

# Reconsidering the National Land and Social Infrastructure

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*(Key words) National land, social infrastructure, population decline, falling birth rate and aging of society, next-generation*

## 1. Introduction

I recently had the opportunity to tour the Science Museum of Map and Survey at the Geographical Survey Institute. One of its many exhibits is the Earth Plaza, a popular attraction which provides visitors with the actual feeling of seeing the Japanese Archipelago from an artificial satellite on an outdoor 22m diameter spherical map, which includes the entire domain of the national land of Japan (cut from a giant terrestrial globe). It is reported that many visitors are deeply impressed by this exhibit. I was, of course, also deeply moved. It motivated me to reconsider, from a brand new perspective, the ideal form of the national land and social infrastructure, which are usually considered from the ground level perspective.

As the population, car ownership, and various other indices are declining, Japan has entered a new era. The social economy suited to a shrinking population is now widely discussed. I would, therefore, like to take a fresh new approach to the question, "How should the national land, where nearly 130 million citizens are living their lives, be managed?"

## 2. Our domain as the foundation of social infrastructure

The foundation of the nation is probably constructed on its land. Consequently, maintaining this domain in stable condition must be considered as part of social infrastructure. Japan seems to be recognized as a small country consisting of many islands enclosing a large sea area, but in actuality, it possesses the world's sixth largest exclusive economic zone (EEZ), and the natural resources existing in this zone have attracted international attention. This is the reason why maintaining the stability and protecting the coastlines, being essential to maintain the EEZ, should be continued. Words such as "domain" may sound exaggerated, but it is well known that a road network, which symbolizes infrastructure, was constructed and maintained by the military of the Roman Empire primarily to protect its expanding domain.

In addition to considering this matter in this way, it is important to consider whether or not our domain will, through the improvement of the social infrastructure, become user friendly as the foundation of the lives and activities of the people. In other words, how will it efficiently and reliably support economic

activities with international competitiveness? Or will it allow us to maintain natural environments comfortable enough for people to spend their lives safely and securely? From this perspective, we will occasionally have the chance to notice the need to revise existing indices of social infrastructure improvement and ways of representing social infrastructure on maps.

## 3. National land continually collapsing

Viewed from the topographical perspective, most of the land of the Japanese Archipelago consists of steep mountains protruding from the ocean surface. These mountains have, since ancient times, continually collapsed under meteorological impacts produced by heavy rainfall and sunlight. It includes places where soil collapsed and discharged from the mountains has finally settled and, over a long period, formed gently sloping land, where people have settled by cultivating the land. They are ephemeral plains created originally by the collapse and run off of mountains, so stabilizing them is acting against the natural force of nature, and we are forced to continue to battle this process. The Japanese Archipelago exists in a high earthquake frequency zone where a number of plates collide and annual typhoons arrive like uninvited guests, causing the destruction of the national land.

The history of flood control in Japan, which is almost synonymous with containing the flow of water and sand in usually unusable space such as river areas, can be called a record of a fierce struggle to overcome the forces of nature. In the face of a continuous population decline and ongoing financial pressure, we have to rack our brains from a variety of perspectives to decide how to efficiently manage the continuously changing national land.

## 4. River basins and transportation infrastructure

Continuous rains and collapsed soil form river basin topography along the course of the flowing water. It is not so difficult to envision, from the perspective of water use, how a culture matured through agriculture, and its economy has been created and developed as river basin units. But when you try to travel from one river basin to another, you are unfailingly forced to travel over mountains. So in Japan, transportation has historically been developed on water, while that on land developed later, remaining poor until recent

years.

So many railways, roads, and other land transportation systems in Japan are often constructed in river basins, that the maintenance of these structures must attempt to preserve the national land from landslides, slope failures etc., especially in mountainous regions. If these structures are built along the sea coast to avoid these threats, salty sea spray causes harsh corrosion, shortening their lives. A battle with landslides on National Highway 112 Gassan Road and with salt damage to concrete bridges and slope collapses on National Highway 7 along the coastline help me recall my impressive experiences at the Tohoku Regional Bureau, Sakita River and Road Office almost 20 years ago. An overview of the management of Japan's national land can remind us how the social infrastructure has been provided under harsh national conditions.

#### **5. Considering the population decline, falling birth rate and aging society**

As mentioned above, the population of about 130 million people now living on the national land has begun to fall. The National Institute of Population and Social Security Research has predicted that the population of Japan will drop below 100 million around 2050. And according to another report by this research institute, the population of Asia and the entire world population including that of Africa will both peak at the same time in 2100.

So, setting aside discussions of the estimated population size and of the population appropriate for the national land, perhaps the configuration of the population of Japan in 2050 will display a certain constancy in line with its low birth rate. Whether or not the structure of the population returns to its previous pyramid shape, the structure of society will probably change accordingly. What this structure will be must be discussed, but a more serious question is how we are to live for next 40 years. In other words, to deal with this structure, which will be extremely top heavy under the impact of the falling birth rate and aging of society, we must complete the renovation of the nation to adapt it to future conditions, through the firm support of economic activities under the burden of huge welfare costs.

So, we must reconsider what sort of social infrastructure to establish and how to operate it so a reduced population can use it effectively and easily. It will definitely be impossible to construct good infrastructure with high costs and with the large quantity of labor which will be needed for its maintenance, considering the poor energy efficiency of its use. I think that this is a strategic research challenge.

#### **6. Conclusion**

Now in this age of population decline, the

improvement of social infrastructure is being replaced by its management and its use. The necessary conventional economic policies are no longer effective under deflation and declining growth, and the conventional economic indices are also ineffective as tools for national land management.

A new book titled *Theory of Japan as an Outlying Country* is now a best seller <sup>1)</sup>. An example of *Nihonjinron*, which means writings on the theory of the uniqueness of Japanese people, it argues that the main stream of scholarship or religion has always been elsewhere, and that Japan, an outlying country from the world's perspective, can only be considered impertinent to do its utmost to try to become a model. It correctly points out the principle of behavior by Japanese people, and that the time has come when we must consider the fact that there are no models in other countries. The global standard has simply been the American standard or the Anglo Saxon standard, rapacious capitalism without morality, a lack shown in the process of sub-prime loans ending in Lehman shock. Japan has existed as a unique civilization up to today because, although it has continually accepted Confucianism, Buddhism and other inflowing cultures from outside the country, it has been able to discard aspects which do not match its essential character to accept only that which is suitable and beneficial.

As you watch only sensational news, you might have noticed the fact that the food, fashion, comics, animated movies and other aspects of the culture of the younger Japanese generation are imitated around the world. When considering the future social infrastructure, you had better realize that its users are the next generation.

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# Perspectives in developing and managing social infrastructure for the next generation

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*(Key words) National land management, construction management, development and management of social infrastructure*

## 1. Introduction

The Research Center for Land & Construction Management (hereinafter “the Center”) is one of three Centers set up to tackle cross-sector initiatives. Through research activities based on the key concepts of “national land management” and “construction management”, the Center’s mission is to support the planning and proposal of policies related to housing and social infrastructure development under the jurisdiction of the Ministry of Land, Infrastructure, Transport and Tourism(MLIT).

With the steady progress of population decline, falling birth rates and population aging, together with the increasing reality of limitation on resources, the target of research activities in the “national land management” sector is to consider how Japan’s national land infrastructure should be developed and utilized as a foundation that supports a safe, comfortable and vibrant national way of life.

Meanwhile, to develop and manage social infrastructure smoothly and efficiently as a means of national land management, it is vital that we constantly review all aspects of construction production systems. Only by doing so, can we ensure and improve the quality of public works, as well as gaining the support of taxpayers through a highly transparent and competitive procurement system. Research on “construction management” technology is an effort to this end.

## 2. National land management and social infrastructure development

As a new image of national land infrastructure, the National Spatial Strategies (nationwide plans) formulated on the basis of the National Spatial Planning Act (2005) state that “As well as building national land infrastructure in which diverse, wide-area blocks can develop independently, steps will be taken to form national land infrastructure that is beautiful and comfortable to live in”.

A major task in achieving this is to cope with the nationwide increase in settlements whose sustenance and existence is threatened by population decrease and progressive aging. In many cases, these face a variety of problems, including uncertainty over public transport, healthcare, welfare and other livelihood aspects, as well as loss of traditional local culture and

abandonment of land. Since fiscal 2006, the Center has promoted studies on the transformation of local community functions in areas facing problems of depopulation, focusing on the importance of local communities in promoting sustainable national land management<sup>1)</sup>. We plan to link this to studies on future maintenance measures.

For example, encouraging the use of domestic timber (including thinnings) in housing and social infrastructure development serves to support the forestry industry and ensure the appropriate management of forests. This, in turn, ensures that forests properly play the role of retaining water and controlling sediment runoff, and that the prerequisites for flood control and water use planning in the whole river basin are maintained. This also encourages interregional collaboration between upstream and downstream areas, culminating in firmly grounded regional development. Preparing and revising standards with a primary focus on encouraging the use of timber has large potential as a trigger for the formation or maintenance of this kind of socially positive cycle.

To form safe and beautiful national land infrastructure while maintaining stable economic growth, the development of quality social infrastructure based on regional characteristics will need to be promoted efficiently as a priority issue. On the other hand, addressing maintenance and renewal accompanying the dilapidation of existing social infrastructure stock is also a pressing task. Inspections based on individual facility characteristics, along with systematic maintenance and repairs based on deterioration prognosis, will be indispensable if we are to reduce lifecycle cost by increasing longevity. They will also reduce the impact on the socio-economy caused by fatal damage under the harsh natural conditions peculiar to Japan, including earthquakes, floods, tsunamis and high tides, sediment disasters and snowpiles. To this end, based partly on the results of preliminary studies by a cross-sector stock management research group inside the Institute, we aim to tackle the development of inspection and monitoring technology for preventive conservation management of social capital in a three-year plan starting from fiscal 2010.

### 3. Ensuring and improving the quality of public works and construction management technology

Following the enforcement of the Act for Ensuring the Quality of Public Works (2005), the Center is responsible for analyzing issues in projects under direct jurisdiction of MLIT, and studies on necessary revisions based on this<sup>2)</sup>. This work is linked to various initiatives aimed at ensuring or improving the quality of public works, including the Overall Evaluation Bidding Method, the Integrated Design-and-Build Procurement Method and the Construction Management (CM) Method.

An important task is to revise the standards, guidelines and others needed for accurate and efficient supervision, testing and works performance appraisal in public works, while responding to the increased sophistication of execution management technology (such as the full introduction of IT-compatible execution). This will enable us not only to obtain reliable outcomes with a high level of quality at the individual works level, but also to establish systems whereby companies' track records and efforts are appropriately reflected in the process of selecting suppliers.

We are also conducting research aimed at appropriately deploying the unit price cost estimation method (a method of cost estimation by multiplying the price for each works unit division, including direct expenses such as material costs and labor costs, and indirect expenses by the construction volume) and expanding construction processes subject to trials. This will not only reduce the cost estimation work load on in-house engineers, but also promises effects that will help to normalize transaction prices between contractor and subcontractor in the construction market.

### 4. Summary

At the end of last year, the government's Council for the Formulation of Growth Strategy (chaired by Prime Minister Yukio Hatoyama) presented the framework of a new strategy for economic growth. The strategy highlighted "Environment & Energy" and "Health (Healthcare & Nursing)" as sectors in which Japan should show greater strength than other countries in future, and "Asia" and "Tourism & Regional Revitalization" as frontiers in which greater demand can be expected in future. Strategic efforts are to be made in six priority sectors, with the addition of "Science & Technology" and "Employment & Human Resources" that form the foundation for the others mentioned above. Steps will be taken to create demand and secure employment, and the aim will be to achieve real economic growth averaging more than 2% by 2020.

It would be no exaggeration to say that the work of developing and managing social infrastructure serves to underpin all of these. Tourism packages that use express coaches depend wholly on networks of expressways, while the "Super Sento" public baths now

booming as local health and leisure facilities could only exist with social infrastructure for a reliable water supply and water treatment. In many cases, social infrastructure facilities, such as beautiful bridges and dam reservoirs harmonized with surrounding environment, themselves have become tourism resources. Moreover, to enhance a region's wide-area healthcare services, it is vital that plans should also include the development of public transport infrastructure.

Social infrastructure development through public investment also plays a major role in promoting R&D in science and technology. Namely, it incorporates science and technology from almost every sector, not only in developing new materials and works execution technology, but also in monitoring and inspection technology after the construction of facilities. The result is that these are efficiently utilized for the public welfare. It should not be forgotten that social infrastructure development projects led to the concept of electronic government becoming a reality, through the electronic conversion of work processes in the form of electronic bidding, electronic delivery and others, and the provision of road services using information technology (e.g. the ETC system). These technologies have the potential to contribute greatly to social infrastructure development in Asia and all countries of the world.

Based on the problem awareness described above, the Center would continue tackling survey and research activities that support the development and management of social infrastructure for the next generation, in close collaboration and appropriate sharing of roles with the Public Works Research Institute, the Building Research Institute, the Port and Airport Research Institute and other related organizations, as well as all departments within NILIM.

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# For Sustainable National Land and Urban Environments in Harmony with Nature

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(Key words) National land and urban environments, sustainability, biodiversity, global environment

## 1. Introduction

Japan is surrounded by oceans and exposed to extremely harsh natural conditions. Being in the path of Pacific typhoons, for example, means that abnormally high tides are prone to occur, while flooding and sediment disasters are frequent. Japan also sits on an overlap between tectonic plates, which increases the likelihood of earthquakes and causes numerous tsunamis. On the other hand, Japan has limited access to minerals and other resources, and the food self-sufficiency ratio is only about 40% on a calorie basis. Given such natural conditions, Japan faces the task of achieving harmony with “environments” in symbiosis with nature.

Another problem is Japan’s constricted landmass and the restricted availability of habitable land. These have produced a national land infrastructure in which about 130 million people live cultural lives in modern-day comfort, efficiency and convenience. However, the population of Japan has already started to shrink, and population aging is expected to advance further in future. To bequeath a healthy environment to posterity, therefore, the question now is what we should do to create sustainable “environments” while we still can.

## 2. The direction targeted by environmental research

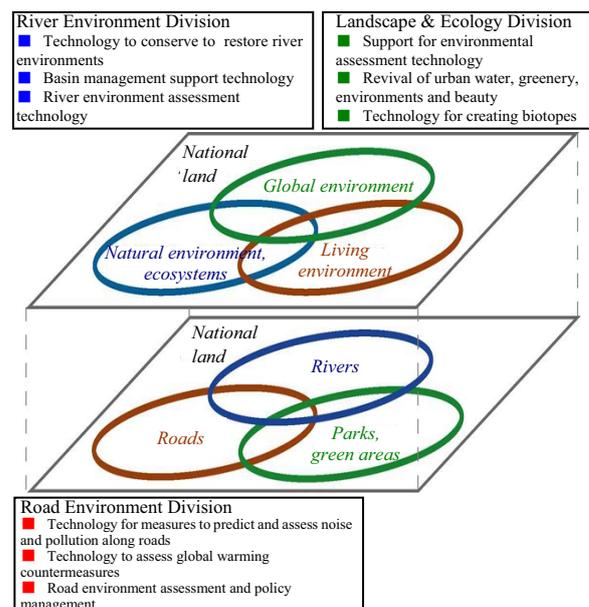
While recognizing the limitations of “environments”, we see it as our pressing task to form national land infrastructure that has sustainability and is in harmony with nature.

Of course, the environmental problems of today are becoming increasingly complex and broad in scope, as illustrated by problems of the global environment. As such, it is important that we pursue comprehensive and strategic R&D on the issues concerned, while clarifying their relevance within the overall picture of broad-ranging problems.

In the Environment Department, amid these marked developments concerning the environment, we see it as an important policy task of national land administration

to conserve, revive or create good national land and urban environments in harmony with nature whenever developing or managing social infrastructure (such as roads, rivers, parks and green areas closely related to the Japanese way of life and production activities). We also see this as the mission of our research.

The themes of our research strategy include issues on a global scale (“global warming”, “sustainability” and “biodiversity”) and issues closer to home (“beautiful, rich and vibrant lifestyles”). These provide the basis for our research and development.



Outline of research by the Environment Dept.

To tackle these issues, we not only conduct research designed to solve problems based on natural sciences; we also conduct research based on social sciences, as is necessary for research related to national technology policies. Besides these, we also undertake demonstration research in collaboration with related institutions and localities.

Since the environmental sector is very broad-ranging and complex, we collaborate positively with related government departments, independent administrative

organizations, the private sector, and universities and research institutions both in Japan and abroad when pursuing this research. We coordinate with these through a variety of channels.

### 3. Pointers for future research

When pursuing environmental research, we focus our attention on three key points.

The first is to strive positively to produce “visible results” from environmental research on social infrastructure. For example, we aim to devise our “Research on the conservation and revival of brackish water environments” in such a way that the behavior of brackish water environments is shown in an easily intelligible form. Again, since our “Development of environmental assessment technology for the lifecycle of social infrastructure” is an important research theme in terms of the global environment and sustainability, we will plan our technical development so that more people can take part. In future, we will need to make even more positive efforts to ensure such “visible results” in various fields.

The second point is to amalgamate natural and social sciences. History often tells us a lot about environments, and in the environmental sector it is particularly important to research the historical changes that have affected society. On changes in coastlines due to movements of the earth’s crust, for example, the appearance of coastal regions in antiquity is mentioned in old books <sup>1)</sup>, while research on the relationship between economic trends and climate change has been published <sup>2)</sup>. We feel that this kind of positive link with social sciences will be even more necessary in future.

The third point, finally, is to positively gather and organize data. We refer to a lot of data when drawing conclusions from our research, but once the research is complete, these data tend to merely lie dormant somewhere. While this may also apply to other fields, in the environmental field, in particular, we often handle complex or new data, and we think the significance of retaining these data is even more important.

In research on the environment, we sometimes have to proceed with a process of trial and error. We would like to pursue basic research while positively taking on new challenges and tackling research that can be used to develop and manage social infrastructure in future – for example, “Research on the predicted impact of habitat environment disruption using DNA”.

### 4. Conclusion

The very environment that surrounds us is going through some marked changes. Rivers, roads, parks and other social infrastructure close to us may sometimes be difficult to understand, in terms of their convenience or the changes that affect them. To manage our national land infrastructure based on the natural and social characteristics of Japan, it is very important that our development and management of social infrastructure closely related to our daily lives are harmonized with the environment. With this in mind, we wish to tackle research and development on the conservation, revival and creation of environments, with the aim of creating wonderful national land and urban environments in harmony with nature that can be bequeathed to the next generation. While there is a surfeit of information in our contemporary society, we would like to strive for research and development through a process of trial and error as well as self-examination. In this way, we hope to achieve real environments in which outstanding natural beauty can be seen, while remaining sensitive to movements concerning the environment.

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**Brackish water environment with a rich natural environment:  
Near the estuary of the Tenryu River (Sept. 30th, 2005)**

# Towards a new evolution for sewerage

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*(Key words) Stock management, sanitary safety, membrane bioreaction, greenhouse gases*

## 1. Sewerage approaches a turning point

Sewerage works in Japan are approaching a major turning point. Until now, the policy emphasis has been on diffusion and expansion as a matter of pressing concern. From now on, however, stress will steadily shift towards safety and environment, with demands for proper management and operation. The basic tasks facing sewerage amid this process may be outlined as follows.

- Immediate tasks in developing sewerage infrastructure
  - Eliminating areas that lack wastewater treatment facilities
  - Addressing the frequent occurrence of concentrated torrential rains and the expansion of flood damage associated with climate change
  - Improving water quality in closed water areas through high-grade treatment
  - Reducing risks to aquatic systems by improving and upgrading sewerage functions related to public hygiene (e.g. improving combined sewerage)
- Tasks in terms of stock management
  - Risk management related to facility dilapidation and systematic asset management facilitating sustainable management
  - Enhanced earthquake resistance of sewerage facilities and retention of functions in the event of an earthquake
- Tasks associated with demographic change
  - Dynamic revision of plans in response to population decline and aging, introducing efficient methods of development and management
  - Strengthening sewerage management infrastructure
  - Contributing to vibrant regional development by making effective use of sewerage facilities and recycled water
- Tasks concerning the contribution to new environmental problems
  - Creating positive water environments by increasing the soundness of water and substance circulation systems
  - Helping to solve problems of global warming, resources and energy by using the resources, energy, etc., provided by sewerage

## 2. Research areas subject to priority efforts

In the field of sewerage research, we undertake priority research with emphasis on the following areas. In this way, we provide technical support for policies

that will form a pillar of national sewerage administration in line with the basic directions of new sewerage technology.

### (1) Areas related to sewerage stock management

Sewerage stock management is a field that is attracting attention internationally, as illustrated by the fact that reviews are in progress with a view to ISO standardization. On the other hand, against a spate of road collapses and other incidents, there is increasing concern over the proper management of sewer pipes. Although pipe renewal and repair technology has progressed tremendously in recent years, we need to accurately grasp the state of deterioration of pipes, in order to make effective use of these technologies. To this end, we are conducting research in various areas based on information from local authorities all over Japan. These include research to establish a formula for predicting soundness that will provide a foundation for estimating the volume of future modification works, and research on methods of deciding priorities for surveys and modification (Fig. 1).

### (2) Areas related to sanitary safety of treated wastewater

With the spread of sewerage systems, the volume of water carried by them has steadily increased, and this has had a relatively large impact on water environments. Meanwhile, the roles of treated wastewater as a water resource are expanding, as illustrated by its reuse in urban landscaping, recreational water, and so on. On the other hand, there have been outbreaks of health hazards caused by waterborne infectious pathogenic microbes including protozoa and viruses. As a result, there are demands that sanitary safety also be guaranteed for treated wastewater, reflecting the role it plays in water environments. Therefore, we are currently drawing up measures to ensure sanitary safety in line with the state of water use and purpose of using recycled water at sites of treated wastewater discharge, in connection with the norovirus (Fig. 2). We have also started studies on measures to address new types of influenza virus that are feared likely to become prevalent in connection with sewerage.

### (3) Areas related to wastewater treatment using membrane treatment technology

Treatment technology using membranes in the process of solid-liquid separation efficiently removes microbes and has a strong capacity for retaining activated sludge. This is therefore considered a promising technique that can not only improve water treatment performance but also make treatment

facilities more compact, make facility modification and renewal smoother, save resources in operational management, and so on, thereby solving a number of problems currently facing wastewater treatment facilities. Thus, as well as promoting objective evaluation of the water treatment performance of membrane bioreaction (a combination of the conventional activated sludge with membrane treatment technology), we are also looking into technical issues and matters for study when attempting to introduce it into actual facilities as a method of treating wastewater.

(4) Areas related to reducing the burden on the global environment

With the effectuation of the Kyoto Protocol, we are expected to take initiatives to meet targets for greenhouse gas reduction. While sewerage works are a source of greenhouse gas emissions, their rich potential as resources and energy (such as treated wastewater and wastewater sludge) could contribute to solving the depletion of resources and problems of the global environment. We are currently studying this dual relationship between sewerage and greenhouse gases, with respect to reducing emissions of nitrous oxide arising from the wastewater treatment process (mitigation measures), and the effect of reducing greenhouse gases through recycled use of treatment water (adaptation measures). Finally, we are also studying the LCA technique in relation to sewerage facilities, with a view to accurately assessing the environmental burden arising from sewerage and the effectiveness of countermeasures.

### 3. Further use of sewerage technology

Currently, activities designed to solve the world's water and sanitation problems and the problems of global warming using sewerage technology accumulated by Japan are being developed in the field of sewerage. The Global Center for Urban Sanitation (GCUS), a body representing the industrial, public and academic sectors, was established for this purpose. GCUS is now pursuing concrete studies based on the hypothesis of targeted countries and issues, and our Department is playing a positive part by contributing to technical aspects. Through this kind of initiative, we expect that steps will be taken to diffuse sustainable sewerage systems based on accumulated Japanese knowhow, from planning and construction to management and operation; and that this, in turn, will assist the further development of Japan's sewerage technology.

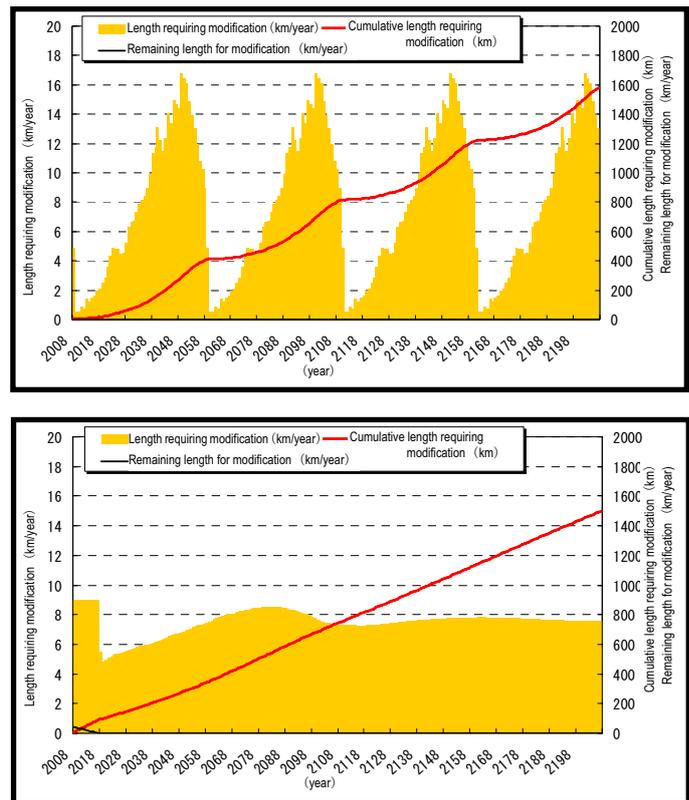


Fig. 1 Example of calculations for future works volume in a model city  
(top: with simple modification after 50 years, bottom: when using the formula for predicting soundness)

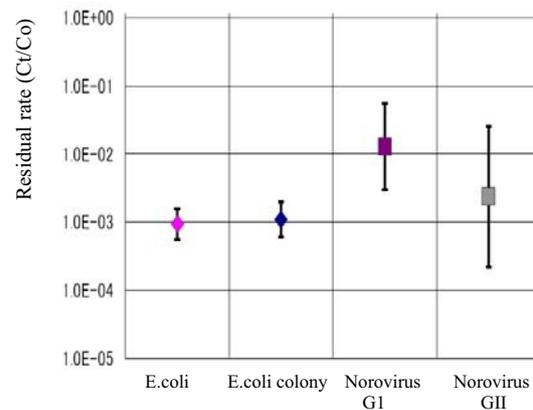


Fig. 2 Comparison of chlorine sterilization for norovirus and E.coli

# Implementing River Projects Adapted to Climate Change

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*(Key words) Climate change, flood control, risk assessment, adaptation*

## 1. National land susceptible to flooding

In Japan, about 1/2 of the total population and 3/4 of total assets are concentrated on alluvial plains covering only 10% of the national land. The land surrounding three large bays (Tokyo Bay, Ise Bay, Osaka Bay) which adjoin the three large metropolitan regions, includes zero-meter belts of land below sea level, occupied by 4.04 million people. And Japan is located at the eastern end of the Asian monsoon zone, one of the world's heaviest rainfall zones, where it is exposed to the risk of the approach and landfall of typhoons. Japan can, for these reasons, be described as land susceptible to direct attack by flooding, sediment disasters and storm surge disasters.

To overcome such national land conditions, the Japanese have worked unremittingly to implement flood control measures such as building series of levees and constructing dams and other flood regulation structures, achieving great improvements in safety from floods. But the state of provision of flood control facilities remains at a low level of only about 60% of the present targets.

On the other hand, a poetic term for the beauty of Japan's mountains means "purple hills and crystal streams", giving the strong impression of a beautiful country endowed with abundant water, and the annual average rainfall in Japan is about 1,700mm, which is about double the worldwide average. But nevertheless, rainfall per unit of population in Japan is low at 1/3 of the world average, so Japan does not possess abundant usable water. Japan has, therefore, responded by providing water resource development systems, but in recent years, annual rainfall has fluctuated widely and years of extremely low rainfall have tended to occur, arousing renewed fears of a decline of the safety of the water supply and of droughts.

Social factors include the declining population, a falling birthrate and aging of society, the concentration of the population and assets in large metropolitan regions, and deteriorating regional economies. Among

farming and fishing villages, so-called villages at the viability limit are increasing, mainly in mountainous regions. Such villages are gradually losing their ability to maintain functions they need to protect their residents from natural disasters, and it is assumed that when a severe disaster does occur, they will suffer unprecedented damage. In Japan, a country susceptible to flooding, droughts, storm surges, and other natural disasters, finding ways to respond to intensifying risk caused by climate change is an important challenge facing future management of the national land.

## 2. Increase of risk caused by climate change

Severe natural disasters which can be associated with the impact of global warming are occurring around the world. Examples include flooding triggered in various parts of Japan by concentrated rainfall in Yamaguchi Prefecture in 2008 and by the recently increasing landfall of typhoons, and the terrible disaster in the southern U.S. caused by storm surges produced by Hurricane Katrina in 2005. In 2007, the Fourth Report of the IPCC predicted prolonged climate change and severe damage caused by this trend.

Japan has prepared concrete estimates of the impact of increasing rainfall during torrential rainstorms, the decline of the flow rate of melting snow etc., in regional and drainage basin units. For example, the degree of flood control safety (annual probability of exceedance) which is a goal under present plans, has declined by between 40% and 70% according to many estimates, and it is reported that in Hokkaido and in Tohoku in particular, there are river systems where it has fallen to about 30%.

And if it is assumed that in the zero meter zones around the three large bays, the average sea level will rise 59cm which is a predicted upper limit shown in the IPCC report, the population living in zero-meter zones will increase about 50%.

In order to survey the impact of and adaptation to

climate change, it is essential to appropriately assess the social and economic impacts of changes of external forces. In Japan, systematic studies have not been conducted, so we must quickly carry out such studies.

### 3. Basic concept of adaptation

The fact that both adaptation and mitigation are vital in order to respond to global warming is not only written in the Fourth Assessment Report by the IPCC, it is also an awareness shared worldwide. But awareness of this point is low in Japanese society where, discussions are liable to be biased toward mitigation. In Japan, a country particularly susceptible to flood disasters, it is vital to increase awareness of the need for adaptation.

And floods, sediment disasters, storm surge disasters etc. which are intensified by climate change, are assumed to vary widely in scale, so it is difficult to provide total protection from all such disasters. It is therefore important to adapt to climate change by clarifying to what extent structures will provide protection from flooding, then based on the results, study measures to restrict runoff in river basins, measures to mitigate damage by submersion of inundation of the land, and measures to restore damaged structures and help damaged regions recover, and in these ways, achieve the goal of “zero victims” of flooding of all scales likely to occur.

And in the Tokyo region and others where core functions are concentrated, it is essential to take priority action to avoid paralysis of the nation’s functions and to minimize damage. And according to region, flood disasters may occur in many river basins simultaneously, so it is necessary to plan for a wide area response encompassing more than a single river basin.

### 4. Responding to growing risk

So at the National Institute for Land and Infrastructure Management, an organization including the River Department, Water Quality Control Department, and the Research Center for Disaster Risk Management has jointly established the “Climate Change Adaptation Research Headquarters”, which undertakes research on rivers and coastline management to respond to climate change as its priority challenge. Specifically, it is now undertaking the following research projects.

(1) Assessment of risk caused by climate change

To study research on climate change, flood disasters caused by the change of the weather which is the premise for the study, and the impact on society and the economy must be assessed as disaster risks, and the results represented in a form easily understood by the public and by concerned organizations. When dealing with flood disasters, it is possible to include flooding of every scale which could occur by analyzing the forms of inundations in the river basin to evaluate the flood risk posed by each form of inundation. It is vital to show the results visually as a risk map. Assessing flood risk is important in the sense that it not only reveals an existing state of susceptibility, but also permits a comparison of the present susceptibility with a case where adaptation has been introduced and the clarification of the results.

(2) Minimization of inundation damage

In order to prepare a flood control plan by evaluating the results of calculation of the risks of inundation by flooding caused by climate change, comprehensive measures combining measures in river basins (for example, setting flood control safety according to land use, and controlling inundation by building backup levees etc.) are studied to compensate for inadequate flood control measures on rivers. When proposing such measures, a classification is made based on conditions on each river (not only natural conditions such as the scale, gradient, etc. of the river, but social conditions which include population, land use, state of concentration of assets etc. in the river basin) in order to propose patterns of adaptation suited to each set of conditions.

To also minimize the harm to residents of the river basin, basic studies of the best way to improve evacuation guidance systems, to guide land use, and to provide flood insurance which economically provides for the risk (risk financing).

### 5. To implement adaptations to climate change

It is essential for Japan, as a nation susceptible to flooding, to clarify assessments of risk under the impact of climate change and to propose appropriate and effective responses. And at the same time it is Japan’s duty to share information of advanced technologies in this field with countries around the world. In either case, there are time restrictions on the process of proposing adaptations to the impact of climate change, so we wish to quickly undertake research.

# For more efficient use of existing road stock

– Key lies in accumulating and using data –

SATO Hiroshi, Director  
Road Department

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## 1. A historic turning point

Japan's social infrastructure development is undergoing a historic paradigm shift, and the road sector is no exception. The systems and environments involving roads are changing enormously; earmarked funding for roads has been converted to general funding, budgets vastly reduced, the Road Structure Ordinance devolved to regulations, expressway toll measures revised, subsidies converted to grants, and so on. Essentially, the fundamental role of a road is a universal one that transcends time and space. While remaining cognizant of this fact, the issues to be resolved will also of course change, in line with socio-economic conditions and changes in public opinion, the development of science and technology, etc.; policies and the R&D that support them must also adapt to the new era. Amid harsh limiting conditions, creative ideas in various organizations and aspects have become even more important, and it is surely vital that we apply reliable technology to support the efficient implementation of policy issues, in particular.

Amid these recent changes to limiting conditions and policy needs, "effective use and appropriate maintenance of existing stock" could be cited as one major issue. And the key to resolving this issue is "continuously and efficiently accumulating, updating and analyzing data". This paper will introduce some of the initiatives for R&D in the Road Department, in line with this perspective.

## 2. Integrated analysis of road traffic data

When carrying out measures to reduce traffic congestion or manage traffic demand as means of making effective use of existing stock, it is difficult to achieve this with road traffic censuses held only once every five years, and even then only on one typical day. Locations need to be selected and countermeasures proposed after comprehensively ascertaining, accumulating and analyzing hourly fluctuating traffic volumes and traveling speeds for the whole country's trunk roads. To this end, we are pursuing the following research with a view to obtaining, accumulating, calibrating, supplementing, and finally using various traffic data such as OD traffic volume, cross-sectional traffic volume and traveling speeds.

- 1) Efficient methods of obtaining traffic data
  - Techniques for estimating traffic fluctuation over a wide area using a traffic volume constant observation system
  - Techniques for using probe data and other ITS data to

obtain traveling speed data, etc.

- 2) Methods of standardizing and accumulating traffic data
  - Methods of standardizing positional data, data headings, etc., and methods of electronic delivery
- 3) Techniques for calibrating and supplementing traffic data
  - Methods of supplementing data in unobserved sections and time zones
  - Techniques of reverse-estimating OD traffic volume using traffic volume data
- 4) Methods of computing evaluation indices, etc., using traffic data
  - Congestion-related indices (aggregation of lost hours, etc.)
  - Indices related to time constancy (time reliability, etc.)
  - Indices related to traffic demand (vehicle kilometers traveled by type of vehicle, etc.)

Our aim is to be able to evaluate the effects and priority levels of individual locations subject to congestion measures by using detailed and highly reliable congestion-related indices, achieve qualitative evaluation from the user's viewpoint by using time constancy indices, and ascertain traffic demand fluctuation on national trunk roads in real time by using traffic demand-related indices.

## 3. Improving traffic safety

In 2009, traffic accidents resulted in 4,914 deaths, the number falling below 5,000 for the first time in 57 years. However, this is still an unacceptable figure, and the new administration has set the target of halving road deaths by 2018 and achieving the safest road traffic environment in the world. Improving traffic safety is synonymous with improving the quality of existing stock, and is one of the most important policies.

On trunk roads, priority measures are effective in sectors with a high rate of accident occurrence. As with congestion countermeasures, we will need to select locations for implementing measures, propose measures, evaluate their effects, etc., while continuously accumulating data on traffic accidents and the implementation of safety measures. To this end, we are pursuing the following research aimed at upgrading techniques for analyzing the current status of accidents, efficiently obtaining data on accidents and hazards, and analyzing the effects of countermeasures, among others.

- 1) Expanding techniques for ascertaining the current status of hazards and upgrading analytical techniques
  - Techniques for analyzing and ascertaining the current status by driving experiments involving eye-mark recorders and video data analyses
  - Methods of using private-sector drive recorder information to glean the present status of hazards
- 2) Upgrading techniques for selecting safety measures
  - Techniques for building a safety measure database, improving accuracy when evaluating the effects of safety measures, and evaluating composite measures
  - Establishing techniques for factor analysis based on driving experiments, etc., in locations where the cause of accidents is difficult to ascertain

We aim to tackle research that will not only enhance the effects of traffic safety policies amid severe budgetary constraints, but will also promote understanding and trust in various regions and in public opinion. This will be done by making it possible to select effective countermeasure locations based on the present status of each location, as well as increasing the reliability of countermeasure effects and making it possible to ascertain and express these quantitatively.

#### **4. Towards “preventive conservation” and “total optimum”**

Japan, as a mountainous archipelago, has a road network supported by a vast complex of road structures, including more than 150,000 bridges and 9,000 tunnels. There have been repeated reports of serious deterioration and damage to these structures in recent years. This is the result of aging, compounded by harsh natural conditions not often found in other developed nations (earthquakes, typhoons, torrential rains, heavy snow, tidal waves, etc.). Establishing conservation measures for these structures is therefore an important task.

To prevent accidents and terminal damage due to the deterioration of structures, we need to carry out accurate inspections, diagnosis, etc., and accumulate data, correctly analyze and ascertain the nature of the deterioration or damage based on the accumulated data, and carry out appropriate repair, reinforcement or preventive conservation measures based on the results of highly reliable prognosis. Roads also have to function as networks, and when assessing structures or implementing countermeasures, we need not only to optimize in units of individual structures, but also to optimize the content of countermeasures, their timing and sequences, etc., for whole groups of structures. This could also be seen as an important perspective in terms of achieving the maximum investment effect amid budgetary and other constraints.

To this end, we are pursuing the following research aimed at gaining an accurate grasp of the status of individual structures, more correctly evaluating their performance, and evaluating whole groups of structures with a view to the total optimum.

- 1) Techniques for accurately ascertaining the status of

structures

- Techniques for optimizing the system of inspections
  - Techniques for prognosis on the status of deterioration, etc., of structures
- 2) Techniques for more correctly evaluating the performance of structures
    - Techniques for estimating the load resistance performance of structures subject to deterioration and damage
    - Techniques for estimating the effects of repair and reinforcement
  - 3) Techniques for evaluating whole groups of road structures
    - Techniques for quantitatively evaluating the maintenance status of groups of road structures

Our aim is to achieve a balance between reducing lifecycle cost and improving the reliability of road services. We will do so by supporting a shift from post facto conservation after carrying out remedial countermeasures for individual structures, to strategic preventive conservation based on the latest data and high-precision prognosis.

#### **5. The role of “roads” as universal entities transcending time and space**

As it happens, the city of Nara is now celebrating the 1,300th anniversary of the establishment of the Heijo capital there. Roads were part of the core infrastructure supporting the birth of the nation at Nara and its subsequent glory. The “Takeuchi Kaido” was a regional trunk road that could be called the very first National Route in Japan. “Taishi Michi” was an access road that supported the project to build the Ikaruga Palace. “Kami-tsu-Michi, Naka-tsu-Michi and Shimo-tsu-Michi” (Upper, Middle and Lower Roads) were urban planning roads to assist area demarcation, and “Yamanobe-no-Michi” (Mountainside Road) was a domestic road that linked settlements on the shores of Lake Yamato. These ancient Nara roads provide conclusive evidence that the fundamental roles and valuable nature fulfilled by “roads” are universal ones that will always transcend time and space. Encouraged by this irrefutable evidence, we would like to tackle research and development with a view to providing a robust response to all kinds of change.

# To incorporate the latest findings in seismology and earthquake engineering in the practice of seismic design

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Building Department

(Key words) Headquarters for Earthquake Research Promotion, seismic motion prediction, building seismic design, Comprehensive Project on Sophistication of Seismic Design

## 1. Introduction

Recently, it has become quite common to see 3-dimensional reconstructions of massive earthquakes occurring along the Nankai Trough. Here, the processes whereby an earthquake occurs and radial earthquake waves spread from the epicenter to the Japanese archipelago are realistically reproduced. We see how high-rise buildings in the center of the capital region sway from side to side, and how major fires are started. When I first saw Sakyo Komatsu's film "Nihon Chinbotsu" (Japan Sinks), it all felt very artificial, but these new visuals are a world apart from those old attempts. And it's not just the video technology that has progressed; we have accumulated so much more scientific knowledge on earthquakes since then.

When the Great Hanshin-Awaji Earthquake struck in 1995, it led to the establishment of the Headquarters for Earthquake Research Promotion (Earthquake HQ)<sup>1)</sup>, a body for unified promotion of research on earthquakes. Every year, it updates its website with announcements of new research findings. In July last year, it uploaded a compilation of these in the form of "National Seismic Hazard Maps", followed by "Long-period Seismic Hazard Maps: 2009 Prototype" in September.

For a hypothetical earthquake, seismic motion is predicted by following a "recipe" (so called because the same results will be produced, whoever uses it), setting models for the epicenter and underground structure, etc. As a specific example, the shaking of the Aichi Prefectural Government Buildings during an earthquake in the Tonankai area is shown in the form of waves. Given sufficient time, however, it is even possible to calculate seismic motion in the grounds of individual building structures during the hypothetical earthquake.

We now need to make studies aimed at using these seismic motion predictions, proposed from the latest research, for practical seismic design work.

## 2. Matters to consider when using seismic motion prediction for practical seismic design work

Seismic motion predictions for various types of earthquake are also made by the Central Disaster Management Council and others, besides the Earthquake HQ mentioned above. Studies are also being made, from different aspects, by the Architectural Institute of Japan and the Japan Society of Civil Engineers, among others. In some cases, these have proudly announced completely different seismic motion predictions for the same location during the same earthquake, leading seismologists to wonder which of them is actually to be believed.

Quite aside from analytical techniques, seismic motion prediction depends on the intricacy of epicenter models describing how the destruction advances from the epicenter, underground structure models showing the course of propagation from the epicenter to the location where seismic motion is to be predicted, and so on. In the proposals by Earthquake HQ, seismic motion is predicted with these models

as givens; there is not necessarily enough explanation as to how the predicted seismic motion is influenced by error inherent in the employed modeling itself. As a result, we must first ascertain the impact of this error when applying these predictions to practical seismic design work.

While the predicted seismic motion is generally assessed at ground level, the seismic motion used in seismic design is the input seismic motion observed directly below the building. Essentially, therefore, these are two different things; it is really not appropriate to apply the proposed seismic motion prediction to practical seismic design work, as if it were input seismic motion, without first studying the relationship between the two.

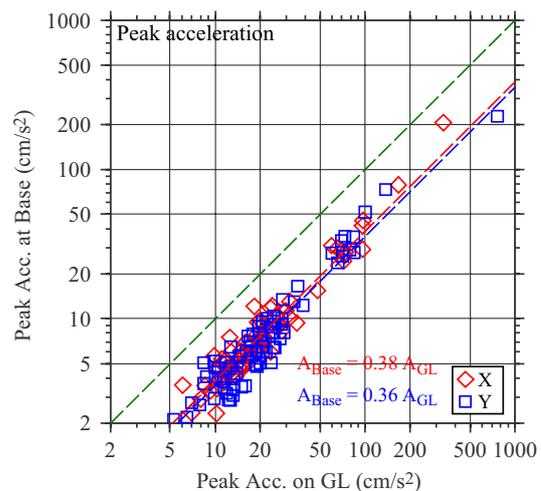


Fig. 1 Strong motion observation inside and outside Hachinohe City Hall (Source: Building Research Institute)

Fig. 1 compares the results of strong motion observation directly beneath Hachinohe City Hall and at ground level adjacent to the building (including observed data from the Iwate-Ken Engan-Hokubu earthquake of July 24th, 2008). The vertical axis shows observation results directly beneath the buildings. Compared to the observation results at ground level, as shown in the horizontal axis, this shows an acceleration of around 40% less. If the relationship between the two is formally converted to the difference in JMA (Japan Meteorological Agency) instrumental seismic intensity, input seismic motion will be around 0.75 smaller than the seismic motion at ground level. Although input loss is known to result from dynamic interaction and other factors, this makes it perfectly clear that seismic motion prediction at ground level must be treated separately from input seismic motion as the force that actually impacts on buildings.

## 3. "Notification waves" in the Building Standards Law

An Enforcement Order was used to provide performance standards in 2000 following the 1998 amendment to the Building Standards Law. The Order specified the acceleration response spectrum (5% damping) at engineering foundations, converted from the earthquake force that had been used in seismic regulations until then (the 1981 amendment to the Building Standards Law, or the New Seismic Design Method). This is known as the notification spectrum, and the “notification wave” that fits this spectrum is used as the input seismic motion in time-history response analysis for buildings approval.

While it has already been pointed out that input seismic motion should be distinguished from seismic motion at ground level, instrumental seismic intensity is sometimes calculated formally from the notification wave created as a unidirectional wave. In Soil Type 2, instrumental seismic intensity has been known to reach around 5.9. Since the instrumental seismic intensity during an actual earthquake is calculated from a 3-directional component earthquake wave, if we similarly consider the notification wave with a 3-directional component, the instrumental seismic intensity will become about 6.05. From this numerical fact alone, some have expressed concern that buildings designed under existing seismic design standards will invariably collapse if the earthquake magnitude is larger than the instrumental seismic intensity of 6.05 (i.e. 6+ or 7). In fact, however, it is not so simple.

This is because an Interim Report<sup>2)</sup> from the Building Earthquake Damage Survey Committee stated that buildings designed in line with the New Seismic Design Method generally manifested good seismic performance, following damage surveys in Kobe City and surrounding areas that suffered human judged seismic intensity 7 during the Great Hanshin-Awaji Earthquake.

Why was there so little terminal damage even in an area subjected to human judged seismic intensity 7, when the instrumental seismic intensity formally calculated from the notification wave was about 6.05? It is conceivable that even in areas with human judged seismic intensity 7, the input seismic motion may in reality have been small, for the reasons shown in Fig. 1. Another reason may well be the point that, since the minimum specified value is used as the strength of materials used in practical seismic design work, there is already a margin in there; an increase in resistance could also be anticipated due to redistribution of stress after plasticization of the buildings; and so on.

#### 4. Comprehensive Project on Sophistication of Seismic Design – Developing technology for evaluating the seismic performance of building structures in response to the advance of seismic motion information –

To study whether seismic motion prediction based on the latest findings in seismology and earthquake engineering can be applied as they are to building seismic design, and to ascertain what kind of study is needed in order to use it, etc., we will start a Comprehensive Project on Sophistication of Seismic Design<sup>3)</sup> in fiscal 2010.

The core of research in this project will lie in surveying the relationship between seismic motion at ground level and input seismic motion by studying the soil-structure interaction model, using existing observed data of strong motion inside and outside buildings. Another important component will be to enumerate the relationship between input seismic motion and seismic motion at ground level for each ground condition, building scale, and frequency. This will be done by accumulating observed data of strong motion inside and outside buildings for ground conditions, structural types and scales of building structure not handled by existing strong motion observation.

Specifically, by conducting the study shown in Fig. 2, we will develop 1) techniques for assessing earthquake force taking into account the properties of both the building and the ground, 2) methods of continuously improving seismic design technology based on strong motion observation results, and 3) efficient seismic restoration technology, including ground foundations, based on strong motion observation results.

To conduct this research, it will also be vital to have the cooperation of the private sector, universities and other related institutions, and to gather and analyze earthquake observation records from as many building structures as possible. As such, we look forward to significant cooperation from related institutions and individuals.

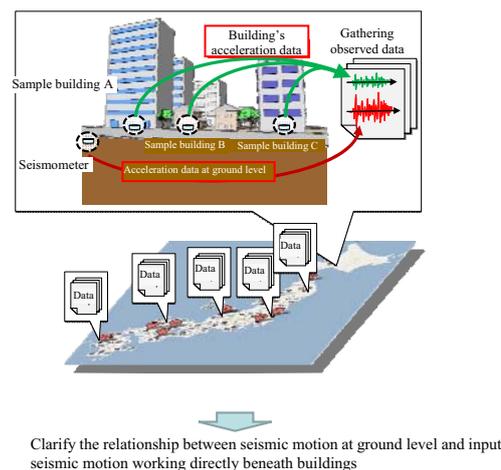


Fig. 2 Image of research in the Comprehensive Project on Sophistication of Seismic Design

#### 5. Conclusion

Methods of seismic design for building structures have learnt many lessons from past earthquakes, leading to their present format.

To boldly incorporate cutting-edge findings from seismology and earthquake engineering, as presented by Earthquake HQ and others, in practical seismic design, we will need to achieve a good balance between research on aspects of seismic motion and research on aspects of building structures. We will also need to aim for an even higher level of regulation on performance than heretofore.

In the Building Department, as one aspect of this kind of research, we plan to embark on the Comprehensive Project on Sophistication of Seismic Design from fiscal 2010.

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# Toward Housing Stock Management for a Mature Society

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*(Key words) Housing stock, housing market, prolonging service lifetime, energy conservation, effects of housing measures, renovation*

## 1. Is housing social infrastructure?

Homes are, needless to say, an element of the three necessary preconditions for life: clothing, food, and shelter. They are required by everyone, normally in family units, as places for human life. But unlike the other elements necessary for human life (clothing and food), a home is immovably anchored to the land, is large, is expensive, and can be used for a long time. And it is not sufficient to simply provide enough for all households; it is extremely vital where each is located (location), how large it is (size) and how comfortable it is (performance).

On the other hand, a home is not used by a large undetermined number of people, but it is occupied exclusively by a specified household, and home owners include few public bodies such as those operating public housing; an overwhelming majority, both occupant owned and rented, are privately owned. Most homes are, similarly, constructed by private builders and distributed mainly through transactions on the private market, by real estate dealers, etc. In this sense, housing has a strong character as a private asset which is owned by the private sector and distributed on the market.

But housing has special features; it is fixed to the ground, is large and expensive and it is used for a long time once it has been constructed, so it is difficult for housing to respond flexibly to social change brought by new human needs and technological revolutions, as other products can. The housing stock now includes approximately 57 million homes, and in recent years, about 1 million new homes have been constructed annually, so even if the level of new housing improves, it is impossible for the overall form of the housing stock to change.

Consequently, in an era when the population soared and was concentrated in large cities for example, resolving housing problems caused by an absolute shortage of homes became a major challenge. This increase was followed by quantitative provision of a full supply, but a period when it was impossible to meet size, location, and price needs continued. A classic example of this were tiny high-rent homes in housing estates accompanied by long-distance commuting: a situation referred to as “far, costly, and narrow” housing. In recent years, the movement to provide barrier-free housing has not kept up with the

rise in the elderly population, and seismic retrofitting of homes has achieved little progress.

Considered this way, most individual homes are not publicly constructed, managed, and utilized, but if the overall housing stock of Japan is not constituted in a form needed to meet social needs, it will not function appropriately through the market. Thus, housing is not social infrastructure in the narrow sense, but is a social asset which is often included in policies which integrate housing and social infrastructure.

## 2. Housing problems in the second half of the twentieth century

Policy approaches are necessary in order for the private stock of homes which are places for private life to form part of the overall social stock. During the postwar years when there was an overwhelming shortage of housing, high volume building construction was the policy challenge. Then as population was concentrated in large cities, it was necessary to not only ensure a quantitative supply, but to provide new urban neighborhoods as places for human life, in housing estates or new towns for example. And when the quantitative pressure ended, the major challenge was providing larger homes, and the target was a level of housing with floor area suited to household size.

As means to overcome such challenges, in addition to systems such as municipal housing, housing supplied by the Urban Development Corporation and other directly supplied by public bodies, and the Government Housing Loan Corporation which offers long-term low interest financing, the government enacts housing construction plans which stipulate medium-term housing construction goals, to systematically supply housing. Eight Housing Construction Five-year Programs (1965 to 2005) have been enacted and changing housing problems have been accompanied by a gradual shift of their priority from ensuring quantities of housing to improving the level of housing.

## 3. Housing challenges in the first half of the twenty-first century

A changing trend seen in Japanese society as the twentieth century ends and the twenty-first century begins is a shift from growth to maturation and from

flow to stock. The population has stopped rising and begun to fall, and the same trend will soon appear in households. And in the field of economic growth, stable growth is now more realistic than high-speed growth seen in the past. The population is also being transformed by a rapidly falling birth rate and aging of society. The flow of the population to large cities has slowed, but the absolute depopulation of outlying regions is advancing.

At the same time, daily life needs are advancing and diversifying accompanied by a boom in highly convenient city center housing. Concern for safety is high as a result of continuous large earthquakes and the problem of seismic design frauds. Environmental problems have become a topic of great interest, and attention has begun to focus on energy conservation performance. Consequently, it is necessary to form a full-scale stock with high location, size, and performance levels. In order to smoothly provide private homes with a variety of properties to people who demand them, the market environment must be improved and suitable compensation paid to the elderly and other people who require public support.

In light of such trends, the government's housing construction program has been replaced by the Basic Program for Home Life (from 2006). Its goals are not specific numbers of new homes, but improving the overall performance of the housing stock, and promoting the renovation and redistribution of old homes. The direct goals are the formation and management of a public stock.

#### **4. Housing research: present state and directions**

The research challenges we face have changed in response to the state of new housing policies.

The initial goal was popularizing long-term superior housing—building good homes, caring for them properly, and using them carefully for a long time—in order to form a full-scale housing stock. In response, the NILIM has, as part of “development of multiple generation use type housing and housing land formation and management technologies”, taken pace-setting initiatives concerning fundamental performances necessary to construct housing which can withstand long-term use, management systems, renovation methods etc., but it will also research technologies and systems which have not yet been adequately established and promote these through summarizing the results in written guidelines (the 2009 to 2011 Comprehensive Technology Development Project is now in progress).

It is also necessary to increase the percentage of overall housing stock which is housing endowed with basic performances which can meet social demands, for seismic resistance, energy conservation, and barrier free etc. Taking energy conservation performance as an example, legal systems have been gradually strengthened, and newly constructed housing provides a higher level in this area, but

measures for the vast existing stock of housing remains a challenge. As “Research on energy consumption performance according to class of housing” we wish to clarify the effectiveness of energy saving improvements according to construction period, scale, structure etc. of existing housing in particular, and to contribute to its promotion (planned for 2010 to 2012).

The effectiveness of such measures must be evaluated. And in order to clarify the degree of inducement effectiveness of policies extending from the government level to local government level according to regional characteristics in regard to the entire housing stock, which consists of an overwhelming share of private housing and tiny minority of public housing, we are undertaking Research on Methods of Evaluating the Effectiveness of Housing Policies According to Regional Characteristics (2008 to 2010, in progress).

It is predicted that new housing (including reconstructed housing) will eventually achieve a very high level, but measures focused on the existing stock are indispensable to transform the overall stock into more desirable form and use it more effectively. Japanese housing includes more new homes than in the advanced countries of Europe and America, but it is extremely far behind these regions in terms of the resale and renovation of old homes. There is also an insufficient supply of statistics which accurately clarify the performance of the overall housing stock. A system to appropriately evaluate the performance of existing housing and to predict the effectiveness and cost of improvements must be developed. Other major technical challenges are protecting consumers through quality assurance and information provision, and introducing housing stock management for a mature society.

In conclusion, because many homes are privately owned, not only must the achievements of our housing research be reflected directly in government policies, but must also contribute to the private sector housing market. If this conforms with the direction of government policies, it will contribute indirectly to its policies.

# Towards the Creation of Safe and Secure Cities

—Urban Disaster Prevention Research: Its Past and Future—

YAMASHITA Koichi, Director

Urban Planning Department

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*(Key words) Urban fire, evacuation simulation, densely populated urban area, cooperative reconstruction*

## 1. Introduction

A long time has passed since we recognized just how susceptible Japan's cities are to earthquakes, to urban fires in particular. According to a damage estimate by the Expert Panel on Measures to Prepare for an Earthquake Directly Under Tokyo of the Central Disaster Management Council, in the worst case, of approximately 850,000 homes which would be damaged, about 80% would be burned down, and of the 12,000 anticipated fatalities, more than half would be killed by fire.

To plan urban disaster prevention, it is, of course, essential to consider disasters of many kinds, including flooding caused by torrential concentrated rainfall which has increased in recent years, storm surges, strong winds, tornadoes, etc., but the Urban Planning Department has conducted a series of research projects concerning urban fires. This report summarizes past initiatives and considers the future direction regarding research on urban disaster prevention, including the perspective of densely populated urban areas where the risk of fire is extremely high.

## 2. Evaluating the disaster prevention performance of urban areas focused on urban fire simulations

A General Technology Development Project implemented from 1998 to 2002, Development of Disaster Prevention Assessment and Countermeasure Technologies for City Planning, was a study of a damage prediction simulation concerning 1) the danger of fire spreading and the 2) difficulty of activities (evacuation, rescue, first-aid, and fire-fighting activities) as a result of road closures.

Specifically, regarding 1), to perform urban fire simulations, a program which visually represents the way fires spread by elapsed time in the process, outbreak of fire → spread of the fire → damage to surroundings → ignition of nearby buildings, has been developed based on data concerning the state of individual buildings in urban areas, positional relationships of buildings, and shielding. Concerning 2), activity simulations, a study was performed to evaluate the degree of difficulty of evacuation, fire-fighting, rescue, and first-aid activities according to the state of the area's facilities, parks, city streets, etc., under conditions where roads have been closed

following an earthquake.

These studies incorporated knowledge concerning the situation when many fires broke out simultaneously in densely populated urban areas and the effectiveness of fire break belts (wide streets, parks, rows of noncombustible buildings) during the 1995 Hanshin-Awaji Earthquake Disaster.

Urban area fire simulations are performed to develop 1) advanced urban area fire simulation technology, 2) urban area fire imaging technologies, and 3) urban area data and building data control technologies as part of Development of Support Tools for Comprehensive Urban Area Fire Measures (2007 to 2009), in order to continue to improve the precision of simulations and visualization technologies.

## 3. Disaster prevention performance evaluations for densely populated urban areas

The 2002 Urban Recovery Project (Third decision) stipulated that during the next 10 years, priority improvement of approximately 8,000 hectares at particularly high risk of major fires during earthquakes from among a total of 25,000 hectares of densely populated urban areas nationwide would be undertaken. And the 2007 Urban Recovery Project (Twelfth decision) stipulated that because, in densely populated urban areas, there are many bottlenecks, including numerous lots which cannot be used effectively under building regulations, and houses difficult to reconstruct, it is necessary to accelerate improvements of such areas.

In response, we tackled disaster prevention problems in densely urban areas based on the results of the General Technology Development Project referred to above as part of Research on Human Suffering During Earthquake Fires Based on the Improvement of Area Facilities in Densely Populated Urban Areas (2006 to 2008). Specifically, the theme of the study was 1) evacuation simulation technologies performed to predict the state of evacuation by area residents incorporating residents' evacuation site and evacuation route selection actions and obstruction of roads caused by the collapse of buildings and by fire. The study also included 2) methods of evaluating the effectiveness of providing small empty spaces (pocket parks, etc.) to prevent the spread of fire by performing urban area fire simulations. Based on 1) and 2), a

technique to clarify methods of effectively improving area facilities etc. comprehensively considering the characteristics of the area was studied and, for example, a method of clarifying a road project site to effectively prevent the spread of fire was presented.

And concerning evacuation simulations, Research on Smoothing Wide Area Evacuation During an Earthquake Fire began in 2009 in order to develop a wide-area evacuation multi-agent program which can be used to deal with a variety of problems encountered during wide area evacuation, including the analysis of locations of evacuation problems and obstructive factors.

#### 4. Densely populated urban area improvement promotion policies

And regarding research on improvement promotion policies for densely populated urban areas, as part of Study and Survey of Early Safety Assurance Promotion Policies for Densely Populated Urban Areas (2004 2005), studies from the perspective of reconstructing deteriorated housing etc., were carried out focused on the use of Special Methods of Cooperative Reconstruction such as special exceptions to building form restrictions under the Building Code of Japan, for example, cityscape inducement type area plans, special approvals of building coverage ratios, and the special design method for group buildings etc.

The term, Special Methods of Cooperative Reconstruction used above means effectively linking individual building plans to reconstruction, by applying special methods under the Building Standard Law as reinforcement measures of so-called bean jam buildings inside urban blocks.

And beginning in 2010, the Development of Cooperative Reconstruction Rule Enactment Support Technologies for Densely Populated Urban Areas was started in order to construct guidelines to the enactment of cooperative reconstruction rules to

promote the improvement of densely populated urban areas. And in order to discover reconstruction needs based on the application of Special Methods of Cooperative Reconstruction, plans call for the development of area performance prediction and assessment tools which local governments and consultants can use easily, including environmental performance items such as access to sunlight and ventilation in addition to disaster prevention performance. (see following figure)

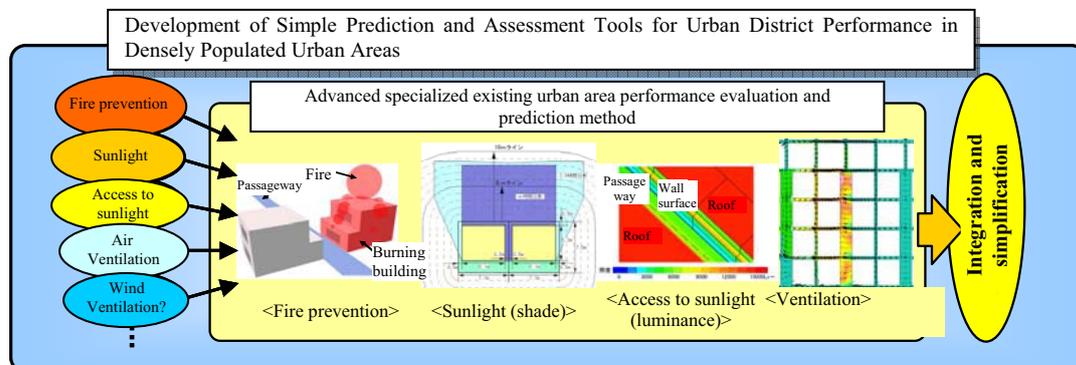
#### 5. Conclusions

Disaster prevention research has advanced under the methodology—considering future measures taking past disasters which have actually occurred as lessons—but severe disasters which actually occur usually trigger damage greater than that anticipated and greatly exceeding past knowledge. In response, we considered that it might be possible to go beyond conventional methodology to use simulation technologies to clarify new forms of disaster damage. It is assumed that from the macroscopic perspective, damage hypotheses of earthquakes bear this role to a certain degree, but it might be possible to search for forms of damage which apparently cannot be imagined applying past knowledge, that related to evacuation after earthquake fires in particular, according to the specific conditions in various urban areas.

#### Resources:

Guidebook to the Operation of Group Regulations to Improve Densely Populated Urban Areas, Technical Note of the NILIM January 2007.

(<http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0368.htm>)



# Seeking beautiful, trash-free oceans

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(Keywords) Drift trash, cooperation with the private sector, numerical model, remote sensing

## 1. Introduction

The amount of trash that drifts along and onto the shores of the East China Sea and Sea of Japan has been increasing in recent years. This trash, which drifts into sea areas around Japan and then onto its coastlines, is causing problems that include degradation of marine and coastal environments. Much of the trash is made of artificial materials that do not exist in the natural world, such as plastic. Because it is not biodegradable, once the trash enters the environment, it will exist as semipermanent drift trash unless it is recovered. This phenomenon occurs not only in the East China Sea and the Sea of Japan. In the North Pacific Ocean near Hawaii, there is a high concentration of trash called the Great Pacific Garbage Patch that is roughly twice the size of Texas.

There are many cases where regions faced with serious drift trash problems are also grappling with the problem of declining population. In such regions, the cost of disposing of onshore drift trash is an excessive burden on local government finances. And even if no financial problems exist, trash that drifts ashore tends to remain where it is because it cannot be reached by people, to say nothing of heavy equipment. Moreover, it is clear that some of the trash that drifts ashore comes from other countries.

Given these circumstances, Japan enacted a “Law for the Promotion of Marine Litter Disposal” in July 2009 to preserve favorable coastal sceneries and environments and to promote smooth disposal and control generation of driftage. In addition to requiring coast managers and others to take necessary measures to dispose of driftage, the law enables the government to quickly enact laws and implement necessary financial measures to promote countermeasures against driftage. The law’s enactment represents a significant step toward resolving the drift trash problem, and it is expected that even further measures will be taken in the future.

To solve the drift trash problem, it will be important

to reduce the amount of trash that washes out to sea as well as to collect trash that is already in the sea. Accomplishing this will require clarification of trash sources and drift processes together with continuous monitoring. The Coastal and Marine Department is engaged in research in these areas in cooperation with concerned organizations. The content of this research is presented below.

## 2. Drift trash prediction experiment in the East China Sea

Implemented under the Ministry of the Environment’s Global Environment Research Fund, this research is a collaborative undertaking involving researchers from Ehime University, the University of Tokyo, NILIM, and AIST as well as an NGO (Japan Environmental Action Network [JEAN]) and local citizens (Goto City). The main research objectives are: 1) identification of places of origin, seasons, and amounts of drift trash; 2) prediction of drift seasons and locations based on the results; and 3) preparation of recommendations on methods for continuous trash survey. Figure 1 provides a research outline.

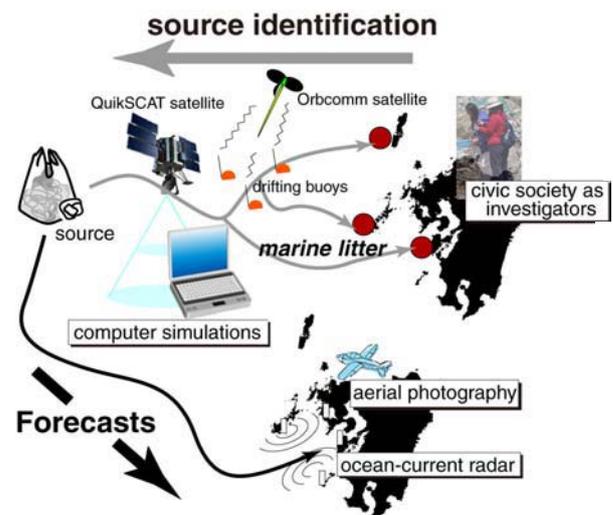


Figure 1: Research outline<sup>1)</sup>

To begin, drift trash is collected on Fukue Island of the Goto Island chain. The trash is then sorted, counted, and weighed. The origins of PET plastic bottles, lighters, and other items are deduced from labels and other clues with the help of the NGO and local residents. Then the locations of origin, seasons of origin, and amounts are back-calculated from a simulation that is based on data obtained in this way. From this, predictions of trash drift to the Goto Islands are made using these calculations as boundary conditions. To identify areas where trash accumulates, which is information necessary for trash collection on the sea, sea areas of accumulation are deduced in real time from surface flow distribution data that are obtained from high-frequency (HF) ocean surface radar for the areas off the west coasts of the Goto Islands. Web camera-based technology for monitoring drift trash is used to verify the accuracy of season and location predictions.

From this research, it has become apparent that large amounts of trash drift ashore during the winter, and that there are clear seasonal fluctuations in locations of origin and deduced by-country drift amounts. Moreover, the researchers successfully performed inverse-estimation based on simulations of drift trash. At the present time, research is focusing on one-month prediction of drift trash with forecasted wind patterns issued by the Japan Meteorological Agency, using the inverse estimates as boundary conditions. Furthermore, the researchers developed methods for identifying trash accumulation regions using the results of HF radar observations, and a method for quantifying movement speed and coverage area by analyzing digital images of trash that is scattered over marine surfaces.

### 3. Issues for the future

The researchers believe that the “drift trash prediction experiment in the East China Sea” produced value data and developed useful methods for resolving problems associated with drift trash. They also intend to make proposals on regional and long-term trash monitoring in the future based on the developed image-analysis technologies and correlations among the amounts of various trash types that were actually collected.

It should be noted that many organisms—including drifting seaweed, juvenile fish, and floating larvae—gather in marine areas of accumulated trash,

and thus the possibility exists that collecting all floating matter could have a serious impact on organisms that, for example, use the junction between two currents in their life cycles. Consequently, it may be necessary to engage in technical development that goes one step beyond “effective collection” to “appropriate collection.”

Furthermore, hazardous substances such as PCB and DDT are absorbed in the surfaces of plastic drift trash in high densities. This suggests that drift trash is not only a problem in terms of scenic beauty but also a serious problem for the ecology. As a result, it is thought that efforts to tackle the drift trash problem will be required from the standpoint of transport of hazardous materials as well.

### 4. Conclusion

Everyone wants to see beautiful, trash-free oceans. There can be no doubt that the best way to achieve this will be to not release trash into the ocean.

Although we may prefer not to think about it, it is possible that hazardous substances attached to drift trash are becoming concentrated through the food chain and winding up in the fish on our dinner tables. Moreover, it is reported that much of the Great Pacific Garbage Patch is made up of trash originating from Japan. Thus, we must recognize that we are not only the victims of the drift trash problem but also its perpetrators. Each of us must understand the drift trash problem and do take whatever action we can to solve it.

At the same time, however, no matter how much we strive to reduce the amount of trash that is discharged into the ocean, some trash will always end up there nonetheless. Thus, in collaboration with various organizations, the researchers intend to continue their research toward development of technologies for appropriate collection and ascertainment of the effects of drift trash.

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# Reconsidering Northeast Asian container flow to North America

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(Keywords) Northeast Asia, international marine container flow, Sea of Japan

## 1. Annual Report 2009: Continuation of the back cover

The back cover of the last year's Annual Report (2009) displayed trends in North America-bound container flow from Northeast Asia as analyzed by the Port and Harbor Department (up to December 2008). This analysis clearly demonstrates how flow to North America dropped rapidly following the Lehman Brothers' collapse in September 2008. Figure 1 shows what happened afterwards. Flow from Japan bottomed out in May of last year, that from China in February of last year, and that from South Korea in January of last year; since then, flow from all three countries has been growing. However, the rebound from Japan is weak compared to the other two countries.

Such trade trends between Northeast Asia—and particularly China—and North America will be an important factor in the future economic growth of not only Japan but the entire globe. Thus, it is important to analyze such trends from a variety of standpoints. For this reason, the Port and Harbor Department is analyzing container cargo flows (such as those shown in Figure 1) as well as actual port calls by containerships. In the research described here, the department newly analyzed the actual sailing of containerships in the seas near Japan. Based on this, the department succeeded in ascertaining actual sailing of containerships through the Tsugaru Strait, for example, and therefore sailing on Japan's Sea of Japan side.

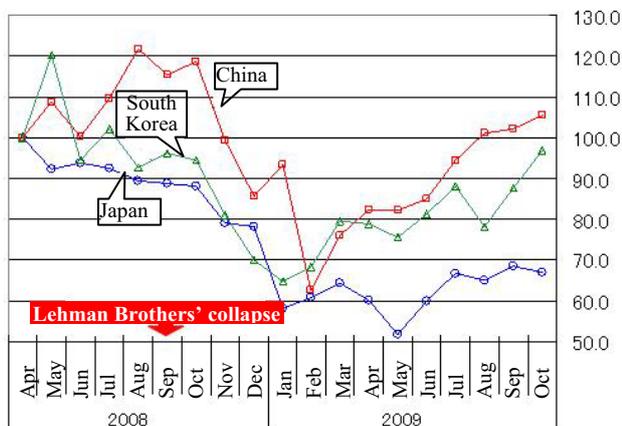


Figure 1: Northeast Asia → North America container flows

## 2. Ascertaining actual sailing by containerships

Japan Coast Guard steadily established Automatic Identification System (AIS) land stations in response to a new regulation requiring that ships carry AIS. Nationwide development of the AIS network was attained when coverage of the seas south of Kyushu was completed in June 2009. As a result, it has been possible to uniformly ascertain ship sailing in all coastal areas of Japan since July 2009. With AIS data supplied by Japan Coast Guard, the Port and Harbor department analyzed actual sailing of containerships in seas near Japan using an AIS data analysis system (NILIM-AIS) that was developed by the department. Figure 2 shows containership tracks for one week (18 to 24) in July 2009. It should be noted that areas where actual observations were lacking were supplemented in the figure by NILIM-AIS.

### (1) Large containerships (Panamax ship or larger)

Figures 3 and 4 show the results of an analysis of four-week periods for both eastbound and westbound sailing by containerships of Panamax size (Pmax) or larger. The results reveal that the share of ships sailing in the Sea of Japan is roughly 40% for both eastbound and westbound directions, and that, of these ships, the percentage of ships that do not stop in South Korea is 20% or more in the eastbound direction and 30% or more in the westbound direction. The results also reveal that the share of ships that do not stop in

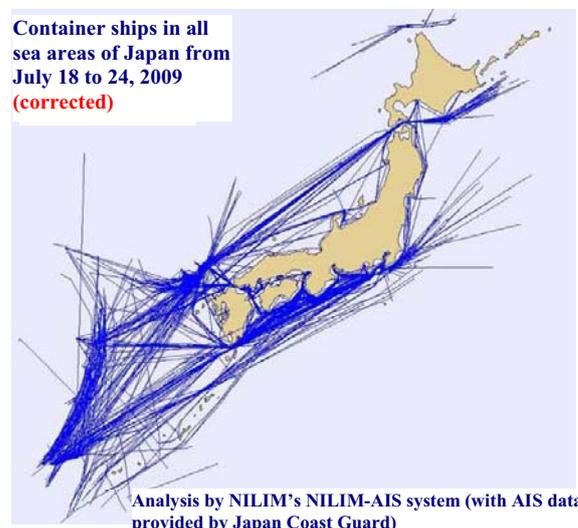


Figure 2: Container ship tracks

Japan is 60% or more for eastbound ships and 40% or more for westbound ships, and that the percentage of ships that do not stop in South Korea is 50% or more for both eastbound and westbound directions.

**(2) Oversized containerships (over-Panamax ships)**

Figures 5 and 6 show the results of a similar analysis for eastbound and westbound directions for oversized containerships that cannot pass through the Panama Canal (over Panamax: O-Pmax). Here, it is revealed that, of containerships that are Pmax or larger, up to roughly 70% are O-Pmax for both eastbound and westbound directions.

**3. Transport of Japan-China cargo on the China-North America route**

Looking at the results of 2 above, it is obvious that China occupies the central position of the Northeast Asia-North America route. Containerships plying Northeast Asia-North America route number 10 per day when both eastbound and westbound directions are combined. However, only roughly half of these ships stop in Japan. Nonetheless, it is possible to view these voyages as being on the Japan-China route. In other words, every day 10 containerships bound for/leaving China pass Japan, and only half of them do not stop.

Currently, Japan's largest trading partner is China, and thus it is thought that this route can be used as a means of transport for Japan-China trade. Traditionally, marine container transport to China has been conducted by small- and medium-sized containerships plying coastal routes, and routes that stop at multiple ports have been the norm. However, having large high-speed ships on the North America-China route stop by Japan may serve as a new "idea" here. The key to realizing such a framework will be the question of whether or not the number of China-bound containers that can be gathered will provide sufficient advantage to justify large containerships' stopping in Japan.

The Port and Harbor department intends to conduct further analysis of this topic.

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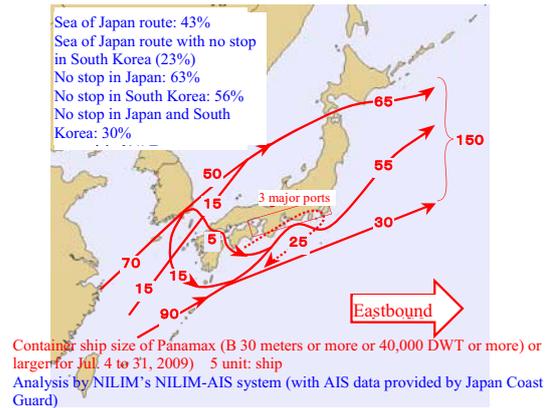


Figure 3: Sailing by container ships (Pmax) (eastbound)

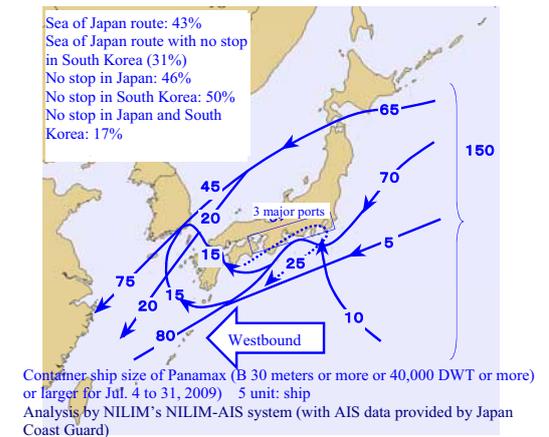


Figure 4: Sailing by container ships (Pmax) (westbound)

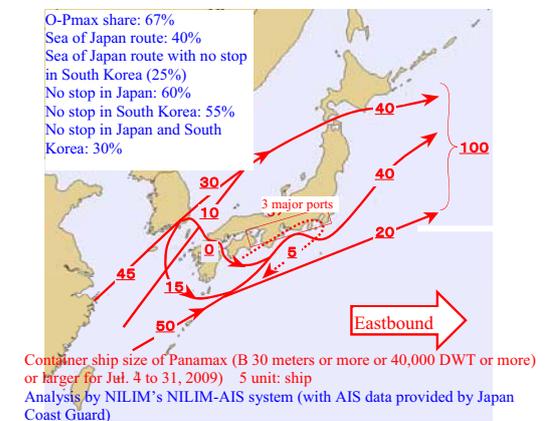


Figure 5: Sailing by container ships (O-Pmax) (eastbound)

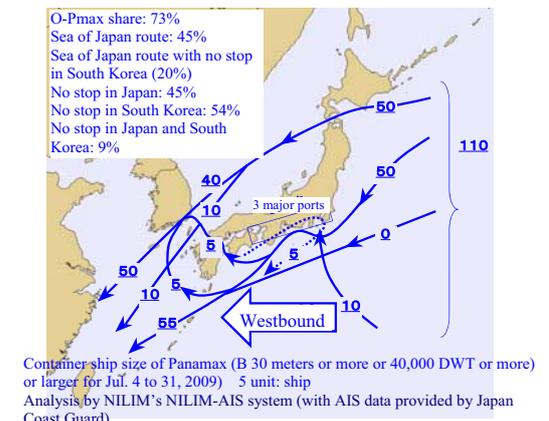


Figure 6: Sailing by container ships (O-Pmax) (westbound)

## Research themes at a time of reform

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*(Keywords) Demand simulation, regional activation by airports, risk management, airport maintenance and management*

### 1. Discussion of the roles of aviation and airports

Fiscal 2009 was a difficult year for Japan's aviation industry. Or more precisely, it may have marked the beginning of a difficult era. The worldwide recession that began with Lehman Brothers' collapse led to cooling demand that resulted in the failure of Japan Airlines International Co., Ltd., a company that was operating with high expenses. Amid expectations that international aviation demand will grow over the long term, particularly in Asia, as globalization continues, one cannot escape the sense that there is something incongruous about JAL's being forced to scale back its routes. It is therefore hoped that JAL will complete its reform and make an early fresh start.

Aviation serves as a public transport system. Almost all passengers traveling long distances use aviation. Aviation is also a valuable means of getting around in the daily lives of people living on remote islands and regions with poor overland transport. Thus, the question of whether or not this means of travel should be abandoned due to the business circumstances of airlines presents a problem. In fact, the plan to bail out JAL is based on the belief that a discontinuation of flights must not occur. Railway companies and bus companies are similar in that they have two aspects; i.e., they are both private companies and public transport systems. However, how airlines—which are subject to international competition and face unstable demand—should exist presents an important topic for discussion.

On the other hand, airports are also a major topic of discussion. Because demand influences how airlines act, airports such as Kansai Airport face severe management conditions when airlines curtail their flights. Currently, discussion is focusing not only on management problems but also on the question of how to use the three airports in the Kansai area. Aviation is a public transport system, and airports are public transport infrastructure. Even internationally, it is common for regional airports to be operated with landing fees combined with the general accounts of local governments. Because airports were originally built to provide convenience for users and stimulate the regional economy, rather than to earn money, it makes no sense to talk about profitability. Discussion is also underway regarding the use of special accounts for nationally operated airports;

specifically, people are asking, “Who will bear the costs of airport maintenance and operation?”

Several years have passed since it was said that airports are moving away from an era of construction to one of operation. No substantial construction of new airports has begun during the past several years. However, insufficient airport capacity in major metropolitan areas, including the Tokyo metropolitan area, continues to be a problem. Even in the Tokyo metropolitan area, where airport functions are being expanded, there are limits to what can be achieved, and therefore efforts are underway to find the best possible way of using airport capacity.

The future airport strategy of the Ministry of Land, Infrastructure, Transport and Tourism's Growth Strategy Council focuses on the “open skies” approach and tourism. However, what will be needed to contribute to these goals? Regardless of the directions the above-mentioned discussions take, there are many issues that are essential to maintaining air transportation. Given these circumstances, the Airport Department sees the following points as priority research topics.

### 2. Research on aviation networks and airport management and operation

- Development of demand simulation methods -

Demand forecasts are essential for aviation and airport policies. Although the Airport Department has developed methods for predicting demand for air transport, demand depends on the destinations and numbers of routes that airlines establish. As was mentioned above, route planning is based on not only actual demand but also on airlines' circumstances. Thus, although realistic forecasting must take into account airlines' behavior, in an era of liberalization, in which routes may be taken over by other airlines, it is impossible to consider the management circumstances of each individual airline. However, as liberalization progresses under “open skies,” it is likely that airlines will gradually behave in patterns that are more in line with market principles. At the very least, it will be necessary to develop forecast methods capable of taking into account market principles-based behavior that are in addition to the current demand projection methods. It is hoped that this will raise the accuracy of pre-implementation simulations of aviation and airport policies and lead to

the formulation of more precise policies. If “open skies” gains momentum, it can be expected that overseas low-cost carriers (LCC) will enter Japan’s market and that domestic LCC will become prominent. This in turn will further complicate use of multiple airports in major metropolitan areas. Thus far, the department has put a model that considers airlines’ behavior to trial use in an attempt to estimate the impact that policies to limit the number of flights at multiple airports will have. However, improving the model’s accuracy and expanding its scope of application remain challenges to be tackled.

The department also intends to study possibilities for routes to come into existence if small aircraft are used even at the regional level, and possibilities for the establishment of new international routes to neighboring countries under the open skies policy.

Looking forward, the need for better simulation technology will be required. This is because the future will demand not only airport construction that matches demand forecasts but also strategic maintenance and operation that are based on demand forecasts.

### **3. Research on higher service levels at airports**

- Striving for airport-led tourism strategies and regional activation -

As aviation has become a mass transit system, airport-related needs have become more diversified and sophisticated. Examples of such needs include barrier-free facilities, simplified check-in, and higher security. At the same time, although airports are not tourist destinations in themselves, they are entryways. Therefore, an airport plays a role in how visitors view the surrounding region. While it is of course important to enhance hospitality and guidance for overseas visitors, promotion that makes use of the merits of each region and airport as a tourism strategy is also important. Although it goes without saying that airport usage differs from airport to airport, and that regional characteristics, geographical conditions, and economic scales vary from place to place, a certain degree of speculation is possible based on traveler movement surveys. The Airport Department hopes to propose tourism strategies that are appropriate for airports based on such speculation, as one of the intentions behind the building of airports should be regional revitalization.

### **4. Research concerning safe and secure airports**

Regardless of what growth strategies are employed or who pays the bills, the building and maintenance of safe facilities form the basis of public transport infrastructure. This point cannot be overemphasized. Today, countermeasures against liquefaction of runways are being implemented at major airports. Airports in Japan, and particularly hub airports, were constructed by taking advantage of various special technologies. This was due to a variety of factors,

including the fact that they had to be built in areas with poor ground conditions or were constructed with massive paved areas. In addition to the design standards for new facilities it has formulated thus far, the Airport Department is currently urgently working to draft an outline for repairs. The department is also studying probability theory-based design methods that are in line with a trend toward performance design of facilities.

As for non-infrastructure-related areas, the department is engaged in research toward quickly securing alternate routes if international air transport hubs become inoperable due to an earthquake or other such event. If there are deficiencies in the current situation, immediate responses will become necessary. This is important from the standpoint of maintaining not only safety and security but also international competitiveness.

### **5. Research on management of airport assets**

Like other forms of infrastructure, how to efficiently maintain the functions of airport facilities that have been built thus far is a question that deserves attention. Although the technologies involved here differ in terms of content, what they strive to achieve is the same. As expenditure for public works projects shrinks, the need to repair infrastructure continues to increase. It will therefore be necessary to overcome various problems, including how to engage in routine management that minimizes this need to the greatest degree possible, and how to perform such management with minimum staffing. And, where the possibility exists that repair costs will balloon as infrastructure deteriorates with age, how should signs of deterioration be identified and what steps should then be taken? Appropriate response lowers life-cycle costs, and implementing repairs that do not affect operation is part of good maintenance and management.

### **6. Conclusion**

The truth is, the research topics described in this paper are extensions of research undertaken thus far. Although circumstances seem ready to undergo rapid change, there does not appear to be any need for a dramatic shift in facilities-related research themes if they are considered separately from issues concerning airlines and bearing of airport expenses. In fact, we who work in the Airport Division believe that the need to continue research in areas we have already targeted as necessary has grown even greater.

# Computerized Construction

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(Key words): Computerized construction, information communication technology (ICT), standardization

## 1. Introduction

In July 2008, the Ministry of Land, Infrastructure, Transport and Tourism enacted the Computerized Construction Promotion Strategy.

This promotion strategy considers the significance of computerized construction to be, “a general term for a new execution system which achieves high productivity and execution quality using ICT for construction execution.” In other words, computerized construction is an execution method intended to achieve high productivity, quality etc., and has an extremely broad meaning extending from using the newest ICT to applying simple ICT.

But, according to the results of a questionnaire survey conducted during a trial execution of computerized construction by the Ministry of Land, Infrastructure, Transport and Tourism in 2008, while the term, computerized construction, is known on the client side in particular, specific technologies have not penetrated the construction field very much. For such reasons, we wish to introduce the general framework of computerized technologies by classifying and organizing such technologies used for trial executions which the Ministry of Land, Infrastructure, Transport and Tourism has performed since 2008 (total of 241 cases).

## 2. Computerized construction technologies

Figure 1 roughly systematizes computerized construction technologies used for past trial executions. If these groups of technology are first classified according to purpose, they can be divided into technologies which support mechanized execution and technologies which support execution control. Technologies in the former group are 1) machine guidance technologies (MG technologies) for construction machinery and 2) machine control technologies (MC technologies) for construction machinery, and these are technologies categorized as those mainly developed by the private sector. Technologies in the latter group are 3) finished work control technologies which apply ICT and 4) quality control technologies which apply ICT, and trial executions are being performed to verify their efficiency and reliability when applied to execution control by a contractor and to supervision and inspections by a customer.

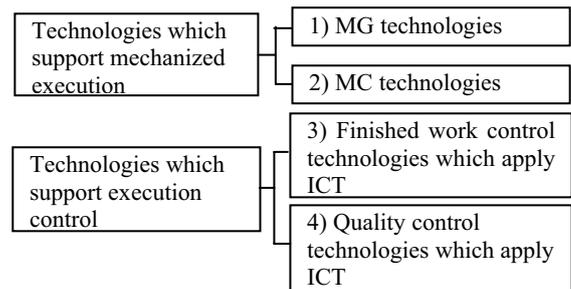


Figure 1. Classification of Computerized Construction Technologies

### 1) MG Technologies (machine guidance technologies)

These are technologies which combine measurement and positioning technologies such as TS (total station) or GPS (positioning system using satellites) etc. with angle sensors, inclinometers and other sensors to obtain data concerning the position and state of operation of a construction machine and provide the operator of the machine with information on an in-board monitor along with three-dimensional design data which has been input to the construction machine. Taking MG technology installed in a back hoe used for cutting work as an example, the object of the excavation is shown on a screen, replacing finishing stakes. It can, therefore, be counted on to eliminate stake installation work and speed up finishing work.

### 2) MC Technologies (machine control technologies)

This is technology which, in addition to the MG technology monitor display, includes a function which calculates the difference between the positions of the bulldozing blade, bucket, etc. of the construction machine with the three-dimensional design data and performs automatic control to achieve the stipulated execution precision. Taking MC technology installed on a grader etc. used for road work as an example, it automatically controls the excavation height. It can, therefore, be counted on to effectively reduce the work of installing and inspecting finishing stakes used as markers and effectively reducing redoing of work.

### 3) Finished work control technologies which apply ICT

This technology converts coordinate values obtained by TS, GPS or other measurement and positioning technologies (for example, three-dimensional

coordinate values, elevation and latitude and longitude based on GPS) to finished work values such as length or height, permitting the use of the coordinate values to control finished work. Taking the state of finished work control based on TS in the embanking work shown in Figure 2 as an example, by inputting three-dimensional design data to TS, the design values, measured values, and the difference between them of elevation and horizontal distances are displayed on the TS screen, permitting the operator to confirm that the standard values are satisfied as the measurements are performed.

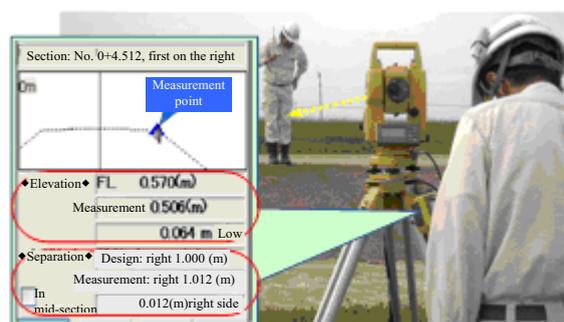


Figure 2. View of Measurement Based on TS used for Finished Work Control

#### 4) Quality control technologies which apply ICT

This is a technology which uses measurement and positioning technologies such as TS or GPS to perform planar control of qualities such as density, strength, etc. at the same time as the execution. Taking embankment soil density control as an example, it is a method of measuring compaction frequency or acceleration response which are correlated with density and which can be measured at the same time as execution as quality control items to replace density.

### 3. Finished work control technology based on TS

The Research Center for Advanced Information Technology has been conducting research and development of finished work control systems based on TS since 2005.

As shown by Table 1, until now, contractors performed finished work control by, repeatedly for each control section, performing calculations to specify the location for finished work control, placing stakes etc. to mark the site and measuring the finished form using levels, measuring tapes, etc., recording these data in their field notebooks, and transferring the data to ledgers and section drawings in the office.

But in the case of finished work control systems based on TS, calculation and marker placement are unnecessary, and this method can be counted on to automate the preparation of ledgers from finished work calculation data, reducing preparation work. It makes it easier for the customer to confirm the

Table 1. Comparison of Conventional and TS Based Finished Work Control

	Conventional method	TS method
Specification of location of finished work control point	Manual positioning calculation and placing markers (stakes etc.)	Automatic positioning calculation so it is not necessary to place markers (stakes etc.)
Completed work measurement	Measuring height with a level and length with a measuring tape	Measuring three-dimensional coordinate values with TS, and automatically converting them to length, etc.
Preparing ledgers from measured data	Preparing ledgers by transferring data from field notebooks	Automatically preparing ledgers

finished work control performed by the contractor, and it is counted on to simplify the task of confirming finished work devised by the customer at any control section. Until now, we have 1) studied the functions of software installed in finished work control use TS and developed prototypes, 2) standardized data formats for input to TS, 3) verified the effectiveness of its introduction, and 4) enacted finished work control instructions using TS. Beginning in 2010, we will use it for standardization of directly managed earth works.

### 4. Conclusion

This report has introduced the overall framework of technologies related to computerized construction. As stated in the introduction, these technology groups are extremely diverse, and details of each technology could not be introduced because of a shortage of space, but please refer to documents such as, "Construction ICT Overview Series (*kensetsu ICT zakkuri shirizu*) published by the ICT Introduction Research Committee at the Chubu Regional Development Bureau as a document clearly explaining their details.

We hope that people in each field will take an interest in such computerized construction related technologies and apply them to boost building construction performance.

# Characteristics of damage in recent natural disasters and initiatives aimed at mitigating damage

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*(Key words) Flood and sediment disasters, large-scale earthquakes, disaster-vulnerable persons, warning and evacuation, instantaneous damage prediction, local disaster prevention capability*

## 1. Introduction

In 2009 alone, July brought torrential rains to Chugoku and northern Kyushu, while August saw an earthquake with its epicenter in Suruga Bay and flood damage caused by Typhoon No. 9. And no sooner had the new year started than a powerful earthquake struck Haiti, causing damage that threatened to ruin this Caribbean island nation. As well as enumerating the issues that have come clear as a result of these disasters, this paper will introduce initiatives being undertaken by the Research Center for Disaster Risk Management to develop technology designed to mitigate the damage caused by natural disasters.

## 2. Main disasters in 2009 and the issues they highlighted

The torrential rains that ravaged the Chugoku region in July caused 22 deaths, mainly in the city of Hofu, Yamaguchi Prefecture. There alone, a debris flow buried an old people's home, killing seven people. Throughout Japan, as many as 13,800 old people's homes and other facilities for disaster-vulnerable persons are at risk of sediment disasters like this. Conventionally, places like this have been subject to priority countermeasures; even the location in question was said to have recently undergone a survey for development of *sabo* (erosion control) facilities. We need to step up work for the development of *sabo* dams and other facilities in places considered vulnerable to calamitous damage.

Owing partly to fiscal constraints, however, it is inconceivable that *sabo* dams and other facilities will all be developed at once. This increases the importance of "soft" countermeasures, such as clearly specifying the scope of hazards and making them publicly known in line with the Sediment-Related Disaster Prevention Act, controlling the use of land in hazardous areas, and giving warnings and encouraging early evacuation at times of danger due to heavy rains, etc.

The disaster location in question had already been designated as a sediment disaster warning zone, and the disaster occurred three and a half hours after the announcement of sediment disaster warning information. Boulders in the debris flow were sedimented on flat land upstream of the old people's home, which was made of steel-reinforced concrete. However, smaller debris entered the facility through

the windows. When this happened, most of the residents were evacuated to upper floors by staff, but seven lost their lives.

Besides the conventional problem that, even when sediment disaster warning information has been released, no recommendation is made by the municipal leader for residents to evacuate, or the recommendation is delayed, other major issues emerge. For example, even if an evacuation recommendation is issued, few of the residents actually evacuate; or, as seen in this disaster with the old people's home, issues remain in deciding how to evacuate disaster-vulnerable persons in need of assistance or care, and how to ensure their safety.

Meanwhile, when Typhoon No. 9 struck land in August, the town of Sayo-cho in Hyogo Prefecture was particularly hard hit. Nine members of three households who were voluntarily evacuating from their homes to the evacuation site due to flooding from the Makuyama River were caught up in the deluge and tragically lost their lives. This was a "voluntary disaster prevention activity" prior to the issue of an evacuation recommendation by the town, at a time when the rainfall volume had increased dramatically. Since the homes of the disaster-affected residents were only damaged by flooding on the ground floor, problems pointed out include the timing of evacuation in conditions of flooding at night, and the need for selective judgment of appropriate evacuation routes and sites in accordance with the situation. On the other hand, depending on the situation, in some cases it may not even be completely safe to evacuate to the top floor of a house, as the house could be carried off in the flood flow. In the damage at Sayo-cho, moreover, the local council office, which should have become a focal point at the time of a disaster, had its own floor covered in water, creating a situation that hindered disaster relief. From these facts, another issue was seen in creating and providing information that would allow residents to choose the appropriate action in the event of an emergency.

In these disasters caused by torrential rains, the damage in both Hofu and Sayo was caused by sudden heavy rains in excess of 70mm in one hour. From these facts, the speed with which information on torrential rains, water levels and furthermore floodplain situations, etc., can be ascertained and provided is of

paramount importance.

Also, to encourage early warning and evacuation, another issue will be how to provide sediment disaster warning information with an indication of imminence, including supplementary information, and how to inform residents, as receivers of information, at both normal and abnormal times.

Furthermore, flood hazard maps are expected to provide necessary information whereby residents can choose appropriate evacuation in accordance with the situation, such as the risk of homes collapsing or being washed away, etc., together with floodwater depth information.

It is also thought important to study realistic safety assurance methods, such as ascertaining and analyzing the distribution and structures of old people's homes and other facilities for disaster-vulnerable persons in anticipated flood zones and sediment disaster warning zones, and methods of evacuation in accordance with the situation of the respective facilities.

### 3. Developing support technology aimed at improving crisis response capability

In the earthquake that struck Haiti on January 13th this year, although the conditions differ greatly from those in Japan, catastrophic damage to urban and residential facilities due to the earthquake striking a major urban area led to a massive death toll in excess of 150,000. It also led to the loss of administrative and information functions, and the rescue operation for disaster victims is colossal in scale. At times of damage of this order, it is considered necessary, firstly, to ascertain information on what sort of damage or disaster phenomena have specifically occurred where, including forward projections, as soon as possible; and then to incorporate this information into speedy recovery measures as quickly as possible.

We are therefore researching techniques for instantaneous damage prediction (Fig. 1) to support the initial mobilization of local headquarters for disaster countermeasures in the event of an earthquake. With this technique, we ascertain an outline of damage near the epicenter and estimate damage to management facilities, based on analysis of seismic motion data obtained from the strong motion seismographs network immediately after the occurrence of an earthquake.

Immediately after the occurrence of a disaster, meanwhile, there is a period in which the local residents have no choice but to cope by themselves with self-help or helping each other until public support from the government and others arrives. Even here, support measures from the administration are considered necessary to improve the disaster prevention capability of local residents, such as being fully prepared for disasters in advance and safely evacuating in the event of occurrence. We are therefore studying techniques for improving local disaster prevention capability.

On this issue of improving local disaster prevention

capability, as a task common to disasters, we are drawing on the center functions of the Research Center for Disaster Risk Management and are studying the issue in a Disaster Risk Management Team set up in April 2009.

### 4. Conclusion

Mainly based on notable disasters in 2009, I have described the issues for damage mitigation that have been clarified by them, and have also introduced some of the support technology being developed by the Research Center for Disaster Risk Management to improve crisis response capability in the event of a disaster.

In Japan, a country where major disasters are prone to occur, disaster countermeasures are a basic theme at the very core of the nation. Although it is difficult to prevent disasters completely, we will continue our efforts to develop technology that will mitigate their effects as far as possible, as well as tackling technical support aimed at reducing damage in the event of a disaster.

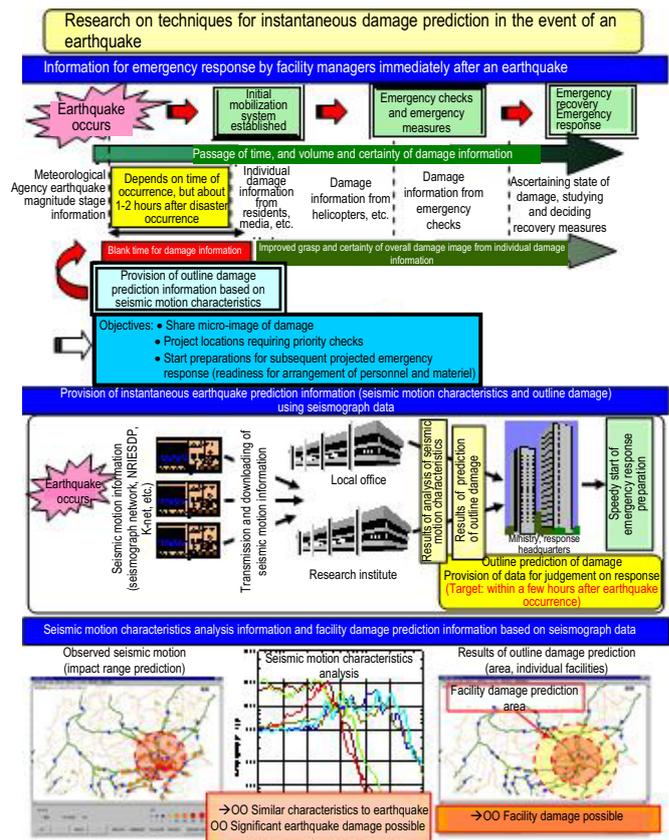


Fig. 1 Research on techniques for instantaneous damage prediction in the event of an earthquake

# Research on Evaluation and Countermeasure Technology to Ensure Safety During Daily Life Activities of People Using Architectural Space

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(Key words) Everyday disasters, safety and security, accident prevention measures, knowledge base

## 1. Background to and Purpose of the Research

As a reflection of the aging of society, many accidents occur within buildings in the course of daily life, including falls in corridors, falling down stairs, and so on. When estimated based on statistics, the number of deaths caused by such accidents will rise as rapidly as traffic accident fatalities in the future. Although there are cases where such accidents are caused by the lack of care of building users, there are also cases where they are the result of inadequate awareness of the occurrence of accidents by building designers and managers, and if these cases are analyzed, it will be possible for users, designers, and managers to each clarify risk through accident cases, and to prevent many accidents by exercising a specified degree of care.

This research collected examples of accidents which have occurred in the normal daily lives and activities of users (building users) in such buildings at the same time as it clarified accident occurrence mechanisms and studied accident prevention measures. The results have been collected and released to the public on the internet since mid August 2009 as the Building Accident Prevention Knowledge Base (Fig. 1).

## 2. Outline of the Building Accident Prevention Knowledge Base

To prevent accidents in buildings during use, it is necessary to deal thoroughly with each part of a building according to the way it is presumably used or the way it is actually used, and in many cases this cannot be covered by building standards which are uniformly applied. The Building Accident Prevention Knowledge Base (below called, "Knowledge Base") must reduce accidents caused by carelessness in buildings (and on lots) by serving as reference materials to encourage designers, managers, and users to exercise adequate care.

The Knowledge Base deals mainly with accidents in public buildings, and contains 750 (scheduled to be increased regularly in the future) accidents and near-accidents, judicial precedents concerning accidents

caused in buildings which were collected through questionnaire surveys, searches for judicial precedents, and reports on accidents in schools, permitting people to search for and refer to accidents based on the type and degree of accidents, places accidents occur etc. And in addition to these, the Knowledge Base provides a wide range of knowledge and information, by permitting searches for related records and documents, providing survey reports, and permitting experts to contribute information regarding 110 accident patterns prepared by classifying accidents and countermeasures and precautions for each of these patterns. And the knowledge base is also equipped with a function for the submission by building users of their experience of accidents and of near-misses which did not become real accidents, and a function allowing the contribution of information such as examples of innovations introduced during design and execution and during building operation regarding measures to prevent everyday accidents on the assumption that building designers and building managers will contribute information. And to expand information of use in predicting accidents, it is counted on to aggressively provide information from people in various fields who have referred to the Knowledge Base.



Figure 1. Building Accident Prevention Knowledge Base (Top Page)

<http://www.tatemonojikoyobo.nilim.go.jp/>

# Drive Recorders

## Towards their Application to Safety Measures for Community Roads

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(Key words) Community roads, traffic safety measures, drive recorder

### 1. Background of the research

Traffic accident fatalities in Japan have tended to decrease in recent years, and fell below 5,000 in 2009 for the first time in 57 years. However, on community roads, the state of traffic safety improvement is still severe compared to that on arterial roads, because hazardous spots are scattered over the extremely high total length of these roads. It is impossible to clarify causes of accidents for each location by analyzing accident data as it is on arterial roads.

Recently, the use of drive recorders has spread rapidly, mainly in taxies, delivery trucks etc. These devices record images of the road ahead, position, speed, acceleration, application of brakes and so on, of motor vehicles in operation. The use of drive recorders enables us to efficiently collect large quantities of accident or near-miss data on community roads.

The NILIM is conducting research on methods of using scientific data collected by drive recorders to plan and implement safety measures on community roads.

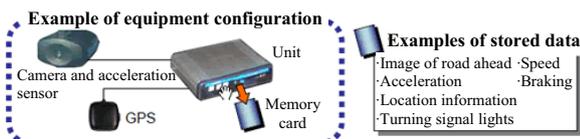


Figure Example of Drive Recorder Configuration

### 2. Research on use of scientific data

The NILIM is conducting research focused on the following two areas in order to apply drive recorder's data to safety measures on community roads.

#### 1) Extracting Method of near-misses data

Drive recorder's data contain useless data for road safety measures such as data on level differences, as data recorded according to changes in acceleration. In order to apply drive recorder's data for road safety measures, it must be possible to efficiently extract near-misses data. The NILIM is researching methods of efficiently extracting near-misses data focusing on the properties of speed and acceleration wave forms etc.

#### 2) Methods of sharing and accumulating data

In order to apply drive recorder data to road safety measures, road administrators must obtain the cooperation of the taxi and delivery companies who possess such data. The NILIM is researching data sharing and accumulation methods taking advantage of Corporate Social Responsibility (CSR), restoring analysis results, etc., to build cooperative relationships which can gain the benefits of public – private sector interactions.

### 3. Future research directions

Simple extraction algorithms proposed by the NILIM increased the percentage of near-miss data to more than 80%. The result of research revealed that drive recorder's data improves the selection of hazardous spots and evaluation of safety measures by road administrators without the complex task of image confirmation etc.

The NILIM will provide technical notes on drive recorder data collection and use to regional road administrators who can get an adequate quantity of data from corporations with taxi or delivery companies, citizens, local governments, police, etc. As it is difficult to promptly obtain sufficient data on community roads throughout the nation, we wish to classify patterns of near-misses and safety measures on community roads based on existing data.

The Road Transport Bureau and the Road Bureau of the Ministry of Land, Infrastructure, Transport and Tourism, the National Police Agency, and various other organizations are showing growing concern with the application of drive recorders to traffic safety. The NILIM will deepen its links and cooperative relationships with concerned organizations, in order to make further use of scientific data in the traffic safety field.

# Road Marking Design Know-how

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(Key words) Traffic safety measures, accident analysis, road markings

## 1. Introduction

Traffic safety measure projects often adopt road marking measures, which can be installed cheaply and take effect immediately (this research examines road marking and colored paving intended to prevent rear-end collisions, intersection collisions). But because design concepts for road markings have not yet been organized, they are often designed based on the experience of road managers. The NILIM has collected examples of road marking measures and analyzed their accident reduction effectiveness to create an inventory of know-how which can be applied to design road markings.

## 2. Analysis of cases of measures

Figure 1. shows typical road marking patterns, which road managers selectively install according to the situation at each location. There are also cases where road managers have designed innovative road markings and combined them with colored pavement. This research involved collecting and classifying road traffic conditions and accident reduction effectiveness and carrying out interviews with road managers and identify the design know-how applied to each case.

Figure 2. is an example: markings installed on an approach to an intersection to prevent rear-end collisions. In this case, 1.25 rear end collisions/year (4-year average) occurred before this measure was taken, but none occurred during the 2 years after it was taken. At the design stage, the planners studied the road marking installation point considering the accident's point, the intersection congestion length (length of congestion of cars waiting for the

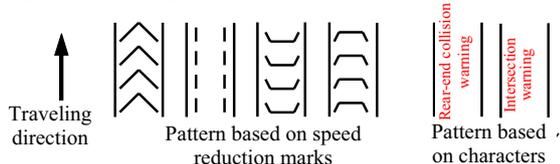


Figure 1. Typical Road Marking Patterns

intersection signal), and the car braking distance. The “rear-end collision warnings”, which show the content of the risk, are placed in advance of the accident’s point and “speed reduction marks (dotted lines)” are installed further on to urge drivers to slow down.

## 3. Conclusion

The following design know-how has been abstracted

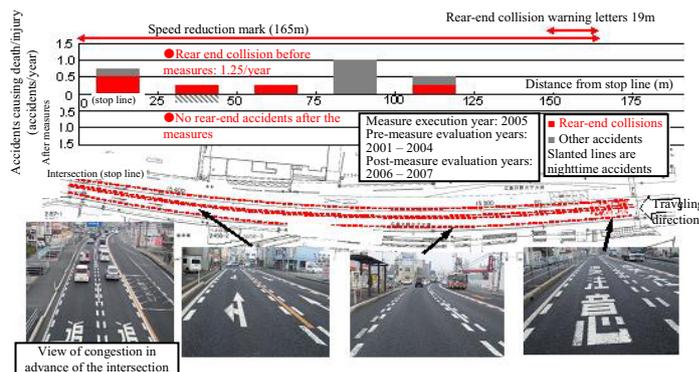


Figure 2. Highly Effective Cases

by a detailed survey of cases in various regions.

- In many cases, characters are marked on the road surface to clearly inform drivers of what they should be careful of. At locations where it is difficult for drivers to notice danger, dangerous locations are emphasized by speed reduction marks.
- Road markings are often placed in front of the accident’s point or intersection congestion length considering the braking stopping distance etc. of cars.
- There are cases where the road markings are difficult to see because of cars ahead on sections with heavy traffic, so the study included the joint use of signboards which are relatively easy to see, even during congestion.

Plans for the future include the verification from many aspects of the design know-how which has been abstracted accompanied by the clarification of conditions for application of each type of know-how, and the provision of the information for road managers.

[Reference:] Web site of the Advanced Road Design and Safety Division (giving access to related reports)  
<http://www.nilim.go.jp/lab/gdg/index.htm>

# Trial Application of the Partial Repainting Manual for Steel Bridges (Draft)

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(Keywords) Steel bridge, local corrosion, repainting, durability

## 1. Background and purpose

On many steel road bridges, severe paint deterioration and corrosion occurs at ends of girders and parts of other members exposed to harsh corrosion environments<sup>1)</sup>, and if corrosion on a supporting part important for load-bearing capacity advances to an extreme degree, even if only within a narrow range on the part, there is a danger of the corrosion severely impacting the performance of the bridge (Photo 1). Although general items regarding repainting methods are specified in, for example, the “Painting and Corrosion-proofing Manual for Steel Highway Bridges (Japan Road Association, December, 2006)”, technical methods for partial repainting, which is difficult to perform with guaranteed high execution quality, have not been established, and there is fear that it is dangerous to leave local paint deterioration, which advances rapidly, until the deterioration of the entire paint membrane has advanced to the point where overall repainting is performed.

Thus, technology to partially repaint narrow parts such as the ends of girders on existing road bridges (referred to below as, “partial repainting”) has been developed, summarized as technical manual, and trial application of it has been carried out on an MLITT



Photo 1. Example of Girder Edge of Main Girder Showing Local Corrosion



Photo 2. Trial Execution on an Actual Bridge

operated bridge.

## 2. Outline of the partial repainting manual (draft)

The following items are main technical characteristics of the partial repainting manual (draft).

- ① To develop a method of ensuring sufficient surface preparation quality on parts where execution conditions are spatially harsh, a test execution was done using full-size specimens taken from a bridge which was removed to set execution specifications based on the combined use of open blast and machine tools.
- ② Because a weak point of executing partial painting is the paint quality along the boundary with the old paint film which has not been renewed, based on existing knowledge and the results of a trial execution, a painting system which considers recoating width and other execution specifications plus the adhesiveness of the new and old paint films was established.
- ③ In order that rational and economical partial painting can be done, precautions required when planning painting, conditions under which partial painting should be studied, and methods of recording an execution for maintenance purposes and other standards have been prepared.

And a final version of this manual (draft) has been prepared by confirming its applicability in the field through a trial execution at an actual bridge (Photo 2).

## 3. Trial application on an existing bridge

The trial application of this manual (draft) is now beginning on MLITT operated bridges, and in the future, follow-up surveys of these applications of the manual and of the trial execution specimens during continuous exposure testing will be carried out and reflected in the revision.

### [References]

- 1) Survey Research on Local Corrosion of Steel Bridges, Technical Note of the NILIM, No. 294, January 2006

<http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0294.htm>

# Publication of Collected Highway Bridge Repair and Retrofitting Cases (2009 Edition)

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Bridge and Structures Division, Road Department

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*(Key words) Highway, damage, repair, retrofitting, fatigue cracking*

Highway bridges in Japan deteriorate and are damaged in a variety of ways as they age, increasing their need for repair or retrofitting work. And to repair or retrofit existing bridges, it is necessary to carry out a detailed study of each bridge at each step from hypothesizing the causes of the deterioration and damage to selecting the countermeasure method because, as a result of the complex interaction of an extremely wide range of factors, universal countermeasure methods have not been established.

Based upon precautions clarified by the study of the analysis of deterioration and damage and by research on its evaluation, technical guidance for repair and retrofitting measures is provided. To take advantage of the results, the Division has collected and analyzed information concerning deterioration of and damage to highway bridges which have been the objects of technical guidance by the National Institute for Land and Infrastructure Management. Based on these, detailed survey methods needed to hypothesize causes, know-how concerning the selection of repair and retrofitting work methods and measures to ensure quality during execution have been organized at the same time

as measures taken in typical damage cases have been reviewed.

With regard to fatigue cracking of corners on steel bridge piers and of steel deck slabs for example, the Division has clarified measures and precautions to deal with this problem by analyzing the results of surveys and inspections by regional development bureaus throughout Japan, by analyzing past designs and executions, and by surveying bridge manufacturing technologies.

The achievements of these survey and research projects have been reviewed along with repairs and retrofitting works by other road companies and local governments, and reflected in the Collected Cases of Highway bridges Repair and Retrofitting (2009 Edition) published by the Japan Road Association, a technical document prepared for road administrators and engineers performing repair and retrofitting work in the field.

## References

- 1) Note on structural details about the beam-column connection of steel pier of highway bridges, Technical Note of NILIM, No. 229, January 2005, etc.

# Design Points of Bicycle Space

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(Key words) bicycle path, bicycle lane, intersection design

## 1. Introduction

Cycling has flourished as a consequence of growing concern with environmental problems and health. This trend has also revealed problems with bicycles, such as the soaring numbers of accidents involving cyclists and pedestrians during the past ten years. The National Police Agency and the Ministry of Land, Infrastructure, Transport and Tourism have worked to ensure bicycle space separated from pedestrians by, in January 2008, designating a total of 98 districts nationwide as bicycle space improvement model districts.

The NILIM has supported improvements in these model districts by inventorying concepts of the design of bicycle traveling space focused on intersection points separately for bicycle paths and for bicycle lanes and in compliance with existing laws, and has summarized the results as Design Points of Bicycle Space (below called, the “Design Points”).

## 2. Outline of the “Design Points”

The Design Points hypothesizes simplified intersection patterns to present design concepts and precautions by bicycle path and bicycle lane, and by intersections of two arterial roads and intersections of arterial roads with narrow back streets. At this stage, few such improvements have been in Japan, and knowledge is inadequate, so priorities and selection concepts for each pattern have not been included. Their design and improvement will advance through coordination between road managers and traffic managers, thoroughly accounting for the state of roads and traffic conditions which differ at each location.

Figure 1 shows an example of a design point for an intersection with a narrow back street in a case where the bicycle lane is provided along the arterial road.

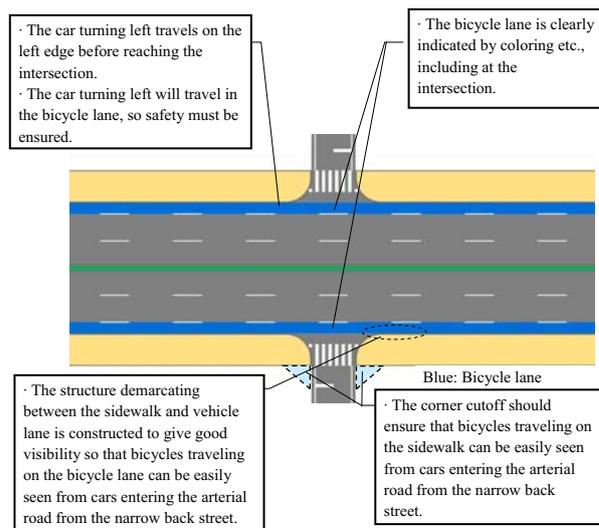


Figure 1. An Example of the “Design Points”

## 3. Application of the Results and Future Development

The “Design Points” which has been sent to managers of each model district and explanation meetings have been held to publicize its contents. Figure 2 shows an example of improvement performed applying the “Design Points” in a model district.



Figure 2. Sample Provision (Amagasaki City in Hyogo Prefecture)

In the future, it will be revised as necessary to reflect new knowledge gained through improvements in model districts.

# Impact of Transfer of Structural Experiment Technology to the Research Institute for Human Settlements, Ministry of Public Works in Indonesia

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Housing Stock Division, Housing Department

*(Key words) Technology cooperation, technology transfer, building component structural testing method, Research Institute for Human Settlement of the Ministry of Public works*

## 1. Introduction

A lesson taught by the disaster caused by the Kanto Earthquake of 1923 (Report by the Imperial Earthquake Investigation Committee, No. 100, Part 3, Vols. 1 and 2, 1926) was that a public testing institute must be established with the ability to verify not only the economic merits and efficiency of building production, but also the safety and rationality of building structures, and to achieve this goal, to provide standards and verify the performance of buildings. Immediately after World War II, Japan established the National Research Institutes, which performed structural testing at universities and private sector research institutes, and now plays a leading role in this field in international society. This report describes the results of the transfer of structural experiment technology to the Research Institute for Human Settlements of the Ministry of Public Works (<http://puskim.pu.go.id>) of Indonesia and to the **structure division**, which receives technical assistance from Japan.

## 2. Background to the technology cooperation

Indonesia is located in an earthquake zone where it is important to ensure structural safety, and the Research Institute is, as the only national testing organization in the housing construction field, responsible for this task. The Research Institute built a building (site area: 96ha) with interest-free investment support by Japan in 1990 under the Bandung Science City Concept Plan, and has moved to Cileunyi about 16km to the east of Bandung. Later, the Government of Indonesia requested that Japan provide technical assistance with the development of collective dwellings suitable for low-income people (periods: 1993 to 1998 and 2005 to 2007), and the Ministry of Land, Infrastructure, Transport and Tourism (then the Ministry of Construction) provided this assistance as an organization specializing in the field. The author, then an expert in the charge of the structural field of this technical assistance monitored the effectiveness of the transfer of structural experiment technology and its impact on the building construction industry in Indonesia from the beginning to the conclusion of the project.

## 3. Contents of the technological transfer of building component structural experiment methods

1) We built experimental equipment which could be used to test columns, beams, walls and other structural members of medium to high buildings, enabling the center to satisfy housing construction policies and meet social needs as a public

institution.

2) The functions of the experimental equipment include the ability to apply axial force to perform positive – negative cyclic horizontal loading of members in order to verify their strength, deformation, failure properties etc. (Photo 1).

3) The equipment places a light maintenance burden on its users.

4) The test organization included researchers who had completed study and training in earthquake engineering (Building Research Institute, International Institute of Seismology and Earthquake Engineering (IISEE))



Photo 1. View of an Element Structure Test (White Part: Specimen)

## 4. Impact of the transfer of the structural experiment technology

1) The Research Institute center has systematized the verification and confirmation of structural performance thanks to its ability to conduct experiments adding compound forces to building structure members, and has been carrying out housing building production related development. In 1999, it established the Prestressed - Precast Association.

2) Building methods it has developed have been applied by the Ministry of Housing and regional governments to build collective dwellings and university dormitories throughout the country. The center has studied the reconstruction of school buildings damaged by the Padang Earthquake of September 2009.

3) Researchers who studied at the IISEE in Japan are working in the structure division of the Research Institute and in the private sector, contributing to the improvement of safe building production technology in Indonesia.

# Efforts by the Typhoon Committee to Popularize Sediment Disaster Warning and Evaluation Systems

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Research Center for Disaster Risk Management, Erosion and Sediment Control Division

*(Key words) Typhoon Committee, sediment disaster, early warning information*

## 1. Introduction

The Typhoon Committee, which is an organization formed jointly by the World Meteorological Organization and the Economic and Social Commission for Asia and the Pacific, held its Forty-second General Meeting in the Republic of Singapore from January 25 to 29, 2010. The Erosion and Sediment Control Division submitted its final report on the Sediment Disaster Forecasting and Warning System Project, which is a project led by the Division, and reported on the state of progress of a new project, the Sediment Disaster Hazard Map Project.

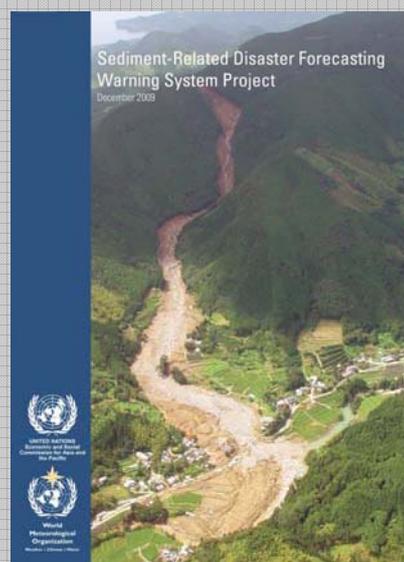
## 2. Sediment Disaster Forecasting and Warning System Project

This project was undertaken to build a sediment disaster forecasting and warning system during the seven year period from 2002 to 2008. The participating countries built the system applying a judgment method which applies Japan's Critical

Rainfall for Sediment Disaster Occurrence Risk with modifications suited to conditions in each country. The six participating countries include China, Malaysia, Vietnam, Philippines, Thailand, and the United States (Guam) in addition to Japan.

## 3. Sediment Disaster Hazard Map Project

The Sediment Disaster Hazard Map Project will be undertaken for three years from 2009 to 2011 as the second step following the Sediment Disaster Forecasting and Warning System Project. Its final purpose is to share Japanese methods of setting sediment disaster risk districts with other countries and to prepare a guideline. At the General Meeting, the state of progress of the project was reported at the same time as the plan and budget for field training scheduled for the autumn workshop were discussed. At the next meeting, technical challenges to the field training will be discussed by the countries participating in the project.



# The New Influenza Virus in Sewers

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*(Key words) Sewerage system, public hygiene, new influenza virus*

Water flowing into sewerage systems contains a variety of bacteria and viruses originating in human excrement. It is known that during the norovirus season in the winter, the norovirus concentration in inflowing water is high, and it is assumed that this reflects its prevalence in the drainage district.

The swine derived new influenza virus (H1N1) confirmed to be prevalent in Mexico in March 2009 was also confirmed in Japan in May, and had spread nationwide by between October and December. It has been reported that a survey conducted in Osaka in May 2009 revealed that 23% of patients complained of symptoms of diarrhea <sup>1)</sup>. This suggests that the new influenza virus may be flowing in sewerage water, and to clarify the actual situation, it was necessary to study impacts on workers and on receiving waters. To meet this need, an emergency survey was conducted.

The emergency survey was a survey of influenza virus genes in water flowing into and water

discharged from two water treatment plants in Japan during the peak of the period of prevalence of new influenza from October to December 2009. The results of the survey show that during the prevalent period, the quantity of new influenza virus flowing into sewerage systems is extremely low and water treatment plants remove it efficiently, so that almost none of the virus remain in the water discharged from the plants. The results have provided basic information to be applied to study measures to deal with spread of bird flu which, it is feared, may gain the ability to infect humans in the near future.

## [References]

1) National Institute of Infectious Diseases: Epidemiological Survey of Epidemics of New Influenza in Osaka Prefecture, September 2009.

([http://idsc.nih.go.jp/disease/swine\\_influenza/2009idsc/report\\_osaka.html](http://idsc.nih.go.jp/disease/swine_influenza/2009idsc/report_osaka.html))

# A survey of container drift damage in Mikawa Port caused by the storm surge of Typhoon No. 18

KUMAGAI Kentaro, Senior Researcher, Coastal Disaster Prevention Division, Coastal and Marine Department  
(Keywords) Typhoon No. 18, storm surge, container, drift, damage survey

## 1. Overview of the damage survey

On October 8, 2009, Typhoon No. 18 came ashore near the Chita Peninsula. The surge associated with the typhoon caused flooding and scattered a large number of containers on the wharves of Mikawa Port (Photo 1).

In cooperation with the Chubu Regional Bureau's Port and Airport Department and the Port and Airport Research Institute, the author surveyed damage to the Jinno-Nishi Wharf in Mikawa Port and its vicinity on October 9, the day following the typhoon's landfall. The main components of the survey were 1) a survey of the conditions of flooding caused by the storm surge, 2) interviews on the actual circumstances of container drift, and 3) a survey of damage to the port facilities.



Photo 1: Scattered containers (provided by Japan Coast Guard)

## 2. Survey results

(1) Damage caused by the storm surge: Tide observation records of the Chubu Regional Bureau showed a highest tide level of D.L.+4.40 meters at 6:20. It should be noted that the tide observation station is located approximately one kilometer from the pier. The ground height of the wharf's No. 8 pier is D.L.+4.11 to 4.16 meters, and there is a gentle upward slope inland from there that reaches D.L.+4.34 meters at its highest point. Behind this is a gentle downward slope to around D.L.+4 meters and then a relatively flat area. Accordingly, it is thought that the flood depth of the wharf, minus the effects of the waves and wind, was between 0.1 and 0.4 meters. In some locations, this is equivalent to a flood depth at which even double-stacked containers would float (see reference\*). Grass that had drifted due to the influence of the waves and wind was entangled in the fence surrounding the wharf (ground height of D.L.+4 meters) to a height of 0.7 to 0.9 meters.

(2) Actual conditions of container drift: According to the Aichi Prefecture's Mikawa Port Office, which has jurisdiction over the port, 136 containers out of 887 stored on the wharf moved significantly. The maximum straight-line distance of movement was approximately 250 meters. Most of the containers were stopped by a steel fence or nets that surround the wharf. The results of an interview with a witness are shown in Table 1.

Marks indicating places where containers had been

dragged were found in several areas on the pavement near the highest point in the No. 8 pier yard (Photo 2). Thus, it was found that some of the containers did not completely float but were rather dragged.

Table 1: Interview results

Time	Witnessed conditions
5:45	Seawater was confirmed overflowing from the No. 8 pier.
6:20	Container drift was confirmed. Containers did not start moving all at once, but little-by-little. They bobbed like boats made of bamboo leaves as they floated. Some containers were carried away while still stacked.
7:00	The containers stopped moving.
7:30	The water was withdrawn completely from the top of the wharf at this time.

(3) Damage to wharf facilities: The posts of the steel fence surrounding the wharf were deformed due to the impacts of the containers. In one example, a post measuring 6 cm in diameter was deformed in two locations at heights of 0.5 and 0.9 meters above the ground (Photo 3). There were no instances where the entire fence was knocked down.

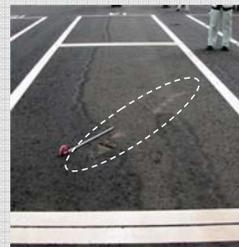


Photo 2: Drag marks



Photo 3: Fence post

## 3. Conclusion

While referring to the results of the survey, the author intends to conduct a numerical analysis of cargo that drifted from the wharf and study appropriate cargo management measures needed for countermeasures against drift damage. The author wishes to express his gratitude to Mr. Yoji Hirai, head of the Chubu Regional Bureau's Mikawa Port Office, and others for their cooperation in this survey.

\*Generally, there is a raised height of approximately 0.15 meters that serves as a tunnel recess (depression for trailer loading), etc. Considering this, it is thought that empty 40-foot containers would float in floodwater having a depth of 0.28 meters when single stacked and 0.39 meters when double stacked.

## How efficient is shipping of major bulk cargoes (coal, iron ore, and grain) to Japan?

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(Keywords) Bulk cargo, Bulk carrier, Berth depth

### 1. Introduction

Bulk cargoes are the basic materials for industry and food ingredients for daily life. They are loaded directly into the holds of bulk carriers in unpackaged form for shipping. The efficiency of such shipping is an essential element in raising the international competitiveness of industry and ensuring stability in the national livelihood. However, because bulk cargo shipping is tramp shipping conducted for specified shippers, information on it is extremely limited. In this research, the author devised a method for determining shipping performance for major bulk cargoes (coal, iron ore, and grain). The author then analyzed the circumstances of such performance in order to contribute to the planning and proposal of measures to improve shipping efficiency.

### 2. Method for determining the shipping performance of major bulk cargoes

To begin, a list of bulk carriers that can ship the relevant items and worldwide loading ports was prepared. Then, using the worldwide record of port calls by bulk carriers, it was determined that a bulk carrier was loaded with the relevant bulk cargo whenever it visited a loading port.

From this, roughly 60 to 90% of all shipping could be determined from contrasting various forms of data.

### 3. Results of comparison of major countries in Northeast Asia

The bulk cargo shipping conditions in major countries of Northeast Asia (Japan, China, South Korea, and Taiwan) were compared. Table 1 presents average per-port discharge volumes that were obtained by dividing loaded volumes when all carriers are fully loaded by the number of discharge ports. Here, if carriers are larger and the number of discharge ports per shipment is smaller, then the average discharge volume grows larger and shipping becomes more efficient. As a result, in the case of coal and grain, Japan had a low average discharge volume because its carriers were small and it had many discharge ports. Particularly in the case of grain, there was a gap of at least roughly 20,000 tons in carrier capacity between Japan and the other major countries. In the case of iron ore, Japan had large carriers, but it also had a large number of discharge ports.

Table 1: Average per-port discharge volume (tons)

Country	Coal	Iron ore	Grain
Japan	49,097	123,335	17,168
China	59,887	103,781	47,727
South Korea	68,330	166,941	44,672
Taiwan	69,603	131,698	38,140

Table 2: Rates of insufficient berth depth for fully loaded carriers

Country	Coal	Iron ore	Grain
Japan	39.3%	79.5%	36.2%
China	-	19.1%	85.4%
South Korea	16.8%	37.7%	58.6%
Taiwan	15.5%	-	57.0%

Note: Because China is a coal exporting country and data could be obtained for only one iron ore port in Taiwan, analyses were not conducted for these items.

The possibility that discharge ports lack capacity is presumed based on the small size of carriers and large number of discharge ports. Here, a comparison of water depth required to handle fully loaded carriers at each port and the maximum berth depth of each port was conducted. Percentages of ports having insufficient berth depths that were obtained from the results are shown in Table 2. In the cases of coal and iron ore, Japan had large berth depth insufficiency rates compared to the other countries. Japan had a smaller insufficiency rate in the case of grain. However, because the carriers were small, this insufficiency rate exceeds 80%—the same level as China—if carriers having the same size as China's had been used in shipping.

### 4. Conclusion

The author intends to continue his analyses in the hope that they will help raise the efficiency of shipping to Japan.

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Journal of the JSCE, Division D, Vol. 65, No. 3, pp. 336-347

# Vessel shelter conditions ascertained by NILAM-AIS at the time of Typhoon No. 18 of 2009

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(Keywords) NILIM-AIS, anchorage size, shelter conditions

Research trends and results

## 1. Outline

The “Technical Standards for Port and Harbor Facilities and their Interpretation” that were revised in 2007 make no quantitative statements regarding anchorage size during times of stormy weather. Although, in the past, the Standards/Interpretation did provide a quantitative formula for calculating anchorage size, this formula was removed at the time of the 1999 revision because the grounds for it were unclear. A real-world problem here is difficulty in ascertaining actual shelter conditions of vessels during stormy weather, and particularly the area of water needed for shelter, and as a result no calculation formula has been proposed.

In 2008, a regulation requiring both ocean-going and domestic vessels that meet or exceed a certain size to carry the Automatic Identification System (AIS) was implemented. Against this backdrop, the Port Planning Division is constructing an NILIM-AIS system by setting up AIS land stations in Japan’s major sea areas. This system functions to observe ship movement in real time and conduct data analyses. The data analysis function was used to ascertain actual conditions surrounding vessel shelter, anchoring by large ships, and movement into/out of ports during the passage of Typhoon No. 18, which struck Japan in October 2009.

## 2. Actual conditions of vessel shelter

Figure 1 shows conditions immediately before the typhoon made landfall at the Chita Peninsula at 4:00 A.M on October 8. The wind speed at Central Japan International Airport (Centrair) was 22.1 meters/second. Each of the ships taking shelter is pointed into the wind direction that was observed in its vicinity.

The ship movement shown in the center of the figure pertains to an ordinary cargo ship of approximately 9,000 tons that was anchored in Mikawa Bay. Until the typhoon made landfall at around 5:00 A.M. on October 8, the ship is swinging around in a circle with little change in the central anchor point.

NILIM-AIS also ascertained the number of ships passing through the Irago Suido Traffic Route in two-hour units. The results are shown in Figure 2. From this figure, it is

possible to confirm the following trends:

- 1) During the roughly 20-hour period centered on the time of maximum measured wind speed, no ships entered or exited the bay. Peaks are observed before and after this period.
- 2) The number of ships entering the bay peaked prior to the typhoon’s approach, and the number exiting the bay peaked after the typhoon passed.

It should be noted that no measurements were made during the period between 4:00 A.M. and noon on October 8 due to a typhoon-caused power outage.

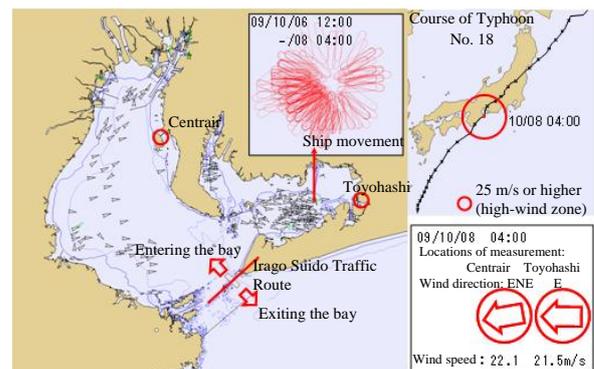


Figure 1: Shelter conditions

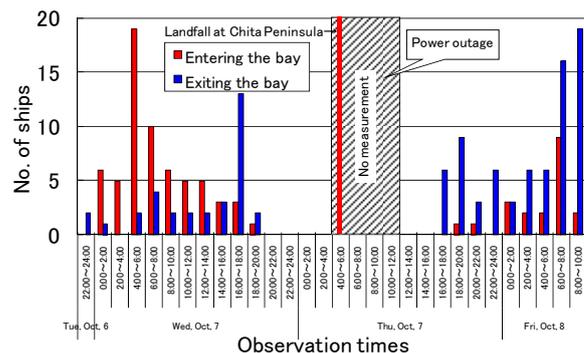


Figure 2: Time-series analysis of numbers of passing ships

The author intends to conduct a more detailed analysis of these results and to reconsider the formula for calculating anchorage size during stormy weather in the Technical Standards/Interpretation.

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# Evaluation of major ASEAN logistics infrastructure projects

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(Keywords) International logistics, infrastructure project, ASEAN, policy simulation

## 1. Purpose of research

In 2007, ASEAN formulated projects for logistics infrastructure as means of contributing to the development of the entire region as well as multiple countries within the region. These projects targeted roads (38), railroads (13), sea transport (20), airports (9), and logistics facilities (11). However, the selection of these projects was made qualitatively based on interview surveys and locational relationships with major transport corridors. This research project expands a multimode international cargo flow model that was developed by the authors to include land and sea transport for all of ASEAN, and applies it toward quantitative ascertainment of the effects the projects will have in reducing transport costs. It should be noted that the research was carried out under a transport logistics working group of the Japan-ASEAN Transport Cooperation project, which is led by the Ministry of Land, Infrastructure and Transport's Policy Bureau.

## 2. The model and envisioned scenario

The authors' model is a traffic assignment model that selects transport routes and ports for import/export based on cargo transport demand (OD cargo volume). The service levels of various infrastructure forms—such as roads, railroads, and ports and harbors—are inputted into the model, and link traffic volume, volumes handled by ports and harbors (as aggregated values), etc., are outputted.

Furthermore, future cargo transport demand for the year 2020 was separately predicted and inputted for simulation. This was done given the strong implication that projects will serve as investments for future economic development. Moreover, in the area of international land transport, consideration was given to a measure (Cross-Border Transport Agreement [CBTA]) intended to lessen resistance caused by cross-border transport, which is a major obstacle because it requires customs procedures, cargo transshipment, etc.

## 3. Simulation results

### (1) Impact on arriving/departing cargo for ASEAN as a whole

It was estimated that the overall amount of reduction in transport costs for arriving/departing ASEAN cargo that would result from implementation of all projects and a regional CBTA would be approximately 15.7 trillion yen per year (equivalent to 8.8% of ASEAN's total cargo transport costs). Moreover, the benefits of land projects (62), sea transport projects (19), and CBTA were estimated to be approximately 8.0 trillion yen, 6.9 trillion yen, and 7.5 trillion yen, respectively. Differences in projected land transport flow arising from whether or not projects are implemented are shown in the figure below.

### (2) Impact on individual countries

The table below shows the reduced transport cost benefit and rate of reduction against total transport costs for

arriving/departing cargo for each country. Looking at the by-country effects of each policy, there are some cases in which, due to circumstances in each country, almost no effect is generated. On the other hand, if all policies are implemented simultaneously, a reduction effect of at least 3 to 4% can be expected. In other words, it is suggested that simultaneous implementation of policies is important for ensuring that all countries receive the benefits of policies that are implemented in a relatively fair manner and for formulation of agreements on project implementation among countries of the region.

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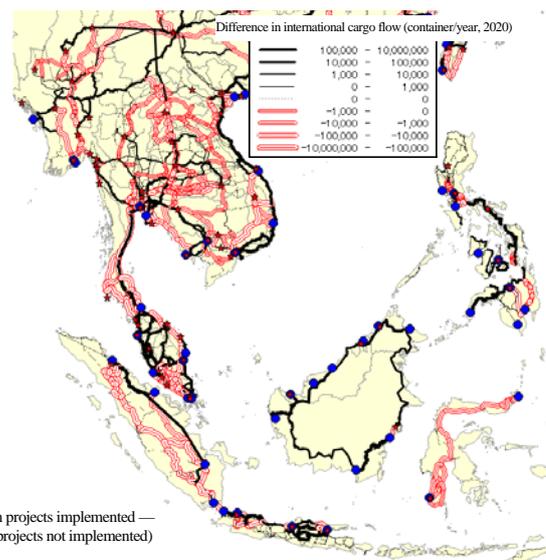


Figure: Differences in land transport flow when projects are implemented/not implemented

Table: Rate of transport cost reduction for arriving/departing cargo of each country

Country/region	When all measures are implemented simultaneously	When only sea transport projects are implemented	When only land transport projects are implemented	When only measures to reduce cross-border resistance are implemented
Japan	1.5%	0.9%	1.2%	0.5%
Philippines	3.7%	2.3%	2.5%	0.9%
Vietnam	12.3%	1.8%	7.1%	5.4%
Laos	22.6%	2.1%	-0.2%	19.2%
Cambodia	4.3%	0.3%	0.4%	2.8%
Thailand	12.9%	7.1%	10.6%	4.0%
Malaysia	6.6%	1.4%	2.2%	6.2%
Singapore	6.8%	2.0%	1.9%	4.2%
Myanmar	5.6%	1.3%	1.5%	3.6%
Indonesia	12.8%	8.3%	2.2%	5.7%
Brunei	9.0%	0.0%	0.9%	7.8%
World total	1.9%	0.6%	1.1%	0.9%
Arriving/departing ASEAN cargo	8.8%	3.9%	4.5%	4.2%

for arriving/departing ASEAN cargo.

# Relationship between Characteristics of Freight and Freight Truck Expressway Use Ratio

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(Keywords) Freight truck traffic, Route selection, Expressway use ratio

Research Trends & Results

## 1. Introduction

The Traffic Engineering Division is conducting research to develop a “route selection model” to be used to predict how freight flow on road networks will be changed by freight truck traffic measures introduced to strengthen international competitiveness and improve living environments in residential districts. This report introduces an outline of an analysis of the relationship between “characteristics of freight” and “expressway use ratio”, which is the most fundamental freight truck route selection behavior in order to obtain basic information for the model.

## 2. Outline of the analysis

We set hypotheses, “the ratio of expressway use, which ensures rapid delivery, is high in the case of the transport of perishables such as raw fish, for which express transport is preferred,” and “delivery time-specified freight is highly likely to be transported via expressways, which are known to be more travel time reliable, as any delay in the delivery of such freight is not allowed,” and verified the hypotheses using data from the Commodity Flow Census (2005). A Z-test performed as shown in Figure 1 confirmed that the ratio of expressway use is higher in the case of refrigerated and frozen freight and delivery time specified freight than it is for other kinds of freight at a significance level of 0.1%.

$$Z = \frac{P_a - P_b}{\sqrt{P_{average} \times (1 - P_{average}) \times (\frac{1}{N_a} + \frac{1}{N_b})}}$$

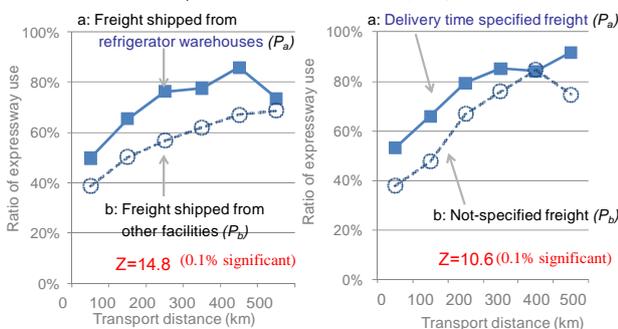


Figure 1. Significant Difference Test

Regressing the Logit converted expressway use ratio  $f$  to four parameters (transport distance (x1), refrigerated, frozen freight dummy (x2), and delivery

time specification dummy(x3) and lot (x4)) obtained an equation which estimates the expressway use ratio according to characteristics of freight (Table 1). Coding conditions conform, and a significance level of 0.1% was satisfied. This suggests that all of the above four parameters are factors which explain freight truck route selection behavior.

Table 1. Parameter Estimation Result

$$\text{Logit}(f) = \log\left(\frac{f}{1-f}\right) = \alpha_0 + \alpha_1x_1 + \alpha_2x_2 + \alpha_3x_3 + \alpha_4x_4$$

Estimated coefficients

Coefficients	Estimate	Std. Error	Z value	Signif.
(Intercept)	-0.5182	0.0522	-9.92	***
X1: Transport distance	0.0050	0.0002	31.47	***
X2: Freight refrigeration status	0.7231	0.0536	13.50	***
X3: Delivery time specification	0.2072	0.0513	4.04	***
X4: Freight lot	-0.1531	0.0200	-7.66	***

0.1% confidence level

Change in expressway use ratio accompanying improvement of commercial practices was simulated using the above equation. As shown in Table 2, it is confirmed that the rise of the just-in-time transport ratio increases the expressway use ratio by 2.6 points.

Table 2. Description and Results of the Simulation

Change of commercial practice	Description of Simulation	$f$	Change
Case 1 Increasing transport distance	50% increase in transport distance	74.3%	+7.4
Case 2 Increasing just-in-time transport	Delivery time specification ratio of 100%	69.6%	+2.6
Case 3 Reducing lot size	Average lot size decrease of 50%	67.7%	+0.8

## 3. Conclusion

This report has shown that it is possible to estimate “change of expressway use ratio caused by future improvement of commercial practices” by applying the resulting relational equation.

It is anticipated that the “relationship between road structure specifications and route selection characteristics” will be studied to further improve the route selection model, and that this knowledge and model will be applied to evaluate freight truck traffic measures.

# Management of Sewers

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(Keywords) Sewers, asset management, micro-management, failure risk

## 1. Introduction

Sewers constructed rapidly since the late 1960s have deteriorated in recent years, demanding appropriate maintenance and large rehabilitation works. It is predicted that population decrease makes it difficult to secure satisfactory budgets for sewer management. From now on, measures must be taken to minimize the failure risk such as road sinkholes and to reduce or level expenses.

This report introduces a study of micro-management, which is a part of sewer asset management.

## 2. Micro-management of sewers

The core of asset management consists of medium- to long-term rehabilitation cost predictions based on statistical analysis of survey results (macro-management) and prioritizing of rehabilitation or maintenance works in individual spans (sewer lines between manholes) (micro-management).

In FY 2009, risk assessments were studied on micro-management. Risk assessments are quantitative evaluations performed by combining “probability of sewer failure” and “consequence which failed sewers might cause.” Prioritizing rehabilitation or maintenance to minimize the risk such as road sinkholes is studied by this method.

## 3. Studying risk assessments

Quantifying the probability of sewer failure is conducted by analysis based on the relationship of sewer survey results (e.g., corrosion or infiltration as in Photo 1) with sewerage registry items (e.g., type of material, age, diameter). Since sewers are buried under a variety of urban environments and ground conditions, registry items cannot cover all factors which influence the occurrence of failure.

This study combines two approaches: logistic regression analysis applied for registry items, and the AHP method for factors other than registry items. Logistic regression analysis is a study approach using sewer survey results and registry items obtained from sampled cities. The AHP method is conducted through a questionnaire survey of engineers of major cities who have much experience in sewer maintenance.



Photo 1. Examples of failed sewers

Equation 1 is a probability equation for failure occurrence with registry items as the independent variables and sewer survey results as the dependent variable, while Equation 2 is an assessment equation by the AHP method. The quantification of the consequence of failure is studied similarly using the above AHP method.

$$\Pr(Y=1) = \frac{1}{1 + \exp[-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 \cdots + \beta_r X_r)]}$$

Equation 1

( $\beta_i$ : coefficients,  $X_i$ : independent variables (registry items),  $r$ : number of independent variables)

Assessment of probability of failure occurrence  
= (Weight of large vehicle passage) × (Score of large vehicle passage) + (Weight of tree planted zones) × (Score of tree planted zones) + ----- + (Weight of ground conditions) × (Score of ground conditions)

Equation 2

## 4. Conclusion

This assessment is a simple method which can be adopted in medium and small cities where expertise of city engineers is limited, contributing greatly to the introduction of nation-wide asset management.

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# Development of a Land-based Pollution Load Model in Northwest Pacific

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(Key words) marine environment, pollution load, simulation, sewerage system

Research Trends & Results

## 1. Introduction

In countries adjacent to Japan, recent rapid population growth and industrial development have been accompanied by an increasingly serious river and ocean water pollution problem. To propose water quality environment conservation measures for Northwest Pacific (Bohai Sea, Yellow Sea, East China Sea, and Sea of Japan) by reducing land-based pollution loads mainly through sewerage systems, our Division is conducting a research in collaboration with researchers from the concerned countries (China, Japan, Korea, and Russia).

## 2. Development of a land-based pollution load model

To clarify the future pollution load reduction effectiveness of providing sewerage systems, our Division adopted a method of verifying the effectiveness of pollution load reduction measures by developing a land-based pollution load model and setting future scenarios. In 2009, our Division started by developing a land-based pollution load model for China.

To develop the model, our Division referenced the framework of Comprehensive Basin-wide Planning of Sewerage Systems in Japan, and adopted a model where pollution loads are calculated by totaling pollution loads (COD, T-N, and T-P) discharged from sources of each category such as residential and industrial in each drainage basin block, then totaling pollution loads from the upstream to the downstream of rivers to obtain pollution loads reaching coasts. The basic land unit for land-based pollution load calculation is an administrative unit (prefecture or

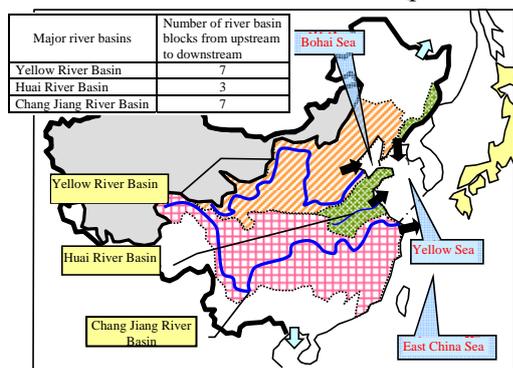


Figure 1. Major River Basin Blocks in China

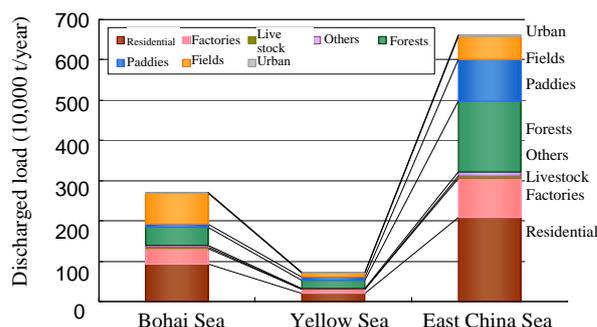


Figure 2. Results of Approximate Calculation of Annual Discharged Load (COD<sub>Mn</sub>) in 2005

city), and river basin block divisions for each water quality monitoring points (where both water quality and water quantity are measured) are set in major rivers.

Figure 2 shows the results of applying the land-based pollution load model to approximately calculate the annual discharged COD loads in each drainage basin in 2005. The modeling included uncertain elements, but it can clarify trends in the annual total discharged loads and the percentages of total discharged pollution loads of each category. More accurate results for the discharged loads will be obtained in 2010.

## 3. Cooperation with Overseas Researchers

Our Division is working cooperatively with researchers from China, Japan, Korea, and Russia to confirm the appropriateness of the land-based pollution load model and to promote concerted efforts by the countries. Fruitful discussions have been conducted at an international symposium at Kyoto University in January 2009 and at an international conference in Tokyo in February 2010.

## 4. Future Works

Based on past research results, our Division conducts improvement of the land-based pollution load model, setting of future scenarios and clarification of future pollutant loads, prediction of the marine water quality through marine simulations, and also the preparation of proposals for marine water quality environment conservation for Northwest Pacific.

<http://www.nilim.go.jp/lab/ebg/kinkai1.pdf.pdf>  
<http://www.nilim.go.jp/lab/ebg/> (Wastewater System Div.)

# Slope revegetation using forest topsoil

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(Key words) Forest topsoil utilization works, buried seeds, revegetation

## 1. Introduction

Given the problems of genetic disturbance and proliferation of alien species when introducing plants for revegetation, local character needs to be taken into account when selecting plants for public revegetation works. Meanwhile, buried seeds in forest topsoil include many of a local character, and are thought fairly easy to collect. In light of this, revegetation works using forest topsoil (forest topsoil utilization works) are thought to present a viable substitute for revegetation using alien plants. In public revegetation works, it is of paramount importance to predict the initial state of growth when judging whether to carry out revegetation using this method. In this study, therefore, we studied the initial state of plant establishment achieved in forest topsoil utilization works.



Fig. 1 A hillside treated with forest topsoil utilization works, and examples of plant seedlings

## 2. Types of buried seeds

Buried seeds mainly exist in around the upper 10cm of forest topsoil; the topsoil of secondary forests is known to contain many seeds of sumac, mallotus, clethra and others. Although present as buried seeds, however, clethra and others have a known tendency not to become established on slopes, depending on the installation conditions.

## 3. Examples of forest topsoil utilization works

We carried out installation experiments on slopes in three national parks, using forest topsoil utilization

works with topsoil mixture ratios of 10%, 20% and 30%. On slopes 1 and 2, fewer individual plants grew. This was thought to be because the installation took place in summer, when not enough germination was achieved, and also because the topsoil contained a large quantity of clethra. On slope 3, conversely, the number of individual plants was large in the first year of installation but had decreased by the third year. This was thought to result from compression by goldenrod and other herbaceous plants. Therefore, when wishing to establish plant colonies quickly, this method may be unsuitable for use in summer installation and in locations where there are many alien species nearby.

Vegetation established through revegetation with forest topsoil is influenced by the slope attributes of the installation site and the season of installation, among others. We plan to produce guidelines for this installation method, in which we clarify the relationship between slope attributes and vegetation based on numerous case examples. In this way, the suitability or unsuitability of use can be judged from the conditions of land scheduled for installation in public works projects.

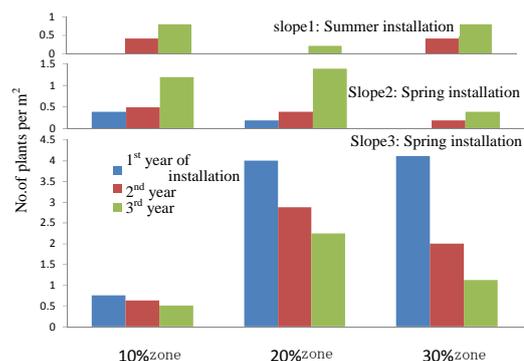


Fig. 2 Number of plants growing on each experimental slope

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# Water Reuse for Global Warming Mitigation

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(Keywords) Reuse of treated wastewater, Greenhouse gas reduction

## 1. Trends in the reduction of energy consumption of water cycle systems.

As global warming mitigation becomes an international challenge, lowering energy consumption of water cycle systems, which include water supply and sewer systems, has become important. Most of the energy consumed in water supply systems is used for water intake and conveyance, water distribution and other water transport functions. It is reported that relocating water intake sites and purification plants upstream could cut total emissions of carbon dioxide from water works in the Tokyo region by approximately 60% <sup>1)</sup>.

In sewer systems on the other hand, approximately 98% of treated wastewater is discharged into the ocean or rivers without reuse. But treated wastewater is considered as a fresh water source available near urban areas. It is expected that reusing treated wastewater as “reclaimed water” for toilet flushing and environment water could lead to further reduction of energy consumption in urban water cycle systems <sup>2)</sup>. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) released the Report of the Panel on Waster Reuse in 2009 <sup>3)</sup> to encourage the use of reclaimed water for global warming mitigation.

## 2. Assessment of the global warming mitigation effects of water reuse.

The Wastewater and Sludge Management Division of the National Institute for Land and Infrastructure Management (NILIM) collaborating with the Sewerage and Wastewater Management Department of MLIT conducts surveys and research on reclaimed water quality management and environmental and socio-economic assessment of water reuse systems.

Establishing reclaimed water quality standards is an important role of the national government in ensuring the sustainable use of reclaimed water. In 2005, the Sewerage and Wastewater Management Department of MLIT and the NILIM established the Guidelines for Reclaimed Wastewater Quality Criteria based on the discussions of a committee of academic experts. Guidelines have been enacted outside Japan in recent years, including Water recycling criteria of the California Code of Regulations (“Title-22”), which assume multi-purpose reclaimed water uses including agricultural irrigation, and the WHO Guidelines for the Safe Use of Wastewater, Excreta, Greywater (3rd ed.) which aims at safe use of reclaimed water in developing countries (revised in 2006) <sup>4)</sup>. Revision of the Guidelines for Reclaimed Wastewater Quality Criteria of Japan might be needed as uses of recycled water expand.

With regard to the assessment of water reuse systems, research is being performed regarding LCA for water reuse systems including wastewater reclamation facilities, reclaimed water distribution facilities and users <sup>5)</sup> and the evaluation of the socio-economic benefits of water reuse <sup>6)</sup>.

## 3. Development and Evaluation of Water Reuse Technologies for the Establishment of a 21st century type Water Circulation System (CREST)

To reduce energy consumption by water cycle systems, the Wastewater and Sludge Management Division implements the CREST project named “Development and Evaluation of Water Reuse Technologies for the Establishment of a 21st century type Water Circulation System” (2009 – 2014) funded by the Japan Science and Technology Agency (JST) collaborating with the Water Management and Dam Division and Research Coordinator for Environmental Affairs of NILIM, Kyoto University, and private companies on membrane filtration. Considering technology development on energy saving of membrane treatment, the project aims at developing and assessing cascade water use systems (Figure) including the relocation of water supply and sewer systems, water reuse and the heat utilization of wastewater for further reduction of energy consumption of water cycle systems inside and outside of Japan.

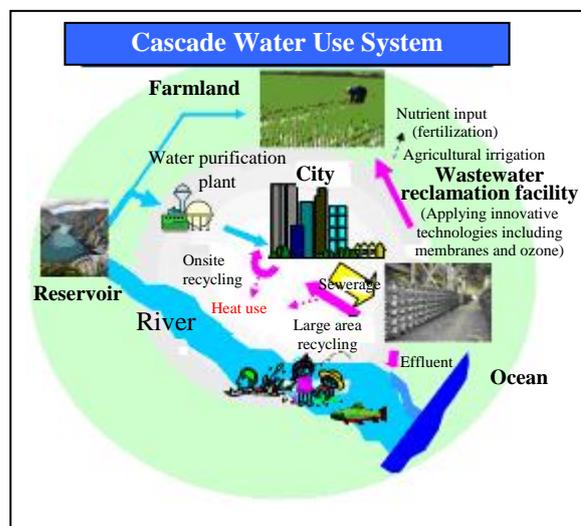


Figure: Concept of Cascade Water Use System

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# Biomass in Sewerage Systems Effective Use of Sewage Sludge

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*(Key words) Sewage sludge, digestion gas, biomass, effective use*

The growing environmental load caused by the consumption of resources and energy is presumed to be causing global warming. The aggressive use of biomass is counted on to help fight global warming, and although sewage sludge and treated wastewater in sewage systems have potential use as resources or energy, their actual use is limited. The NILIM has surveyed the state of the effective use of sewage sludge, treated wastewater, and energy in sewage treatment plants through Japan and summarized sewage sludge recycling rates etc. in order to study, implement, and follow up on measures to promote their effective use.

The sewage sludge recycling rate is the percentage finally reused in terms of its solid dry weight when it is produced, but is an index which does not reflect the

effective use of digestion gas. To promote the aggressive use of sewage sludge as biomass, the “Sewage Biomass Recycling Rate” calculation method, which defined “Quantity of organic material in sludge which is effectively used, as energy for gas powered thermal plants or on green farm land” has been established as a new index for the effective use of sewage sludge including the use of digestion gas, and has been computed.

The results of these surveys will be announced publicly by the Ministry of Land, Infrastructure, Transport and Tourism and are applied as basic material in the inventory of the Intergovernmental Panel on Climate Change.

# Membrane Treatment Technology

## ～ Guidelines and General Evaluation ～

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Water Quality Control Department, Wastewater and Sludge Management Division

*(Keywords) Membrane treatment technology, guidelines, A-JUMP, general evaluation*

In plants applying conventional sewerage treatment methods, sedimentation tanks or filter basins provide a solid-liquid separation function in order to remove suspended substances from wastewater, but in recent years, the membrane separation activated sludge method (MBR) which applies membrane to replace this function has attracted attention. Applying MBR eliminates the need for a sedimentation tank or filter basin, reducing the land area requirements, and can also improve treated water quality and simplify system maintenance. Until now, it has been introduced mainly in small scale wastewater treatment plants, but research and development work is now being performed in order that in the future it can be applied to the reconstruction and renewal of deteriorated medium and large-scale wastewater treatment plants and to the enhancement of treatment functions.

In May, 2009, the Ministry of Land, Infrastructure, Transport and Tourism (MLITT) enacted the Guideline to the Introduction of Membrane Treatment Technology to Sewerage Systems (First Edition) to summarize basic

information concerning present membrane treatment technologies and the significance of their introduction to sewerage systems, plus items to be studied and precautions followed to introduce MBR to a new or existing treatment plant, in order to popularize and expand the use of membrane treatment technologies. The MLITT is now conducting the study, Japanese Version Next Generation MBR Technology Development Project (A-JUMP), in order to enact the Second Edition of the Guideline with more complete technical elements in addition to achievements of MBR proving projects at actual facilities including its application to medium and large scale wastewater treatment plants accompanied by the most up-to-date knowledge from both inside and outside of Japan. The ministry is now evaluating treated wastewater quality based on results from MBR facilities now in operation (referred to as, “general evaluations”) in order to position MBR as a standard wastewater treatment technology under the Enforcement Order of the Sewerage Law.

<http://www.mlit.go.jp/common/000046580.pdf>  
Guideline (First Edition) MLITT website

# Formation of urban landscapes starting from urban parks

– Creation of (Draft) Guidelines for the development and management of urban parks with links to adjacent facilities, streets, etc. –

Landscape and Ecology Division, Environment Department

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(Key words) Urban parks, urban landscapes, Landscape Act, public facilities of landscape importance, public facilities

## 1. Background and development

In Japan, the “Three Landscape Greenery Laws” were enacted in June 2004 with the aim of forming beautiful and characteristic national land, creating rich living environments and giving individuality and vitality to local communities. Urban parks, as core facilities for the formation of good urban landscapes, are indispensable facilities for green and refreshing urban development. By linking related projects together, it is expected that even better urban landscapes can be formed.

To meet this expectation, departments in charge of developing and managing urban parks are also expected to give due consideration to links with the areas around parks, adjacent facilities, etc., with a view to forming integrated landscapes. However, ways of achieving such links have yet to be identified, much less evaluated. By researching good examples of this, therefore, we have drawn up principles for effective links with surrounding areas, adjacent facilities, etc., points to bear in mind, and other matters related to the development and management of urban parks.

## 2. Outline of the creation of (Draft) Guidelines

### (1) Compilation of case studies from Japan and abroad

We gathered and surveyed cases of good urban landscapes, in which urban parks are integrated with adjacent facilities and their surrounding areas, are “open” and “have beautiful neighborhood characteristics”, mainly in urban areas. Of these, we produced a compilation consisting of 20 domestic and 10 overseas cases.

The compilation starts by giving an “Outline of Integration and Links with Adjacent Facilities, etc.”, continues through “Outline of Urban Parks”, “Outline of Adjacent Facilities, etc.”, “Main Steps When Creating Links”, “Location and Landscape Status of Urban Parks, Adjacent Facilities, etc.”, and “Content of Links”, and concludes with a data section.

### (2) Study of principles for developing and managing urban parks

Our (Draft) Guidelines bring together the principles, matters to be borne in mind, and other issues when promoting the development and management of urban parks with links to adjacent facilities and surrounding areas, as came clear in our analysis of case studies.

The Guidelines have been created so that urban parks can make a greater contribution to forming good urban landscapes through wide-ranging, diverse links with adjacent facilities, etc. The aim is that local authority departments in charge of developing and managing urban parks will use the Guidelines when seeking ideas for diverse links in line with the characteristics of their respective areas.

The Guidelines consist of “Part 1: Steps When Creating Links”, in which we indicate general matters to bear in mind when forming good landscapes through links, divided into stages; “Part 2: Links in Tune with Adjacent Facilities”, in which we show the points to bear in mind for each type of linked adjacent facility; and “Case Studies”, a compilation of cases from Japan and abroad that will provide useful reference for these.



Photo 1 Greenery along Jozenji-dori, a case study in Sendai City

### 3. Publication of results

The resultant (Draft) Guidelines were published under that title in “NILIM Material No. 542” in August 2009. They have also been published as a pdf file on the NILIM website. <http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0542.htm>

# Creation of a “Conservation Manual for Trees of Landscape Importance”

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(Key words) *Trees of landscape importance, giant trees, landscapes, conservation measures, tree diagnosis, maintenance & management*

## 1. Background

In 2004, a Landscape Act was passed to promote the creation of good landscapes in Japan’s cities and rural areas. The law makes it possible to specify landscape planning areas and designate “trees of landscape importance” (trees that are important to the formation of good landscapes in those areas). The designated trees then need to be managed appropriately to ensure that good landscapes are not lost. Many of these trees are thought to be giant trees or old trees that function as symbols for their local areas. So far, not enough has been done to establish techniques or technology for maintaining or improving the vitality of these trees in consideration of their landscapes. This has made it necessary to create guidelines for managing trees of landscape importance.

Therefore, as a basic material for drawing up management guidelines for trees of landscape importance, we have compiled a manual on techniques of conservation for trees. The manual is mainly designed for giant trees and old trees, in consideration of their landscapes.

## 2. Outline of the “Conservation Manual for Trees of Landscape Importance”

Chapter 1: Basic matters concerning trees of landscape importance

As well as explaining the significance attached to trees of landscape importance in the Landscape Act, this chapter introduces the specific profile of these trees and examples of designation. It also includes commentaries on standards and aims applied when designating trees of landscape importance.

Chapter 2: Basic matters on conserving trees of landscape importance

This chapter gives a commentary on the need for conservation and the targets of conserving trees of landscape importance. It also explains ideal systems when carrying out conservation and ways of using trees of landscape importance.

Chapters 3-5: Methods of tackling the conservation of trees of landscape importance

Chapter 3 gives information on surveys and diagnosis. It highlights points of note in methods of surveying and diagnosing landscapes and the state of

growth, and explains the specific content of surveys and diagnosis.

Chapter 4 is concerned with proposals of conservation plans. As well as giving a commentary on setting conservation targets and selecting conservation work, it also illustrates methods of drawing up conservation plans and other documents.

Chapter 5, the section on installation and management, provides commentary on basic matters to be borne in mind when carrying out work, and precautions in each type of work involved in conservation. It also highlights the need to verify effects after the conservation work, and explains methods of doing this.

## 3. Publication

The “Conservation Manual for Trees of Landscape Importance” has been published as NILIM Material No. 565. We have also published a “Case Study Collection of Conservation Measures for Giant Trees and Old Trees”, in which we compile past methods of conservation measures for giant trees and old trees, together with information on their subsequent growth.

It is hoped that these publications will promote the designation of trees of landscape importance in future, and that precious trees that have been carefully protected at local level will continue to be conserved in good condition in the future.

<http://www.nilim.go.jp/lab/dde/index.htm>

