importance (three levels from *important* to *not important*) were measured in terms of the elements of housing and living environment (a total of 30 items). The CS portfolio analysis was undertaken using the results of this survey to extract important and high priority determinants for the improvement of Housing Satisfaction Levels.

This analytical method is designed to extract determinants for improvement by analyzing the correlation of the satisfaction level of each element vis-à-vis an overall evaluation of satisfaction levels (deviation value) and also the correlation of the importance level of each element vis-à-vis the mean score of importance levels (deviation value) and by plotting the deviation values of the satisfaction levels of the elements on the vertical axis and the deviation values of the importance levels of the elements on the horizontal axis. The basic concept of this analytical method is shown in the figure.

The results of the CS Portfolio analysis on a nationwide basis by using the results of the 2008 Comprehensive Housing Survey are shown in the table. Priority improvement items vary according to household type, but common items include, in terms of the elements of housing, safety in the event of an earthquake, a typhoon, etc., crime prevention, airtightness and thermal insulation, and noise insulation, and in terms of the elements of living environment, safety for walking on neighboring roads, public security and crime prevention, and lower noises, among other elements.

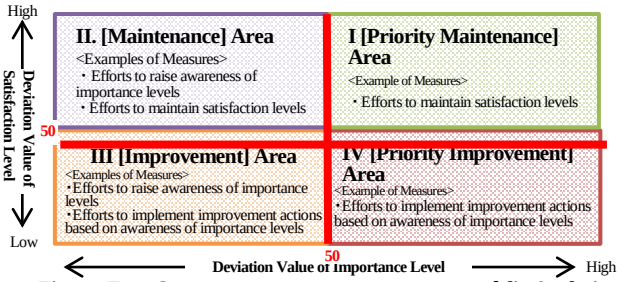


Figure: Four Quadrants of Basic Concept in CS Portfolio Analysis

Table: Results of CS Portfolio Analysis (2008 Comprehensive Housing Survey)

	Element \ Household Type	Single person household		Married couple household		Parents with children household		
		1	2	1	2	3	4	5
Elements of Housing	Size and room layout of housing units	I	I	I	I	I	I	I
	Plenty of storage space, easy to use storage space	I	I	IV	IV	IV	III	III
	Easiness to use and size of kitchen, bathroom and other wet areas	IV	I	I	I	I	II	II
	Safety of housing units in the event of earthquake or typhoon	IV	IV	IV	IV	IV	IV	IV
	Safety of evacuation in the event of fire	I	I	I	I	I	I	I
	Crime prevention in housing	IV	I	IV	IV	IV	IV	IV
	Housing devoid of wear and tear	II	II	II	III	III	III	III
	Easy to maintain housing	II	II	II	II	II	II	II
	Thermal insulation and airtightness of housing	IV	IV	IV	IV	III	III	III
	Energy-efficient housing	IV	IV	III	III	III	III	IV
	Elderly-friendliness, etc.	III	III	III	III	III	III	IV
	Ventilation performance	III	IV	III	III	III	III	III
	Daylighting in main living rooms	I	I	I	I	I	I	I
	External noise insulation	IV	IV	IV	IV	IV	III	III
	Insulation against sounds from upstairs, downstairs and neighbors	IV	IV	IV	IV	III	III	II
Elements of Living Environment	Safety in the event of fire, earthquake, flood, etc.	I	I	IV	I	I	I	IV
	Barrier-free access to housing and its premises	III	III	III	III	III	III	III
	Safety for walking on neighboring roads	III	IV	IV	IV	IV	IV	IV
	Public security and crime prevention	IV	IV	IV	IV	IV	IV	IV
	Low noises, low atmospheric pollution, etc.	IV	IV	IV	IV	IV	IV	I
	Convenience for commuting to work, school, etc.	I	I	I	I	I	I	I
	Convenience for daily shopping and for access to medical welfare facilities, cultural facilities, etc.	I	I	I	I	I	I	I
	Playgrounds for children, parks, etc.	II	II	II	II	IV	IV	II
	Interaction with nature, such as greenery and water front	II	II	II	II	II	II	II
	Large housing premises, and sunny and airy environment	I	I	I	I	I	I	I
	Townscape, scenery	II	II	II	II	II	II	II
	Proximity to parents' or relatives' houses	III	II	II	II	II	II	II
	Involvement with neighbors and community	III	II	II	II	II	I	I
	Availability of welfare and nursing care services, etc.	III	II	III	III	II	II	I
	Availability of child rearing support services	III	III	III	III	IV	IV	III

[Classification of Household Types]
(i)up to 34 years old, (ii) 35 to 44 years old, (iii) Eldest child: up to 5 years old, (iv) Eldest child: 6 to 11 years old, (v) Eldest child: 12 to 17 years old

3. Next Steps

We will clarify key factors that determine the Housing Satisfaction Levels of the younger generation and child-rearing generation through ongoing detailed analysis.

For low-carbon urban development using greenery

OHASHI Masamiki Senior Researcher
KIUCHI Nozomu, (Ph.D. in Engineering) Head
Urban Planning Division, Urban Planning Department
ASHIE Yasunobu (Ph.D. in Engineering) Head
Building Environment Division, Housing Department

(Keywords) Low-carbon urban development, urban greening, heat island

1. Introduction

The Low Carbon City Act was enacted in December 2012. With this law, activities have been implemented to develop low-carbon urban cities based on three fields of (i) an urban structure and transportation field, (ii) energy field, and (iii) green field. Among these fields, the green field is expected to have direct effects of fixing and absorbing CO_2 through urban greening and indirect effects of reducing carbon through energy conservation effect of buildings near areas where the thermal environment is improved through greening. Yet, it is difficult to identify the quantity of greens. Thus, the current studies are only estimating the converted amount of direct CO_2 fixation and absorption by plants in parks where conditions of greens such as the number of plants are being controlled.

Therefore, the National Institute for Land and Infrastructure Management (NILIM) started a three-year plan of a study[1] concerning the development of methods to evaluate low-carbon urban development by improving the urban thermal environment using greens from FY 2015 to 2017.

2. Detail of the study

Figure 1 describes the structure and content of the study.

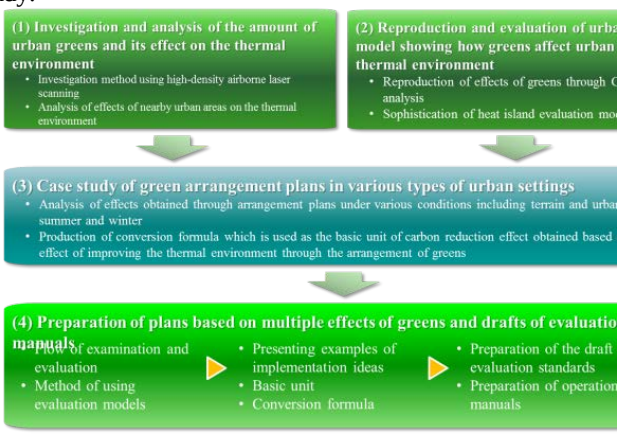


Figure 1. Structure of the study

Step (1) of the study first investigates three-dimensional distribution of greens using airborne LiDAR to identify conditions of urban greens, which are difficult to capture from the ground (Fig. 2). Effects of greens on the thermal environment of nearby buildings are investigated in this step. In step (2), flows of heat and wind are recreated and evaluated by individual blocks using the method of computational fluid dynamics (CFD) that simulates them using numerical computation. A method to quantitatively convert the effect of carbon reduction is established in this step. In step (3), urban thermal environment evaluation tool[2] of which functions are improved based on the analytical outcomes in (1) and examinations in (2) is used to find a method to effectively arrange greens to suit regional conditions. In step (4), the draft of a manual for local governments is created based on the examination in step (3).

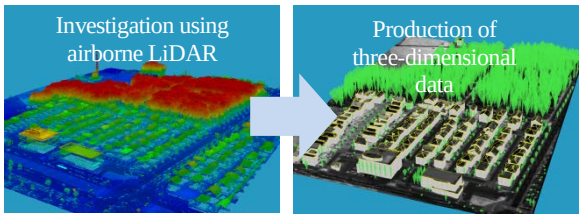


Figure 2. Investigation of the three-dimensional distribution of greens

3. Conclusion

Future activities of this study include the following: development of methods to quantitatively convert indirect carbon reduction effect of green; preparation of a manual for proper arrangement of greens to reduce carbon in cities; and technically support local governments to effectively and efficiently create low-carbon cities using greens with these tools.

☞Details

1) Website of NILIM Urban Planning Department Urban Planning Division
http://www.nilim.go.jp/lab/jbg/green/green.html
2) Urban thermal environment effort evaluation tool
http://www.nilim.go.jp/lab/icg/hyouka-tool.htm

Evaluating the Location of Manufacturing Establishments in Cities by Utilizing a Preliminary Tool to Monitor Neighboring Noise Effects

KIUCHI Nozomu (Doctor of Engineering), Head, Urban Planning Division, Urban Planning Department
HIRAMITSU Atsuo (Doctor of Engineering), Head, Equipment Standards Division, Building Department

(Keywords) Use restrictions, manufacturing establishments in cities, noises, Permission under the Proviso

1. Foreword

In Japanese cities, where historically, many urban built-up areas with a mixture of land uses have been formed, it is necessary to realize a livable urban environment and functional urban activities by limiting and harmonizing the conflicts of different land uses that may arise under the regulation of use districts. Given government policies and social trends toward promoting the creation of cities with centralized urban structure, fostering and protecting traditional industries and manufacturing *monozukuri* (Japanese art of manufacturing) industries, and introducing new forms of manufacturing and service activities, it may be appropriate to promptly and accurately evaluate and identify major external factors that may affect the location of manufacturing industries in cities during urban planning.

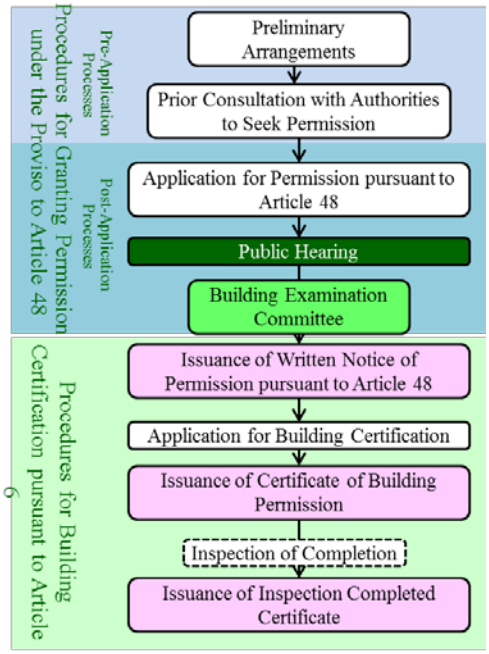
Based on that recognition, in the last fiscal year, we focused our study on the noise generated from manufacturing establishments in cities, and developed a calculation sheet designed to calculate the levels of noise generated from manufacturing equipment at any outdoor evaluation point.[1] In this fiscal year, we evaluated advantages and disadvantages in using this calculation sheet as a preliminary evaluation tool to monitor neighboring noise effects (hereinafter referred to as the "Evaluation Tool") for the purpose of the procedures for granting permission pursuant to the provisions of the proviso to Article 48.1 of the Building Standards Act.

2. Issues with Permission under the Proviso and Utilization of Evaluation Tool

Appendix 2 to Article 48 of the Building Standards Act specifies for each use district the uses for which buildings or structures can or cannot be built or constructed. In addition, even with regard to the uses for which buildings or structures cannot be built or constructed, if a specific administrative agency agrees that such prohibited uses do not compromise the environment of residential areas or are both necessary and unavoidable from the standpoint of public interest for any particular use district, it may grant permission to such prohibited uses after holding a public hearing and obtaining the approval of the relevant building examination committee (hereinafter referred to as "Permission under the Proviso").

With regard to the location of manufacturing establishments in cities, the levels of noise are one of the most important metrics in terms of environmental impacts in urban built-up area and thus for granting Permission under the Proviso. In this connection, we have confirmed that the following advantages can be expected from the use of the Evaluation Tool by applicants for Permission under the Proviso and specific administrative agency officials, among other people: (i) It is possible for them to forecast the levels of noise and therefore to use the forecast results as objective evidentiary materials for reviewing and granting permission by the building examination committee, and (ii) as it is possible to quantitatively and objectively identify the effects of noise control measures, the data obtained can be used to help resolve troubles with neighbors, among other things.

Then, with the cooperation of several specific administrative agencies, based on past examples in which the granting of Permission under the Provision was examined, we examined the possibility of making calculations based on submitted materials, verified the appropriateness of the calculation results and verified that it was possible for specific administrative agency officials, et al., to input data into the Evaluation Tool and operate it. Accordingly, we have confirmed that the use of this Evaluation Tool is appropriate for the purpose. With regard to the mechanism and processes for examining the granting of Permission under the Proviso by the use of the Evaluation Tool (see the figure), which is focused on the levels of noise, we have prepared, on a trial basis, a sample noise calculation sheet format and also sample entries in the evaluation document used for review by the building examination committee (equivalent to a staff report in the United States), by reviewing, for reference, a mechanism for issuing a conditional use permit in the United States.



In addition, we have identified issues, such as verifying the completion of buildings or structures and taking action when necessary, and whether it is appropriate for administrative agency officials, who should remain in the background, to prepare the evaluation document. Accordingly we have obtained and organized opinions from experts and working-level people concerning these issues.

3. Next Steps

Based on the study results in this fiscal year, we will summarize and publish the utilization method of this Evaluation Tool and its utilization permission processes, together with an instruction manual thereof, through the NILIM website.

---

[1] NILIM 2015 report, p.124, "Developing a Preliminary Evaluation Tool to Monitor Neighboring Noise Effects from a Manufacturing Establishment inside the City"
http://www.nilim.go.jp/lab/bcg/siryou/2015report/ar2015hp102.pdf

Initiative to Enhance the Quality of Public Open Spaces

SHINGAI Hiroyasu, Head
YOSHIDA Jundo, Senior Researcher
Urban Facilities Division, Urban Planning Department

(Keywords) City center, pedestrians, attraction of pedestrians, public open space, experiment

1. Foreword

In order to ensure that a greater number of people utilize a public open space in the city center as a place for relaxation or interaction, NILIM has undertaken a study of enhancing the quality of public open spaces. As part of the study, we conducted an experiment to clarify how the arrangement of street furniture, for example big trees and benches, in a public open space in the city center affects the behavior of pedestrians. In this paper, we would like to introduce the contents of our experiment.

2. Outline of Experiment

The experiment was conducted at the Toyama Grand Plaza (indoor open space) for five weekdays (six hours per day). The arrangement of trees, chairs, tables, and benches, among other things, was changed on each day of the experiment period, and the behavior of pedestrians was recorded daily. The recording methods used are (1) tracing method (in which an investigator observes pedestrians and records the trajectory of pedestrian movement), (2) static log method (to monitor the behavior of pedestrians when they stay around in a certain area in the open space), and (3) gate count method (to survey the pedestrian traffic volume at the entrance and exit of the open space). The data obtained are shown in the figure so as to enable readers to visually understand the flow of pedestrians and their behavior when using the open space.

Photo. Scene of Experiment

3. Results of Experiment

During the experiment, (1) when a sense of enclosure was created, for example by arranging plants or setting up a restaurant, coffee shop, or café, in a certain area of the open space where pedestrians were predicted to stop and stay around for a while, indeed many pedestrians stopped and stayed there for some time, and (2) by changing the arrangement of seats and plants, the distribution of pedestrian movement changed more drastically than expected, resulting in fewer pedestrians walking through without stopping. As a result of the experiment, it has been found that the arrangement of space and furniture can greatly affect how the space is used.

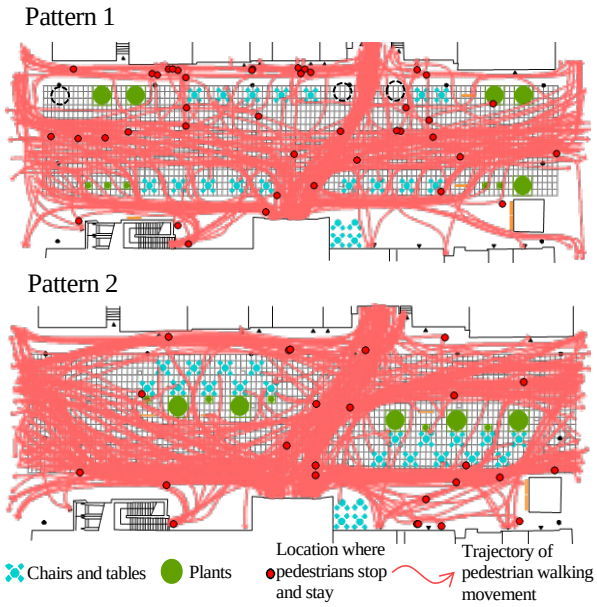


Figure. Examples of Arrangement Patterns and Pedestrian Walking Dynamics

4. Next Steps

Based on the data obtained during this study, we would like to analyze how the layout of public open spaces affects their quality (for example, the attraction of pedestrians or the formation of community) by studying the detailed behavior of pedestrians while they use a certain area (for example by surveying the number of conversation topics, and what they eat there).

In addition, we are planning to publish a manual that, by helping to classify public open spaces by the attributes of users and the conditions of connection to surrounding facilities, supports the development of measures to promote public open space activities that are suitable for each location and the creation of public open spaces that best fit in with the surrounding environment..

[Related Material] Manual on Measures to Attract More Pedestrians "*Hakken* (Discovery)"
http://www.nilim.go.jp/lab/jcg/index.files/nigiwai.pdf

For the development of pedestrian spaces to respond to diversified types of pedestrians

SHINGAI Hiroyasu, Head
YOSHIDA Jundo, Senior Researcher
Urban Facilities Division, Urban Planning Department

(Keywords) Aging society, pedestrian space, walking speed and pedestrian density

1. Introduction

There are a variety of types of pedestrians in large cities in terms of attributes (e.g. gender and age), purpose of walking (e.g. commuting to work or school, shopping, and sightseeing), and things they are carrying (e.g. suitcase and baby stroller). Various types of actions (e.g. walking fast and staying at one spot) are intermingled at a significant level in cities. Meanwhile, past studies argued that walking speed and pedestrian density could be expressed using a certain relational expression depending on nearby conditions.[1] Since the volume of pedestrian traffic can be computed from speed and density, the traffic volume can be found if only the speed is known. This can be used for designing the capacity of pedestrian walks. Under such circumstances, National Institute for Land and Infrastructure Management is seeking an ideal development of comfortable pedestrian spaces where various types of pedestrians are walking at various speeds.

As a preliminary step in this study, the team identified conditions and compared pedestrian spaces in large cities using a case in which pedestrians with various attributes are intermingled (case 1) and a case in which pedestrian attributes are relatively homogeneous (case 2). This paper introduces the result of this preliminary investigation.

2. Overview and outcome of the investigation

For case 1, the team selected Roppongi, Ueno, and Nihonbashi subway stations on weekdays from 15:00 to 18:00, when the subway stations were crowded with people on shopping. For case 2, the team selected the sidewalk of Sotobori-dori Street near Shinbashi Station on weekdays from 8:45 to 9:00, during which most people walk in the same direction to go to work. The team observed pedestrians using video cameras and collected walking speed and other conditions.

Photo: Sidewalk near Shinbashi Station

The team then categorized pedestrian attributes based on gender, age, whether they were forming groups, and any baggage they were carrying for each case and organized average speeds for each of the categories. In addition, the team conducted F-test and t-test for sets of attributes. The team categorized multiple attributes into the same group if no significant difference was seen between them. The team then organized the attributes in the table below. The team found that the average walking speed of case 2, mainly consisting of the traffic of commuters, was generally faster than case 1, consisting of intermingled people on shopping. The team also found that the difference between elderly people and non-elderly people was small, and that difference between male and female was small in case 2.

Table. Average walking speed (m/s)

Group	Baggage	Case 1				Case 2			
		Non-elderly		Elderly		Non-elderly		Elderly	
		Male	Female	Male	Female	Male	Female	Male	Female
Solo	None	**1.41**	1.29	**1.13**		1.59	1.53	1.45	1.42
Solo	Suitcase	1.37	1.25	1.07		1.63	-	-	-
Solo	Baby stroller	1.19				-	-	-	-
Two people	None	1.33	1.17		1.04	1.38	1.48	-	-
With a child	None	1.03				-	-	-	-
Three or more	None	1.16	1.05	**0.88**		-	1.37	-	-

*Elderly: Pedestrians who appears to be age 65 or older based on the judgment of an inspector
- mark: No data

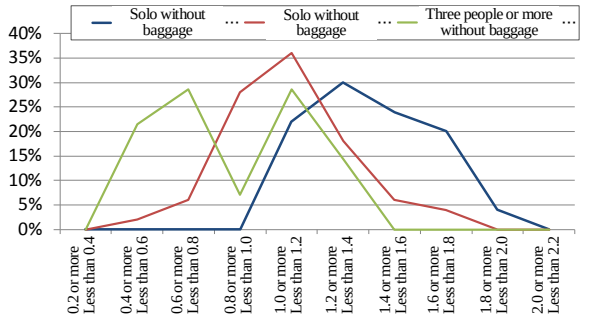


Figure. Frequency distribution of speed by attribute

3. Future studies

The team will add more areas to be investigated in the future to analyze how differences in nearby conditions and attributes of walking will affect walking speed and pedestrian density. The team will also obtain the relational expression of walking speed and pedestrian density based on current conditions of large cities in which the composition of pedestrian attributes is changing to find ideal pedestrian spaces.

1) *Traffic Engineering Handbook* (in Japanese) (2005 edition)

Towards the Application of Population Flow Statistics Using Data Transmitted Through Mobile Phone Networks to the Field of Urban Transportation

SHINGAI Hiroyasu, Head
YOSHIDA Jundo, Senior Researcher,
Urban Facilities Division, Urban Planning Department

SHIGETAKA Koichi, Head
TORIUMI Daisuke, Researcher
Maintenance Information Technology Division, Research Center for Land and Construction Management

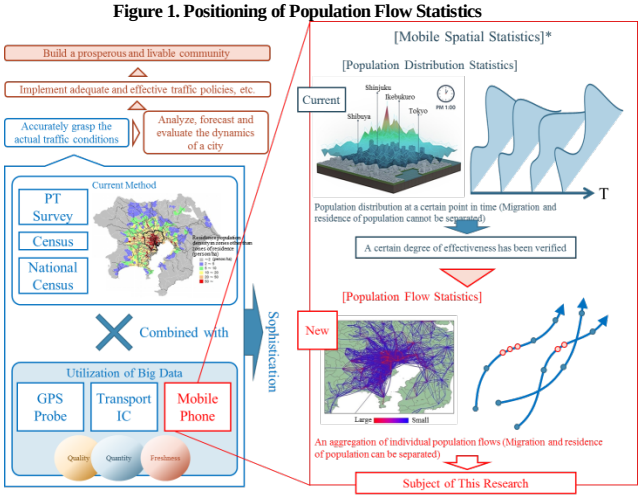
HASHIMOTO Hiroyoshi (Ph.D. in engineering), Senior Researcher
Road Division, Road Traffic Department

(Keywords) Big data, mobile phone base station, population flow statistics, urban transportation, person trip survey

1. Background and Purpose of Research

In recent years, there has been rapid progress in the research on utilization of big data and the actual use thereof in the field of transportation. The purpose of this research, which focuses on data transmitted through mobile phone networks (see Figure 1), is to establish a methodology for generating statistical data and verify the effectiveness of such data, in order to facilitate a more sophisticated utilization of big data in the field of urban transportation and also to enable us to grasp the flow of population such as the migration and residence of population.

Figure 1. Positioning of Population Flow Statistics



2. Main Content and Results of Research

Based on data available at mobile phone base stations, we clarified a methodology for developing population flow statistics (see Figure 2) and its specifications with which we can estimate the migration and residence of population. The characteristics of the population flow statistics are that it is possible to locate the places of transmission and receipt of data over wider areas across the nation and also to obtain data continuously without any interruption 24 hours a day and 365 days a year. A comparison of major characteristics between the current statistical surveys, etc., and the population flow statistics is summarized as follows:

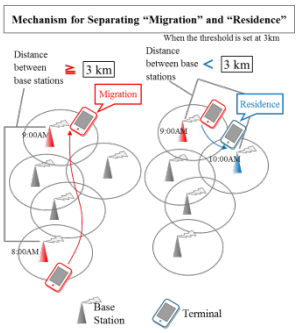


Figure 2. Judgment Criteria for Preparation of Population Flow Statistics

Table. Comparison of Major Characteristics between Current Statistical Surveys and Population Flow Statistics

Target for Comparison	Area: Depth	Area: Wide Area	Sample Size	Attribute: Age, etc.	Attribute: Purpose, etc.	Survey Frequency	Characteristics
PT Survey	△	×	△	○	◎	×	The PT Survey, which is conducted every ten years, enables us to grasp **trip data**, **purposes of trips, etc.** in a comprehensive manner.
Population Flow Statistics	△	◎	◎	○	×	◎	The Population Flow Statistics are based on data on the migration of population that are estimated for **24 hours a day, 365 days annually** from a **large sample size.**
GPS Probe Survey	○	○	×	△	△	◎	Although its sample size is small, the GPS Probe Survey enables us to grasp **detailed migration routes at any time**.
Traffic Volume Survey	◎	×	△	○	×	△	The Traffic Volume Survey enables us to grasp **actual traffic numbers, such as actual traffic volume**, for specific days and places.
National Census	△	×	◎	◎	×	×	The National Census, which is conducted every five years, is a detailed statistical survey **targeted at the whole of the population**.

Then, in order to better clarify the characteristics of population flow statistics, we checked the effectiveness of population flow statistics by analyzing their correlation with the results of metropolitan area person trip (PT) surveys, among other things. Specifically, we compared the results of the Shizuoka-Chubu Metropolitan Area PT survey and population flow statistics in terms of OD (origin-destination) amounts. As a result, we confirmed the high correlation between the two in city zones (see Figure 3).

Likewise, we compared the two in terms of the migration and residence of population. As a result, we found that they were broadly consistent with each other in all zones except for some urban zones, where there were some gaps in the data. It has become apparent that we need to further analyze the relationship between the footprint and base station density of mobile phone base stations and spatial resolution.

3. Next Steps

In order to ensure that population flow statistics will be utilized to enhance tourism and disaster prevention, among other things, which is the policy goal, we consider it necessary to conduct more practical research on population flow statistics going forward, including enhancing spatial and temporal resolutions, which would make it possible to more accurately grasp the migration of population, among other things.

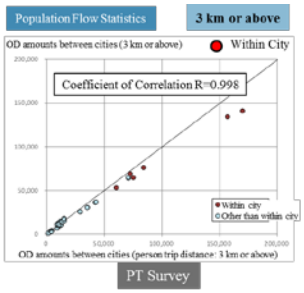


Figure 3. Comparison with PT Data (Distance between base stations: 3km or above)

---

1) "Research on the Application of Population Flow Statistics Using Data Transmitted Through Mobile Phone Networks to the Field of Urban Transportation", A Collection of Studies and Lectures on Civil Engineering Planning, Volume 52 by the Japan Society of Civil Engineers, November 2015

Research on the method of making Green Master Plans to respond to population decline and degeneration of cities etc.

KURIHARA Masako, Head
ARAGANE Keita, Researcher
Research Center for Land and Construction Management, Landscape and Ecology Division

(Keywords) Population decline, degeneration city, compact city, green master plan

1. Introduction

Green spaces and open spaces are infrastructures with essential functions to create safe and comfortable urban lives, such as providing spaces for people to play and relax, as well as improving the urban environment as a whole. Park greening measures based on the green master plan have developed a certain amount of green spaces so far.

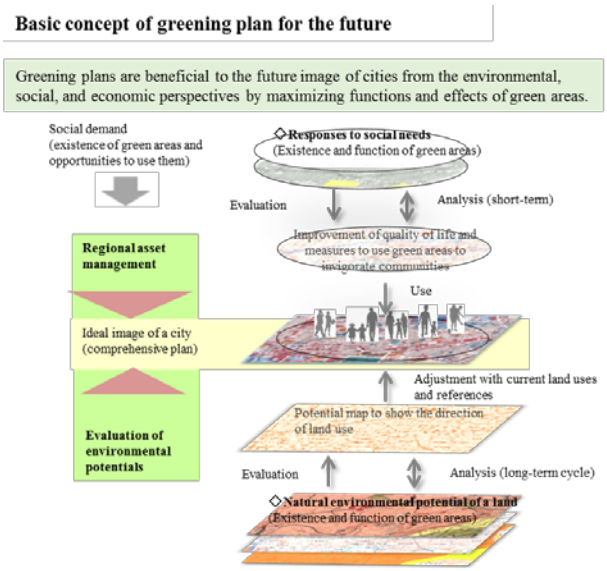
Meanwhile, the population in Japan started to decrease after peaking in 2008. The ratio of the elderly population is expected to reach about 40% in 2050. As the population declines from the declining birthrate and the increasing ratio of the elderly population, cities are expected to maintain a balance or shrink instead of expand as they have done so far. The functions of cities are expected to be integrated. Cities are also expected to handle unused lands randomly located around integrated areas and undermanaged green areas.

The Landscape and Ecology Division conducted research on the method of making green master plans to respond to the population decline and degeneration of cities etc. (research period: 2013-2015) based on an awareness of the above problems. The Division installed a research group to explore the future of a green master plan. The group held seven sessions to discuss new roles and directions expected in the green master plan of the future with advice from experts.

2. Effective methods and technologies for future greening plans

In FY 2015, effective methods and technologies for future green master plans are organized based on the focuses of the experts presented in the research group and outcomes of investigations conducted in the past.

Future green master plans need to incorporate new perspectives such as improving the attractiveness and sustainability of a region through greening and using natural resources in addition to aiming to quantitatively increase parks and green areas. Park and green area development administrations need to be implemented with broad perspectives based on plans with these new perspectives. Effective methods and technologies to realize the above include approaches based on environmental conservation and solutions to problems to evaluate regional environmental potentials and present policies for using natural lands. Other effective methods and technologies include ones that position greening plans to effectively use green areas with the perspective of regional asset management (figure below).



Basic concept of greening plan for the future (Image)

3. Future plans

Outcomes of this research are organized in a reference describing roles expected in greening plans and planning methods to present knowhow and ideas of ideals of future cities, green areas, and green master plans. The reference thereby assists local governments to establish and revise green master plans. Activities and efforts are expected to

increase the use of greens and open spaces as tools to improve regional attractiveness and sustainability.

Provision of Support for Municipalities' Initiatives to Plan and Develop Historic Districts

NISHIMURA Akihiko (Ph.D. in engineering), Researcher
KURIHARA Masao, Head
Landscape and Ecology Division, Research Center for Land and Construction Management

(Keywords) Historic districts planning and development, traditional scenery, scenery, cultural heritage, database

1. Foreword

With the Act on Maintenance and Improvement of Traditional Scenery in Certain Districts (Historic Districts Planning and Development Act) put into effect in 2008, many municipalities across the nation have actively undertaken initiatives to plan and develop historic districts by taking advantage of their unique heritage and culture. Certified municipalities under the Historic Districts Planning and Development Act have been making strenuous efforts to maintain and improve traditional scenery in their own districts with the support of the national government. Forty-nine municipalities have been certified over six years since the enforcement of this Act and they have been making various efforts to plan and develop their own historic districts. There is an increasing need for these municipalities to share the ideas and expertise that they have built up over the years concerning the planning and development of historic districts. Under these circumstances, NILIM has been engaged in the development of database that collectively summarizes information concerning the certified municipalities' initiatives to plan and develop their historic districts.

2. Opening of Information Website on Planning and Development of Historic Districts

NILIM publishes and makes publicly available the database information on its information website, which was opened in July 2015, in order to help the municipalities improve the operation of the Historic Districts Planning and Development Act and to promote their efforts to plan and develop their historic districts. Information, including basic information, a brief description of traditional scenery, and the status of operation of various systems under the Historic Districts Planning and Development Act for each of these municipalities, is summarized and posted on the *Certified Municipalities* pages. In addition, an information search page is provided on the website so that visitors can search cross-sectionally information on restoration and maintenance projects undertaken by the certified municipalities and historic building and structures whose preservation they have been working on.

Figure 1. Main Menu of the Website

Figure 2. *Certified Municipalities* Page (e.g. Gifu City)

Figure 3. Information Search Page (e.g. Project search)

3. Next Steps

In order to promote the use of this website, we have been providing technical support to certified municipalities and other municipalities which are planning to apply for certification, including providing explanation thereof. We hope that municipalities will be able to further enhance the attractiveness of their regions to help promote tourism through the use of this website. Going forward, we plan to study the development of a district planning and development scheme through the preservation and utilization of traditional civil engineering construction methods, etc., and evaluate the effectiveness of efforts made by municipalities to plan and develop historic districts, including considering the possibility of introducing the plan–do–check–act (PDCA) cycle.

[Information Website on Planning and Development of Historic Districts]
http://www.nilim.go.jp/lab/ddg/rekimachidb/

[Reference]
Akihiko Nishimura: "Opening of Information Website on Planning and Development of Historic Districts, Studies on Effective Civil Engineering Construction Methods for Maintenance and Improvement of Traditional Scenery", New Cities, Vol. 69, No. 12, pp. 61-66, 2015

Dispatch of TEC-FORCE and other experts to disaster sites and technical support activities

1. Introduction

The recent localization, concentration, and intensification of natural impacts have already been recognized and activities to minimize damage by combining structural and non-structural measures have been increasingly promoted. As one of the effective means in such measures, the Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") founded Technical Emergency Control Force ("TEC-FORCE") in 2008 and has been accumulating activities for prevention of occurrence / expansion of damage, early recovery of affected areas, etc.

2. TEC-FORCE and other activities by NILIM

TEC-FORCE installed in the NILIM functions as "High Technology Guidance Team" based on the knowledge etc. accumulated through daily studies, etc., covering mainly events and damages that are complicated or difficult to determine. Main roles of TEC-FORCE include advice based on high-level determination for preventing secondary disasters in addition to damage investigation and safety assessment of facilities.

In the September 2015 Kanto-Tohoku Heavy Rain, we dispatched experts of the fields related to damage to the sites of debris flow, damaged roads, etc. including the damaged site in Kinugawa.

In addition to activities as TEC-FORCE, we are continuing technical support activities by dispatching experts promptly in response to requests from local governments, Regional Development Bureaus, etc. in the affected areas. We also conduct independent surveys actively and activities to improve technical capability for disaster prevention / mitigation.

Table: FY2015 Dispatch of Experts (as of January 2016)

Disaster	Date of dispatch	Location	Purpose of dispatch	Section
Nepal Reconstruction Assistance Survey	May 20 - July 15	Nepal	Request from the Japan International Cooperation Agency	KANEKO Hiroshi, Director Urban Planning Department SHINKAI Hirosuke, Head Urban Facilities Division, Urban Planning Department
Seasonal rain front etc. continuing from June 10	June 19	Yoshino-cho, Kagoshima-shi, Kagoshima	Request from Kyushu Regional Development Bureau	TANIGAWA Seiji, Senior Researcher Pavement and Earthworks Division, Road Structures Department
	June 30 - July 1	Tarumizu-shi, Kagoshima In the site of Futagawa-fukaminato	Request from Kagoshima-ken	KUNITOMO Masaru, Head SUZUKI Yamato, Researcher Sabo Risk-Management Division, Sabo Department
Typhoon No. 12	July 24	Anan-shi, Tokushima	Independent survey	HATTORI Atsushi, Head MORI Hirotoshi, Senior researcher SASAOKA Shingo, Researcher River Division, River Department YAMAMOTO Akira, Senior Researcher Flood Disaster Prevention Division, River Department
Heavy rain by Typhoon No. 12, etc.	July 28	Daisen-shi, Akita-ken In the site of Shimizuazakanabumi	Request from Akita-ken	HATTORI Atsushi, Head MORI Hirotoshi, Senior researcher SASAOKA Shingo, Researcher River Division, River Department
Heavy rain by Typhoons No. 17 and No. 18 September 2015 Kanto-Tohoku Heavy Rain)	Sep. 11	Joso-shi, Ibaraki-ken	TEC-FORCE	HATTORI Atsushi, Head MORI Hirotoshi, Senior researcher SASAOKA Shingo, Researcher River Division, River Department
	Sep. 12	Joso-shi, Ibaraki-ken	Independent survey	HATTORI Atsushi, Head MORI Hirotoshi, Senior researcher YAMAMOTO Yoko, Senior

				Researcher NAKAMURA Kento, Researcher River Division, River Department
	Sep. 14 - Sep. 18	Joso-shi, Ibaraki-ken	Independent survey	SUZUKI Hiroyuki, Researcher SASAOKA Shingo, Researcher SUZUKI Atsushi, Researcher TAKENAKA Hiroshi, Researcher River Division, River Department
	Sep. 15	Joso-shi, Ibaraki (Kamimisaka site, Wakamiyato site)	Independent survey	YAMAMOTO Yoko, Senior Researcher River Division, River Department INOMATA Hironori, Researcher OTANI Amane, Researcher Water Cycle Division, River Department YAMAMOTO Akira, Senior Researcher HOSODA Satoshi, Researcher YUASA Naomi, Researcher Flood Disaster Prevention Division, River Department
	Sep. 15	Yunishigawa, Nikko-shi, Tochigi-ken	Request from Tochigi-ken	YABU Masayuki, Head TANIGAWA Seiji, Senior Researcher ENOMOTO Tadao, Researcher Pavement and Earthworks Division, Road Structures Department
	Sep. 16	Joso-shi, Ibaraki	Independent survey	ITO Hiroyuki, Head YAMAMOTO Akira, Senior Researcher YUASA Naomi, Researcher Flood Disaster Prevention Division, River Department OKUTA Yasuo, Research Coordinator for Disaster Mitigation of Building Building Department NAKAGAWA Takafumi, Senior Researcher Material and Component Standards Division, Building Department
	Sep. 15 - Sep. 16	Serizawa area, Nikko-shi, Tochigi	Request from the Kanto Regional Development Bureau	SAKURAI Wataru, Head Sabo Planning Division, Sabo Department MATSUSHITA Kazuki, Senior Researcher Sabo Risk-Management Division, Sabo Department
	Sep. 16	In the site of Furukawanishiarai, Osaki-shi, Miyagi	Request from Miyagi-ken	HATTORI Atsushi, Head River Division, River Department
	Sep. 29	Usukubo, Tsugamachi, Tochigi-shi, Tochigi Kawaji Onsen Kawaji, Kobyaku, Nikko-shi, Tochigi	Request from Tochigi-ken	YABU Masayuki, Head AZUMA Takuo, Researcher Pavement and Earthworks Division, Road Structures Department
	Oct. 8	Bando-shi, Ibaraki	Request from Ibaraki-ken	HATTORI Atsushi, Head MORI Hirotoshi, Senior researcher SASAOKA Shingo, Researcher River Division, River Department
Chile Earthquake / Tsunami disaster	Sep. 20 - Sep. 27	Chile (Coastal area from Coquimbo to Valparaiso)	National Research and Development Agency Port and Airport Research Institute	HONDA Kazuhiko, Senior Researcher Coastal Disaster Prevention Division, Coastal, Marine and Disaster Prevention Department
Typhoon No. 23	Oct. 13 -	Nemuro-shi, Hokkaido	Independent survey	ASAI Tadashi, Head

	Oct. 14			NAITO Ryuji, Senior Researcher Coastal Disaster Prevention Division, Coastal, Marine and Disaster Prevention Department
	Oct. 17	Oozora-cho, Hokkaido	Request from Hokkaido	HATTORI Atsushi, Head MORI Hirotoshi, Senior researcher SASAOKA Shingo, Researcher River Division, River Department
Sediment Disaster at Koumi-cho, Minami-Saku-gun, Nagano	Dec. 3	Saku-gun, Nagano	Request from Nagano-ken	MATSUSHITA Kazuki, Senior Researcher Sabo Risk-Management Division, Sabo Department
Fall of mortar pieces from Matsuoka Tunnel at the Hirooka site on National Highway No. 410	Dec. 24	Kimitsu-shi, Chiba	Request from Chiba-ken	MASHIMO Hideto, Director Road Structures Department MABUCHI Toshiaki, Head INAMOTO Yoshimasa, Senior Researcher Foundation, Tunnel and Substructures Division, Road Structures Department
Pier subsidence at Yura Area, Matsuyama Port, Ehime	Jan. 12	Matsuyama-shi, Ehime	Request from Ehime-ken	FUJII Atsushi, Research Coordinator for Advanced Port Technology Port and Harbor Department

* Only the emergency response immediately after the disaster is listed by omitting technical support, etc. provided continuously after the disaster for emergency / full-scale recovery.
* In the column of dispatched persons, only the relevant personnel of the NILIM are listed (Section and position are at the time of dispatch)

Extent of Damage to Buildings Caused by the Flooding of the Kinugawa River in the City of Joso, Ibaraki Prefecture, on September 10, 2015

OKUDA Yasuo (Ph.D. in engineering), Research Managing Coordinator for Advanced Building Technology
Material and Component Standards Division, Building Department
NAKAGAWA Takafumi (Ph.D. in Engineering), Senior Researcher, Material and Component Standards Division
KABEYASAWA Toshikazu (Ph.D. in Engineering), Senior Researcher, Standards and Accreditation System Division
Building Department
ITO Hiroyuki (Ph.D. in agriculture), Head/**YAMAMOTO Akira**, Senior Researcher/**YUASA Naomi**, Researcher/**HOSODA Satoshi**, Researcher
Flood Disaster Prevention Division, River Department
YAMAMOTO Yoko (Ph.D. in engineering), Senior Researcher
River Division, River Department

(Keywords) Flooding of the Kinugawa River, City of Joso, investigation of flood damage

1. Foreword

The flooding of the Kinugawa River of September 10, 2015 caused extensive damage across the city of Joso, Ibaraki Prefecture. On that day, the Kinugawa River overflowed and burst its banks, submerging residential houses, buildings, other structures, farm fields, etc. across a wide area of the city, scouring the ground right beneath the collapsed levees, washing away residential houses, buildings, structures and vehicles, among other things, or making them tilt. Concerning damage to buildings and other structures caused by the flooding of the Kinugawa River, NILIM, in conjunction with the Building Research Institute, conducted on-site investigations on September 16 and October 7, 2015, to grasp the extent of damage to buildings and other structures caused primarily by the flow of floodwaters in areas right beneath the collapsed levees and other inundated areas.

2. Damage to Wooden Residential Houses and Prefabricated Residential Houses

Most of the buildings and other structures in areas supposedly hit directly by floodwaters bursting through the collapsed levees were washed away from foundations, but there were several wooden residential houses whose structural frames remained without being washed away. We saw the second floor section of a two-story wooden residential house whose structural frame had been heavily damaged and washed away (see Photo 1) and a heavily-tilted wooden residential house with the ground of its premises scoured (see Photo 2), among other wreckages. We saw a steel fabricated residential house, which was located approximately 150 meters away from the collapsed levee, with the ground all around it scoured, but we could not find no visual structural damage in the upper structure of the house. We saw some of foundation piles exposed in the scoured sections of the steel prefabricated residential house's premises, but it was later found, based on the manufacturer's information, that these foundation piles were those for ground improvement work.

3. Damage to Other Buildings and Structures

In addition to damage to residential houses, we saw electric poles that had been heavily tilted in the direction of the flow of floodwaters, street lamps that had been completely uprooted together with their foundations, concrete slabs or asphalt slabs on subgrade that had been washed away downstream, vehicles that had been washed away or overturned, fallen trees that had been completely uprooted together with their roots, and heavy erosion of the ground, among other things.

Going forward, we plan to estimate the magnitude of external forces exerted, and study the mechanism of damage occurrence, on the damaged buildings, structures, etc., by analyzing conditions in which they had been washed away or had survived.

Photo 1. Wooden residential house whose structural frame was heavily damaged and washed away

Photo 2. Wooden residential house with the ground of its premises scoured

☞For further information, please visit the following:

1) NILIM website on investigative report
http://www.nilim.go.jp/lab/bbg/saigai/h27/20150910kinugawa.pdf

Provision of Emergency Support for the Development of Master Plan for Reconstruction and Rehabilitation of Nepal following the Massive Earthquake and Resilience against Earthquake Disaster Risks

SHINGAI Hiroyasu, Head, Urban Facilities Division, Urban Planning Department

(Keywords) Nepal, reconstruction and rehabilitation from earthquake disasters, BBB, master plan, provision of technical support overseas

1. Background and Purpose of On-Site Support Activities in Nepal

The Nepal earthquake occurred on April 25, 2015, with a magnitude of 7.8 Mw, killing 8,891 people and injuring approximately 22,300 people. Approximately 610,000 houses were completely destroyed, with approximately 290,000 houses, partially destroyed. The total economic cost of the destruction from Nepal's earthquake and aftershocks is estimated to total approximately US$7 billion, which is equivalent to approximately one-third of Nepal's gross domestic product (GDP). In order to promptly provide support for the reconstruction and rehabilitation operations in Nepal's earthquake affected areas by taking advantage of the insights that Japan has gained and lessons that it has learned to date through its own experience of reconstruction and rehabilitation from earthquake disasters, in response to the request of JICA (Japan International Cooperation Agency), NILIM has decided to send its four employees to Nepal for two months as short-term experts to provide practical technical support in a variety of areas.

Period of Investigation: Wednesday, May 20 through Wednesday, July 15, 2015 (57 days) Place of Investigation: The Federal Democratic Republic of Nepal Delegates: [NILIM] Hiroshi Kaneko, Director, Urban Planning Department; Hiroyasu Shingai, Head, Urban Facilities Division [Public Works Research Institute (PWRI)] Shigeki Unjoh, Earthquake Engineering Research Team [Building Research Institute (BRI)] Tomohisa Mukai, Senior Researcher (June 18 to June 28) Purpose of Delegation: Investigate the current situation in earthquake-stricken areas, support the holding of seminars, etc., Support the construction and exhibition of earthquake-resistant post-disaster housing models, Support the reinforcement of infrastructure and the development of policies for reconstruction, rehabilitation and resilience against earthquakes, etc.

Table: Overview of On-Site Investigation Team Organized for the Purpose of Providing Support to Nepal's Reconstruction and Rehabilitation Efforts

Figure: Locations of Major Earthquake-Stricken Areas in the City of Kathmandu and its Surrounding Regions

2. Main Technical Support Contents

To support Nepal government's reconstruction and rehabilitation efforts, we made an on-site investigation into the situation in earthquake-stricken areas, presented and shared Japan's insights and lessons learned concerning reconstruction and rehabilitation efforts from earthquake disasters at a variety of seminars, and supported the Nepal government's efforts to perform post-disaster needs assessment, among other support activities. In addition, as a big earthquake occurs frequently in Nepal, we offered the following advice and guidance based on the Build Back Better (BBB) concept[1]:

(1) Proposal on Earthquake-Resistant Post-Disaster Housing Models

As the current earthquake seriously damaged fragile masonry houses constructed of stones and bricks bonded with mud mortar, we proposed earthquake-resistant post-disaster houses in consideration of the current local housing conditions, available construction materials and local construction method, and we carried out a demonstration construction and exhibition of proposed earthquake-resistant post-disaster houses.

(2) Evaluation of Seismic Performance of Buildings and Recommendation on Technology for Renovation for Earthquake-Resistant Structures of Buildings

As we witnessed the story collapse of buildings, out-of-plane collapse of brick walls, etc., with respect to buildings of confined masonry construction with

reinforced concrete (RC) frame, we recommended the establishment of robust standards for seismic performance of buildings that govern all aspects of building construction from construction materials to structural members and buildings.

(3) Recommendation on Reinforcement of Infrastructure

We evaluated the seismic performance of road infrastructure, such as bridges, in the Kathmandu metropolitan area, extracted and proposed issues thereof, and recommended the establishment of unique standards for seismic performance of bridges, among other things.

(4) Support for the Development of Master Plan for Reconstruction, Rehabilitation and Resilience against Earthquakes

In order to help the Nepal government prepare for a larger earthquake in the future, we proposed a preliminary draft master plan for reconstruction, rehabilitation and resilience against earthquakes, which consists of the establishment of fundamental infrastructure networks in the Kathmandu metropolitan area, whose population has been growing rapidly, the implementation of urban disaster prevention measures in city centers where old buildings are densely populated, and the implementation of well-planned urban development initiatives in suburban areas, among other initiatives.

Photo: Proposing Preliminary Draft Master Plan for Reconstruction, Rehabilitation and Resilience against Earthquakes at the Meeting of Supporting Countries

3. Conclusion

We hope that the on-site investigation team's accomplishments will be incorporated in Nepal's national plan for reconstruction, rehabilitation, and resilience against earthquakes to help the Nepal government to achieve better results on the reconstruction and rehabilitation of the country.

---

1) The BBB Concept is one of the four specific priorities for action in the Sendai Framework for Disaster Risk Reduction 2015-2030 that was adopted at the Third United Nations World Conference on Disaster Risk Reduction, which was held in Sendai, Japan in March 2015. The on-site investigation team's activities to support the reconstruction and rehabilitation of Nepal following the massive earthquake were the first practical initiatives since the adoption of the Sendai Framework for Disaster Risk Reduction.

International research activities

1. International research activities of the NILIM

The following four policies are basic policies for the international strategy of the NILIM, based on the important research themes of the NILIM and the international policies of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT):

(1) Reinforcement of understanding of foreign technical policy trends related to important research themes of the NILIM
(2) Promotion of international collaboration
(3) Reinforcement of activities for international standardization
(4) Promotion of exporting infrastructures and systems

Based on the basic policies mentioned above, we have held or joined international conferences between two or more countries to collect detailed information on technical trends, and have also actively worked on international standardization. In addition, in expectation of the diffusion of our excellent infrastructure-related technologies, we are promoting cooperation with mainly Southeast Asian governmental research institutes. To prepare standards for traffic safety and environmentally friendly pavements with increased local adaptability, we are jointly conducting studies based on a road map. In FY2015, the NILIM organized various international conferences, including a technical discussion to understand the traffic volume with increased local adaptability, and a cooperative workshop with the Institute of Road Engineering (IRE) of the Ministry of Public Works and Housing in Indonesia, based on collaborative research, where we exchanged opinions about future collaborative research. We simultaneously promoted collaboration with the Japan International Cooperation Agency (JICA) experts, and the invitation of mid-career and young researchers.

2. Organizing international conferences

2.1 Japan-US-EU Trilateral ITS Conference (US: July 23 to 30, 2015)

Between the Japanese and US governments, the Road Bureau of MLIT and the US Department of Transportation's Research and Innovative Technology Administration (RITA) signed a memorandum for cooperation in the field of ITS in October 2010. In addition, between the Japanese and European governments, the Road Bureau of MLIT and the Information Society & Media Directorate-General of the European Commission (currently the Directorate General for Communications Networks, Content and Technology) signed a memorandum for cooperation concerning Cooperative Systems in the field of ITS field in June 2011. Based on these memorandums, the Japan, US, and European Commissions have exchanged opinions and conducted cooperative activities in the ITS field. In this fiscal year, individual working groups on automated driving, probe data, and evaluation tools had meetings in the US cities of Ann Arbor and Boston, and the participants exchanged information about their countries, reported on the progress of shared works, and checked on the details of future works.

2.2 18th conference between US Department of Transportation, Federal Highway Administration and NILIM, regarding bridges and structures (US: January 14 to 15, 2016)

At the time of the revision of the Agreement between Japan and US on Cooperation in the Research and Development of Science and Technology (the Japan-US Science and Technology Agreement) in 1994, "bridges and structures" was newly added as a cooperation subject, and Federal Highway Administration (FHWA) of the US Department of Transportation, the Road Bureau, and the NILIM of MLIT exchanged information regarding revised technical standards and political measure trends. In this fiscal year, the conference was held in Washington DC in the US, and the participants from Japan and the US discussed and exchanged opinions about the technical standards, and preparation condition of political measures related to the design, construction, and maintenance of road bridges. In particular, we understood the problems associated with the sophistication of inspection and durability design, in a dialogue with the US government, which called on individual states to maintain and upgrade their road bridges based on periodic checkup data.

2.3 15th Japan and Indonesia Research Collaboration Workshop (Japan: February 5 to 9, 2016)

Based on the Cooperation Arrangement concerning Joint Research and Development in the field of Roads and Bridges between the NILIM and the Institute of Road Engineering (IRE) of the Ministry of Public Works and Housing in Indonesia, which was agreed to on November 2014, the 15th Japan and Indonesia Research Collaboration Workshop was held in Tsukuba City, Ibaraki, Japan. In this workshop, the participants reviewed the utilization guideline for asbuton (locally produced natural asphalt), which was supposedly buried in large quantities around the Buton Island of Indonesia, discussed activities to slightly stabilize the quality of asbuton by the addition of an adulterant, reviewed technologies to completely extract asphalt from asbuton, and exchanged opinions regarding factory tours and

future activities. In addition, they visited a model of the nationwide roadside stations (Michi-no-eki), "Motegi," which was particularly recognized as a station that continuously worked as an excellent regional activation site, and exchanged opinions about the activities and operation of the station.

2.4 Japan-South Korea joint study group (Urban Planning) (South Korea: February 17 to 20, 2016)

Since the NILIM signed a memorandum regarding cooperation with the Korea Research Institute for Human Settlements, the main national land research institute of South Korea, in November 2012, we have cooperatively researched common and different tasks regarding urban redevelopment.

In this fiscal year, as South Korea's efforts related to the low-carbon urban development and relocation of the capital, we interviewed local government officials of Incheon City and Jeju-Do, which had promoted green city activities, model cities corresponding to climate change, and new sustainable urban planning, to understand the latest status . Moreover, concerning the current status of the relocation of the capital for the purpose of balanced development of the nation, we researched and exchanged opinions about the preparation status of innovative cities, and the effects of urban activation by transferring public agencies in typical rural cities such as Busan City and Jeju Island (Seogwipo City).

2.5 Joint research on Hydrology, Water Resources and the Effects of Global Climate Change on Them, with US Geological Survey (US: February 22 to 23, 2016)

Under the Japan-US Science and Technology Agreement (in the global science and global environment field) called "Hydrology, Water Resources and the Effects of Global Climate Change on Them," the NILIM and the Public Works Research Institute have conducted joint research on hydrology, water resources, and the effects on climate change with the US Geological Survey (USGS) since 1992, and have organized a total of nine joint workshops in the past. At this time, we reviewed the collaborative research activities of both countries after the 9th workshop held in February 2014, and agreed on future collaborative research and orientation regarding new tasks, such as forecasting to provide advanced notices and warnings about floods, which are seriously required in Japanese society. In addition, we effectively collected information and exchanged opinions concerning the latest research conditions and trends regarding three concrete collaborative research themes under the joint research (flood observation and modeling, mountain stream sediment discharge observation and modeling, and the collaboration of CommonMP and iRIC).

2.6 16th Japan and Indonesia Research Collaboration Workshop (Indonesia: February 29 to March 3, 2016)

Based on the Cooperation Arrangement concerning Joint Research and Development, agreed on by the NILIM and the IIRE of the Ministry Department of Public Works and Housing in Indonesia, the 16th Japan and Indonesia Research Collaboration Workshop was held in Jakarta City, Bali, Indonesia. In this workshop, in cooperation with the Public Works Research Institute, we organized individual workshops for regional development, traffic data collection technologies, pavements, and tunnels, and exchanged opinions regarding the progress of the collaborative studies and future activities.

At the same time, jointly with the Japan Society of Civil Engineers (JSCE), PWRI, and IRE, we held an open seminar with the theme of regional development in Jakarta City, Indonesia. The head of the Regional Infrastructure Development Agency of the Ministry of Public Works and Housing in Indonesia, the head of the Research and Development Agency of the Department of Public Works and Housing in Indonesia, Professor of Tokyo Metropolitan University (Tetsuo Shimizu), and the Director of the NILIM Road Traffic Department participated in the workshop, and made presentations. More than 120 engineers from Indonesia and Japanese resident officers, etc., also joined the workshop.