PWRI

National Research and Development Agency

Public Works Research Institute

2017

Message from the President

Kazuhiro Nishikawa
President
National Research and Development Agency
Public Works Research Institute (PWRI)

I am Dr. Kazuhiro Nishikawa. I assumed the presidency of the Public Works Research Institute (PWRI), a national research and development agency, on April 1, 2017. I would like to make a few remarks on this occasion.

PWRI originally started with the Road Materials Research Center of the Ministry of Internal Affairs, established in 1920, and the Research Laboratory of the Civil Engineering Department of the Hokkaido Prefectural Government, established in 1937. It has been 95 years since the establishment of the Road Materials Research Center and 80 years since the establishment of The Research Laboratory. For these years, PWRI, including its predecessors, has devoted itself to developing and disseminating a diverse range of civil engineering technologies. For our country, which is prone to hazards of different types such as typhoons and earthquakes, technologies developed by PWRI have provided a secure foundation for the design, construction, maintenance and management of civil engineering structures, which have in turn not only ensured safety but also sustained strong economic growth.

At present, the primary focus of PWRI is to perform research and development according to the 4th medium- to long-term project plans for the 2016-2021 period, as directed by the Minister of Land, Infrastructure, Transport and Tourism and the Minister of Agriculture, Forestry and Fisheries, to achieve the following goals:

1. Realization of a safe and secure society
2. Strategic maintenance, management and renewal of social infrastructure
3. Realization of a sustainable and vibrant society

Our nation faces many serious challenges such as mega-scale earthquakes expected to occur anytime soon, severer damage from intensified natural disasters, and increasingly aging social infrastructures. Naturally, civil engineering research and development is expected to play a more important role in improvement of social infrastructure. In addition, we also need to pioneer new areas of research and development by incorporating ICT technology, AI, big data and other innovations into civil engineering and developing advanced civil-engineering materials and technologies for practical use in collaboration with other research institutes.

PWRI has been conducting research and development in civil engineering to provide and improve quality public infrastructure effectively and efficiently. Likewise, we will continue working on research and development in response to social needs from short- and long-term viewpoints. We will also promote international contribution as a global center of research and development in civil engineering. We would appreciate your continued support and cooperation in these regards.

April 1, 2017

Contents

What is the Public Works Research Institute?

The National Research and Development Agency Public Works Research Institute (PWRI) conducts high-quality studies as a core institution of civil engineering research in Japan. PWRI was founded to improve civil engineering technology by conducting research and development on civil engineering techniques, providing technical support, disseminating research results, etc., and to contribute to society by improving infrastructure and promoting development of Hokkaido.

PWRI began anew in April 2006, when the Civil Engineering Research Institute of Hokkaido, which had been established in 1937 as the Testing Laboratory of the Civil Engineering Department of Hokkaido Agency, was integrated into PWRI, which itself had been established in 1920 as the Road Materials Testing Department of the Ministry of Internal Affairs, and was transformed into a "national research and development agency" in April 2015.

The PWRI has been working towards the major objective of the National Research and Development Agency, which is to maximizing the effectiveness of the outcome of R&D, committing to the R&D to;

1. Realization of a safe and secure society
2. Strategic maintenance and renewal of public infrastructure
3. Realization of a sustainable and vibrant society

History of PWRI

May 1921	Established as the Road Materials Testing Department in the Ministry of Internal Affairs.
Sep. 1922	Reorganized as the Civil Engineering Laboratory in Komagome, Tokyo.
Aug. 1937	Founded as the Testing Laboratory of the Civil Engineering Department, Hokkaido Agency.
Sep. 1947	Became independent as the Hokkaido Civil Engineering Institute.
July 1948	Renamed as the Public Works Research Institute, Ministry of Construction.
July 1951	Attached to the newly established Hokkaido Development Bureau and renamed as the Civil Engineering Research Institute.
Apr. 1988	Reorganized the entire body.
Apr. 2001	Established the Independent Administrative Agency Public Works Research Institute. The Niigata Experimental Laboratory and the Aqua Restoration Research Center remained with PWRI.
Apr. 2001	Renamed as the Independent Administrative Institution the Civil Engineering Research Institute of Hokkaido.
Mar. 2006	Established the International Centre for Water Hazard and Risk Management.
Apr. 2006	Integrated as the Incorporated Administrative Agency Public Works Research Institute.
Apr. 2008	Established the Center for Advanced Engineering Structural Assessment and Research.
Apr. 2015	Transformed into the National Research and Development Agency Public Works Research Institute.
Apr. 2015	Established the Innovative Materials and Resources Research Center.

Number of Staff · Budget

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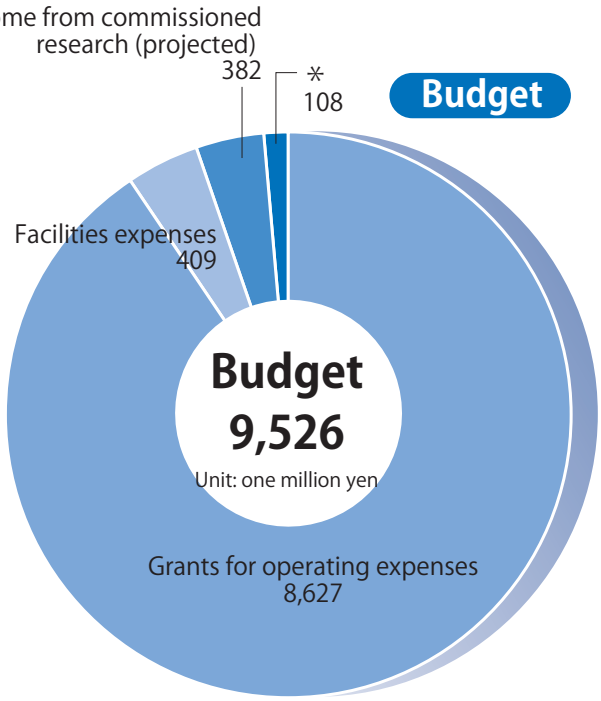
Budget



*Income from rented facilities and others (projected)

Note: Units are rounded off, so totals may not match.

As of April 2017

Research Concepts & Attitudes of Researchers

Research Concepts

1. **Research that can assume the responsibility for society for the coming one hundred years**
2. **Research that is recognized by academia and trusted by local communities and practical engineers**
3. **Research that respects traditions and has enterprising spirit**

Attitudes of Researchers

- **Work on research with a view to society for the coming one hundred years.**
- **Remember that a wonderful study is an impressive one.**
- **Endeavor to cultivate insight and culture at all times based on a broader vision.**
- **At a critical moment, always consider the responsibility to coming generations.**
- **Be enthusiastic and carry out discussions as much as you can without leaving any doubts.**

Organization

As of April 1, 2017

Executives

- President
- Vice President (2)
- Auditor
- Auditor (part-time)
- Councilor
- Auditing Director
- Executive Director for Research Coordination (2)
- Executive Director for Earthquake Engineering

Management

- Audit Office
- Compliance Management Office
- General Affairs Department
  - General Affairs Division
  - Welfare Division
  - Budget and Accounting Division
- Planning and Research Administration Department
  - Planning and Management Division
    - Research Evaluation and International Section
  - Facilities Management and Research Information Division
- Administration Department
  - Administration Division
  - Accounting and Contract Division
- (Executive Director for Research Coordination)
  - Deputy Director for Research Coordination
  - Planning Division

Research

Tsukuba Central Research Institute

- Construction Technology Research Department
  - Promotion Coordinator for Cold-Region Construction Technology
  - Advanced Technology Research Team
- Geology and Geotechnical Engineering Research Group
  - Geology Research Team
  - Soil Mechanics and Dynamics Research Team
  - Construction Technology Research Team
- Water Environment Research Group
  - River Restoration Research Team
  - Water Quality Research Team
  - Aqua Restoration Research Center
- Hydraulic Engineering Research Group
  - River and Dam Hydraulic Engineering Research Team
  - Hydrologic Engineering Research Team
- Erosion and Sediment Control Research Group
  - Volcano and Debris Flow Research Team
  - Landslide Research Team
  - Snow Avalanche and Landslide Research Center
- Road Technology Research Group
  - Pavement Research Team
  - Tunnel Research Team
- Director for Geological Research

Civil Engineering Research Institute for Cold Region

- Director for Cold-Region Technology Development Coordination
  - Cold-Region Technology Promotion Division (Northern Hokkaido and Eastern Hokkaido Branch Office)
  - Machinery Technology Research Team
- Cold-Region Construction Engineering Research Group
  - Structures Research Team
  - Geotechnical Research Team
  - Geological Hazards Research Team
- Cold-Region Maintenance Engineering Research Group
  - Materials Research Team
  - Road Maintenance Research Team
- Cold-Region Hydraulic and Aquatic Environment Engineering Research Group
  - River Engineering Research Team
  - Watershed Environmental Engineering Research Team
  - Port and Coast Research Team
  - Fisheries Engineering Research Team
- Cold-Region Road Engineering Research Group
  - Traffic Engineering Research Team
  - Snow and Ice Research Team
- Cold-Region Agricultural Development Research Group
  - Rural Resources Conservation Research Team
  - Irrigation and Drainage Facilities Research Team
- Director for Special Research
- Director for Geological Research

International Centre for Water Hazard and Risk Management

- Water-related Hazard Research Group
  - Chief Researcher (Communications and Training)
  - Chief Researcher (Risk Management)
  - Chief Researcher (Water Hazard)

Center for Advanced Engineering Structural Assessment and Research

- Bridge and Structural Engineering Research Group
  - Chief Researcher (Management System and Substructures)
  - Chief Researcher (Structural Assessment and Superstructures)
  - Chief Researcher (Rehabilitation and Earthquake Engineering)
  - Chief Researcher (Inspection Technology and Concrete Structures)

Innovative Materials and Resources Research Center

- Materials and Resources Research Group
  - Chief Researcher (Advanced materials and improvement)
  - Chief Researcher (Recycling)
  - Chief Researcher (Cocrete and metallic materials)

Medium to Long-term Objectives / Plan

Medium to Long-term Objectives

Medium to long-term objectives are the objectives national research and development agency must achieve during a period of not less than five years and not more than seven years, decided by the competent minister and instructed to relevant national research and development agency. The Minister of MLIT and the Minister of MAFF announced the PWRI the 4th medium-and long term objectives on February 29, 2016.

Medium to Long-term Plan

Medium to long-term plan was planned to achieve the medium to long-term objectives, and created by a national research and development agency for a purpose of obtaining the authorization for such a plan from the competent minister. In PWRI we created a medium to long-term plan based on the 4th medium to long-term objectives and received the approvals from the Minister of MLIT and the Minister of MAFF on March 31, 2016.

The 4th medium to long-term objectives of PWRI

■ Period for the medium to long-term objectives

For 6 years from April 1, 2016 to March 31, 2022

■ Role of PWRI (mission)

"Maximization of research and development achievements" is the mission of the Public Works Research Institute. In other words, we, as the entire nation, “maximize” creation of research and development achievements that contribute to people's lives, economy, healthy development of culture and other public interest. Based on the primary purpose of the national research and development agency, as a core research base for civil engineering in Japan, we will contribute to the promotion of efficient maintenance and the development of Hokkaido for quality public infrastructure through giving research results back to society and disseminating results. We execute our mission following the national policy for the land, infrastructure and transportation as well as for the promotion of agricultural and fishery industries.

We will conduct research and development to gain the technological knowledge that could be used for establishing the relevant policies and technical standards, thus we will maximize results of research and development. These are the examples: the risk management technology for water-related disasters occurring more frequently and severely, damage mitigation technology for snow and ice disaster due to climate change, effective implementation method of maintenance responding to aging of the stock of infrastructure, approach to river channel planning technology for the conservation of the river environment. These will contribute to building sustainable national land against disasters and also maintain, organize and use the foundation of the national land. They also contribute to formation of sustainable national land with safety and security by appropriate management.

We will strive to understand the needs of infrastructure particularly in order to fulfill its mission to support the national and local governments, which are responsible organizations of public infrastructure for road/rivers. We work closely with the business of the Regional Development Bureau of MLIT and the Hokkaido Regional Development Bureau. We also maximize the research and development efforts of the entire Japan, including research results of universities and private sectors. Therefore, we will make even more efforts to promote cooperation with people-to-people exchanges and joint research.

Taking into account of PWRI's strong points, during this medium to long-term plan period, we will focus on our R&D efforts on:

1. Realization of a safe and secure society
2. Strategic maintenance and renewal of public infrastructure
3. Realization of a sustainable and vibrant society

We also promote R&D on civil engineering technologies adjusting to effective improvement of caliber social infrastructure in snowy and cold regions, covering approximately 60% of Japanese areas.

R&D Program

PWRI will work on the following issues revealed at the medium to long-term objectives to focus on socially demanding issues while looking at the future.

1. Contribution to realization of a safe and secure society
2. Contribution to strategic maintenance and renewal of public infrastructure
3. Contribution to realization of a sustainable and vibrant society

For achieving these issues effectively and efficiently, PWRI categorizes these issues as "R&D programs" by the subjects to be solved, or the method of such as technical instruction and technological dissemination. By these units of methods, we establish 17 research and development programs and proceed efficiently.

R&D Program

1. Contribution to realization of a safe and secure society	(1) Development of design technique for disaster prevention facilities against recently more frequent and intense water hazards
	(2) Development of technology to support risk management for water-related disasters occurring more frequently and severely in Japan and overseas
	(3) Development of technology to prevent or mitigate damages from sediment-related disasters caused by sudden natural phenomena
	(4) Development of seismic technology for strengthening earthquake resilience of infrastructure facilities
	(5) Development of technology for the mitigation of snow and ice disasters caused by extreme weather
2. Contribution to strategic maintenance and renewal of public infrastructure	(6) Development on the efficiency and reliability of the maintenance cycle
	(7) Research on renewal and new construction technology aiming at longer-life and efficiency of maintenance for public infrastructure
	(8) Research on the maintenance and reconstruction of the infrastructure subject to frost damage and combined effect of deterioration
3. Contribution to realization of a sustainable and vibrant society	(9) Development of technology for public infrastructure construction to achieve sustainable construction recycling
	(10) Research on effective use of resources/energy focusing on sewer facilities
	(11) Development of river channel management technology that satisfies both flood control and environmental sustainability
	(12) Development of sustainable sediment management technology in sediment transport system
	(13) Development of water quality management and control techniques for regional water use and aquatic ecosystem conservation
	(14) Research on ensuring the safety and reliable road transport services in winter
	(15) Study on improving landscapes and the efficient use of infrastructure for attractive local development
	(16) Research on maintenance and management of agricultural infrastructure in the snowy cold regions contributing to improving food supply
	(17) Study on the development and conservation of fishery infrastructure of cold waters that contribute to strengthening food supply capacity

Contribution to realization of a safe and secure society

(1) Development of design technique for disaster prevention facilities against recently more frequent and intense water hazards

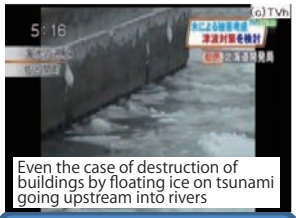
Research Summary

Research period: FY 2016 - FY 2021
Program leader: Director of Cold-Region Hydraulic and Aquatic Environment Engineering Research Group

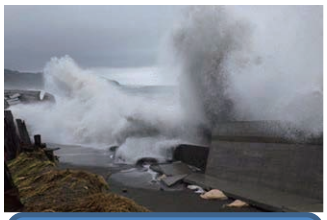
Research background

Levee breach by overflow beyond the designed level

Levee breach by piping

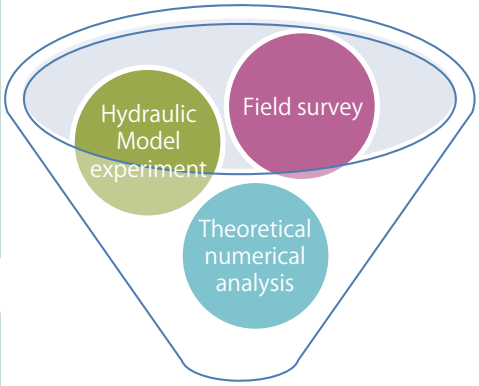


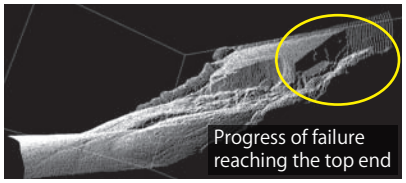
Collision by tsunami debris



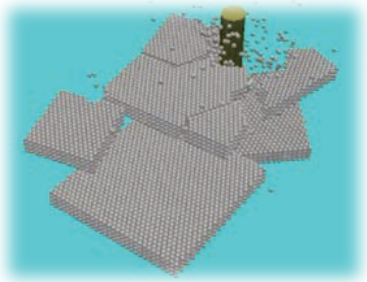
Future risk for extream waves and storm surge

Technical evaluation using full-scale experiment





Progress of failure verified by the permeation model experiment



Development of numerical calculation method for collision/fracture of tsunami debris such as sea ice floes

Development of technology for non-structural measures to mitigate damages for the new stage of water-related disasters and massive earthquakes/tsunami

Understanding the effect on structures by experiment of tsunami running up a river

In recent years, intensive and heavy rainfalls in local areas cause frequent floods that is beyond the capacity of facilities. Levees are destroyed by overflow and seepage, and river structures are damaged by high-speed flow. In addition, due to the 2011 Great East Japan Earthquake, working on tsunami disasters has become an urgent issue.

Furthermore, the technology capable of responding to hydrographic changes such as massive waves caused by the low-pressure is required, because frequent low-pressure system developing into a powerful level equal to typhoon due to climate change is expected to approach the coastal area facilities.

However, the research has not been fully conducted to establish technologies to make higher resilience against devastating destruction. For this reason, in this research, we develop technology for structural measures to mitigate damages against the new stage of water-related disasters and massive earthquake/tsunami caused by climate change in consideration of the external force of disaster at the level of reaching maximum and causing shocking destruction. In order to achieve these goals we will work on the following research topics.

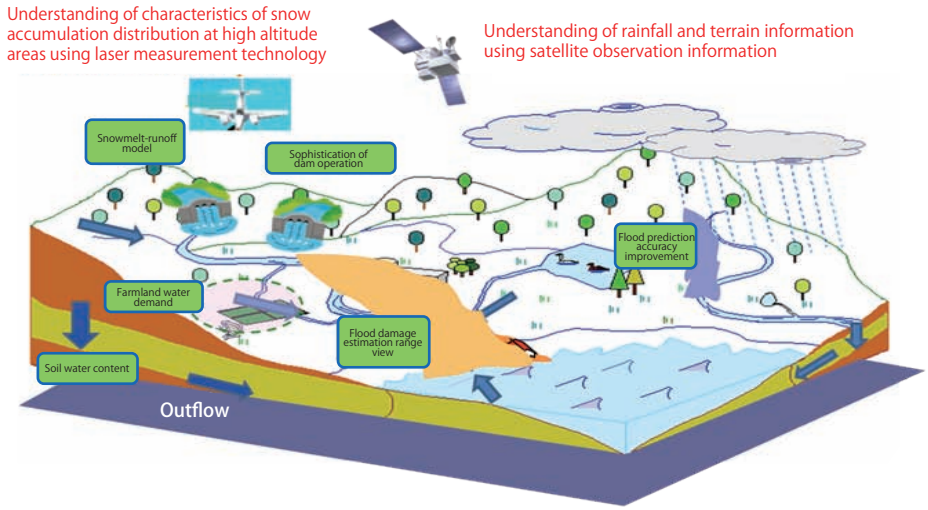
(1) Development of technology for evaluation/strengthening river levees against overflow and erosion
(2) Development of technology for evaluation/investigation of safety of river levees against water permeation.
(3) Development of technology for evaluation of impact of tsunami on structures and design method
(4) Development of technologies appropriate for hydrographic changes due to climate change

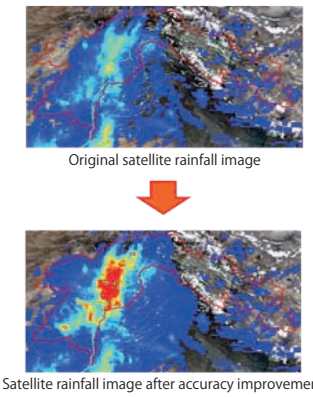
(2) Development of technology to support risk management for water-related disasters occurring more frequently and severely in Japan and overseas

Research Summary

Research period: FY 2016 - 2021
Program leader: Director of Water-related Hazard Research Group

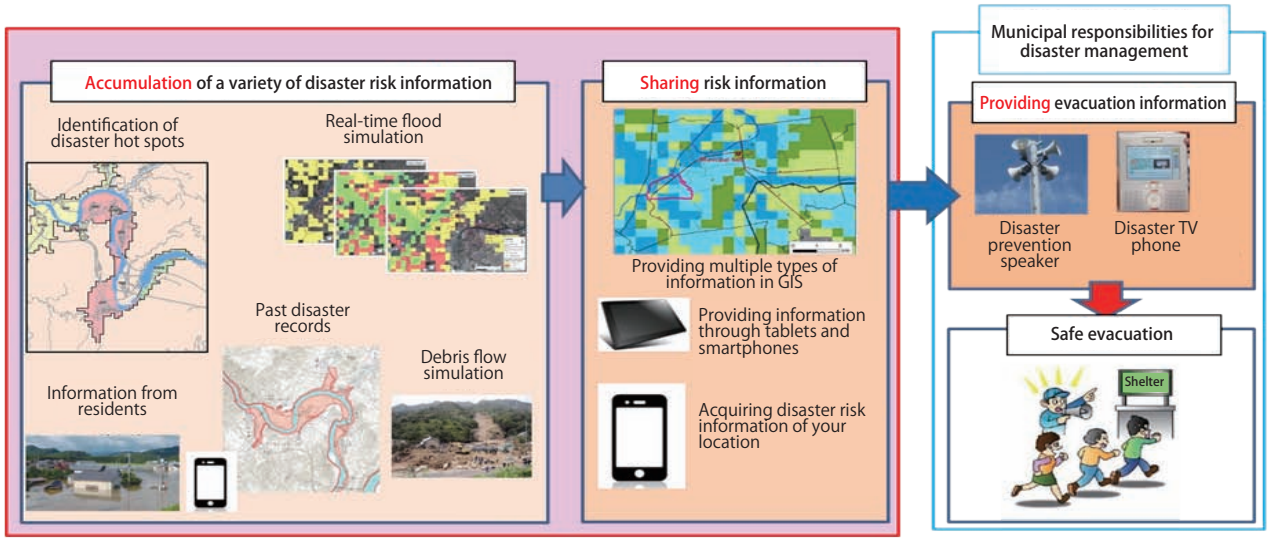
Various simulation images using satellite information





An example of accuracy improvement on satellite rainfall information used for flood forecasting

Outline of the current disaster information system



In recent years, rainfall events have become more localized, intensive, and extreme; for example, more events with an hourly rainfall of over 50 mm have been observed throughout Japan. In the future, due to the impact of global warming, more regions of the country will suffer from extreme rainfall that may be even more intensified and frequent. In constant, snowy cold regions are projected to have a shorter snowfall period and, as a result, less snowpack.

In this research project, we aim to develop technologies to characterize water-related disasters in terms of meteorology, hydrology and resulting damage. We will also develop technologies for various organizations to cope better with disasters using technologies for collecting and providing information. The following are the main research goals:

(1) Development of technologies and models for improving accuracy of flood forecasting and long-term water balance analysis

(2) Development of technologies for analyzing water disaster hazards in various natural and local conditions, methods for water-related disaster risk assessment using highly accurate, advanced estimation approaches, and indicators for evaluating the effectiveness of disaster prevention measures

(3) Development of methods for producing, utilizing and communicating useful information on disaster prevention and disaster status to assist efforts in disaster prevention and mitigation

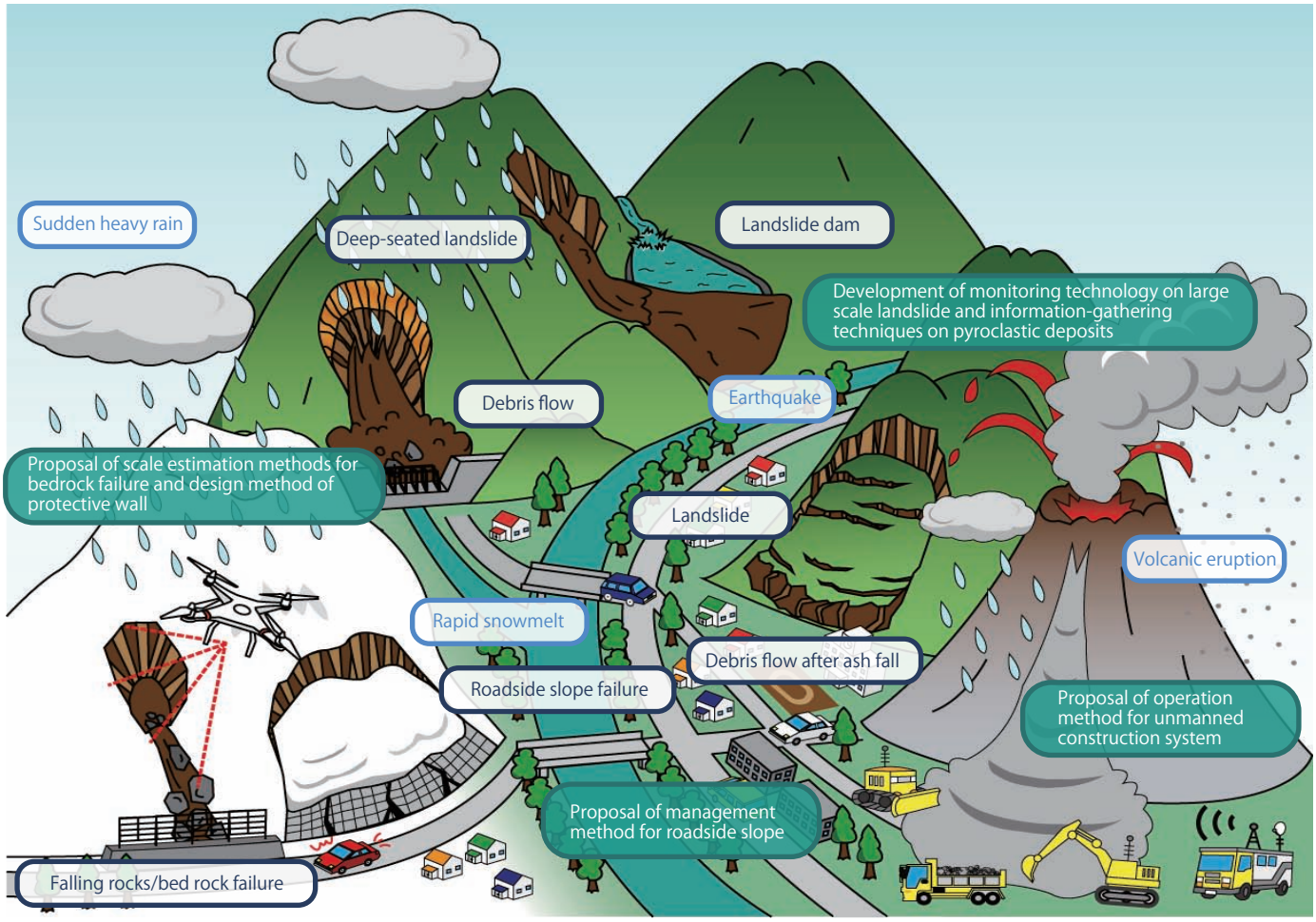
These technologies and methods will be used to establish systems to estimate damage and risk using real-time observation information. Such systems will make reliable disaster information readily available for municipal disaster management personnel, who will thus be able to make well-informed decisions for effectively fighting floods and leading safe evacuation in time of disaster.

Contribution to realization of a safe and secure society

(3) Development of technology to prevent or mitigate damages from sediment-related disasters caused by sudden natural phenomena

Research Summary

Research period: FY 2016- 2021
Program leader: Director of Erosion and Sediment Control Research Group



In recent years, sediment-related disasters (such as volcanic eruptions, large-scale earthquakes, sudden heavy rain and rapid snow melting) caused by sudden natural phenomenon has occurred and the increasing number of emergency responses are required.

It is necessary to have engineering capable of executing the initial response of the disaster more quickly and effectively to respond to sudden sediment-related disasters. Also technology that maximize function of the existing stock without fatal damages is required.

This research has 3 sets of goals to achieve disaster prevention and mitigation of sediment-related disasters disasters caused by sudden natural phenomena.

(1) Development of technology to monitor sediment movement and technology to inspect/maintain roadside slopes.
(2) Development of technology to estimate the range of sediment movement and technology to assure safety of road traffic.
(3) Development of the design technology and the robot technology to prevent/reduce sediment-related disasters.

For (1), we conduct research to discover the location of sediment-related disasters at the early stage through the development of a vibration sensor that detects the deep-seated landslides.

For (2), we develop advanced technology to estimate the landslide area and evaluation technology on sudden heavy rain slope stability in consideration of sudden heavy rain and snowmelt. From these, we study risk assessment on life/property/social infrastructure.

For (3), we conduct research on design technology of sabo-dams for large scale debris flow and also study unmanned construction technology under the dangerous situation such volcanic eruption.

We aim to deploy the disaster prevention measures to "protect human life" and "avoid the catastrophic damage on the social economy" in case of sediment-related disasters that occurs suddenly.

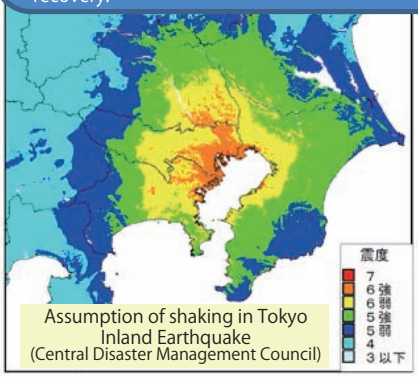
(4) Development of seismic technology for strengthening earthquake resilience of infrastructure facilities

Research Summary

Research period: FY 2016 - 2021
Program leader: Executive Director for Earthquake Engineering

Research background · Needs

- Imminent occurrence of large-scale earthquakes such as massive earthquake in the Nankai Trough and Tokyo Inland earthquake is pointed out.
- Based on the lessons learned from the 2011 Great East Japan Earthquake, it is necessary to develop structural and non-structural countermeasures aiming to protecting human life, maintaining essential functions, minimizing damages, and quick recovery.



Assumption of shaking in Tokyo Inland Earthquake
(Central Disaster Management Council)

Research contents

- Development of seismic technology to strengthen earthquake resilience of infrastructure facilities (technologies for minimizing damage and quick recovery, performance evaluation and countermeasures)
- Targeted structures: roads and river structures (bridges and embankments)
- Hazards to be taken into account: shaking, tsunami, flood, liquefaction

In the Great East Japan Earthquake of 2011, the wide areas of Pacific Ocean coast from Hokkaido to Kanto suffered the extensive damage by the strong shaking and huge tsunami. Moreover, strong vibrations and greatly changing ground situations had serious impacts on public infrastructure struck by the 2016 Kumamoto earthquake. It is pointed out that there is a high probability of the imminent occurrence of large-scale earthquakes, such as Nankai Trough Earthquake and Tokyo Inland Earthquake, all over in Japan.

For such earthquakes, pressing issues are to prevent and minimize the earthquake damage, and to improve the earthquake resilience (strong and resilient against earthquakes) of infrastructure facilities including; road facilities which play a key role for emergency/life-saving activities and transportation of emergency goods; river facilities to prepare for the tsunami or flood occurred in a complex way after earthquakes.

This research consists of the following three segments for the purpose of development of the countermeasure technology to prepare for large-scale earthquakes and complex disasters after the earthquake that exceeds the past experience.

(1) Development of technology for minimizing damage of structures against earthquakes and recovering the damage quickly
(2) Development of seismic design technology consistently applicable for ground, underground, and aboveground structures.
(3) Development of liquefaction evaluation method for soil layers considering the effect on structural responses

We develop and improve the evaluation method of seismic performance and seismic measures for road bridges, road soil structures, soft ground, and river structures.

With proposing practical application of developing technology and the reflection to the technical standards and manuals, we aim to contribute to the realization of earthquake resilient society by minimizing damage of infrastructures and recovering functions quickly at the time of disasters for future large-scale earthquakes.

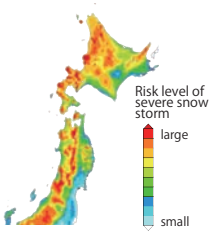
(5) Development of technology for the mitigation of snow and ice disasters caused by extreme weather

Research Summary

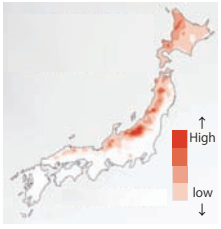
Research period: FY2016 - 2021
Program leader: Director of Cold-Region Road Engineering Research Group

Identification of the actual condition of snow and ice disasters caused by extreme weather and development of risk assessment technology

- Proposal of indicators to evaluate the severity of a single event of snow storm and heavy snow
- Proposal of development of hazard maps for snow storm and heavy snow, risk evaluation method of the avalanche caused by large amount of snowfall in short period of time.



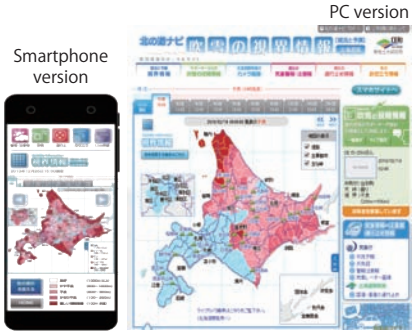
Distribution map of snow storm (image)



Frequency distribution of the avalanche risk (image)

Development of technology for prediction of poor visibility occurred on various winter roads

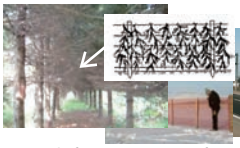
- Development of technology for forecasting snowstorm-induced poor visibility adding "visibility deterioration mechanism by the types and the intensity of snow fall"



Snowstorm Visibility Information System

Development of technology to improve performance of snow-storm countermeasure facilities and snow removal vehicles

- Proposal of management approach towards stable performance of snow protection for the snowbreak woods.
- Elucidation of the effectiveness of countermeasures for sudden change of visibility at the end or opening of the snow fences.
- Proposal of technology to support snow removal work by preventing collisions and lane-departure at the time of poor visibility.



Proposal of countermeasures for the lower dead branches in the snowbreak woods.

Support operation of snow removal vehicle (image)

Examples of countermea-sures for the end of the snow fences

Mitigation by snow and ice disaster posed by extreme weather

In recent years, a large number of vehicles stranded on the roads, traffic closure for long hours and isolation of communities have caused by unusual snow storm, snow falls, and avalanches due to effect of climate change.
Therefore, in this research program, we are committed to realizes the three goals below based on "technology development in order to reduce the damage caused by snow and ice disasters that extreme weather will bring".

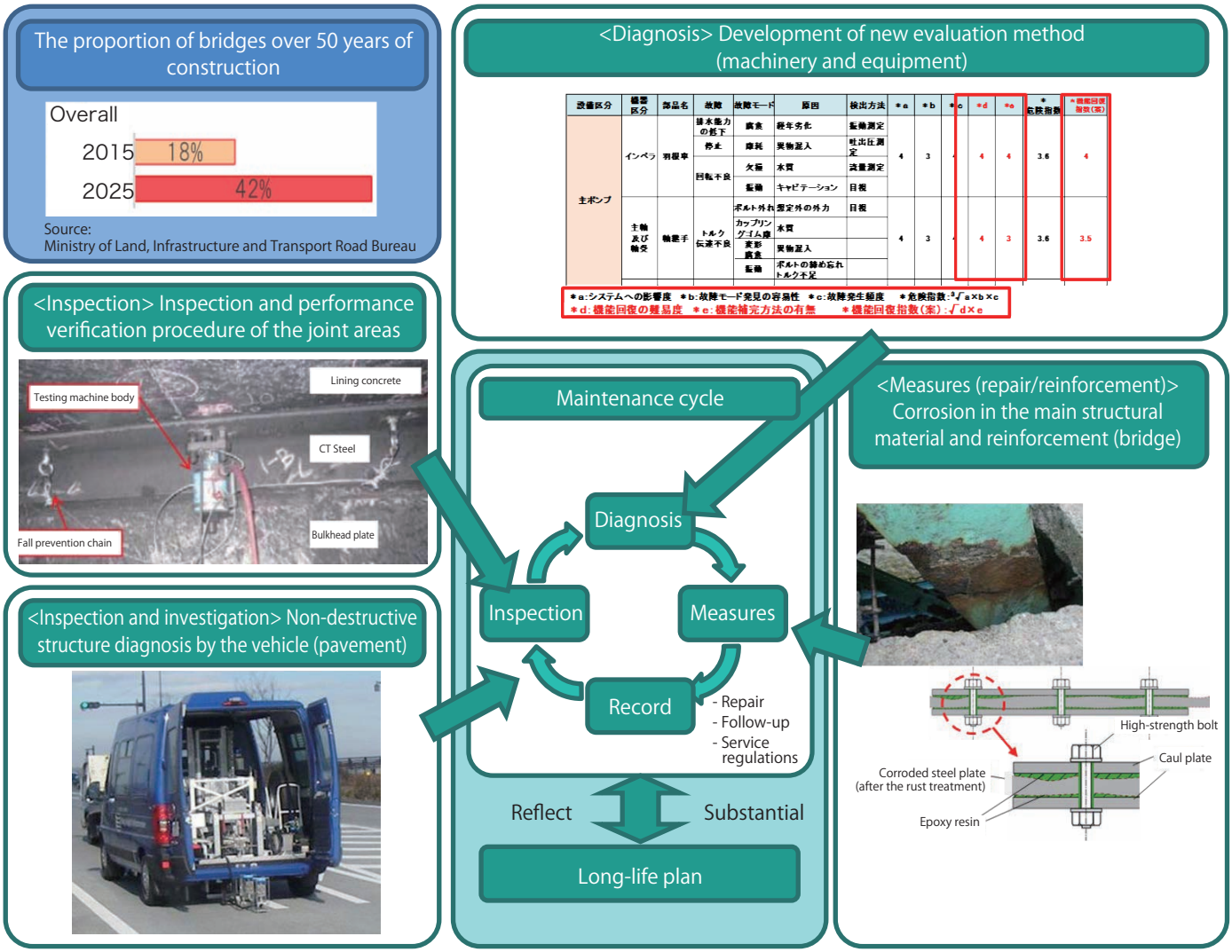
(1) Identification of the actual condition of snow and ice disasters caused by extreme weather and development of risk assessment technology
(2) Development of technology for prediction of poor visibility occurred on various winter roads
(3) Development of technology to improve performance of snowstorm countermeasure facilities and snow removal vehicles

We will give research result of above goals back to society and continue to support reduction of traffic interruption or damages to communities caused by snow and ice disaster which have occurred more frequent and complex.

(6) Development on the efficiency and reliability of the maintenance cycle

Research Summary

Research period: FY2016-2021
Program leader: Director of Bridge and Structural Engineering Research Group



Currently, aging of public infrastructure has been progressing rapidly. The serious damage due to deterioration occurred in Sasago tunnel and it caused the accidents. Aging of social capital has become major social problem.

In order to respond to these challenges, we need to implement maintenance cycle without fail and ensure to keep the health of social capital.

In this research we work to solve the following technical problems that we face at each phase of maintenance cycle (inspection, investigation, diagnosis, measures (repair and reinforcement)).

(1) Inspection/Investigation: technology to improve efficiency and reliability of monitoring and investigation contributing to improvement of the reliability at time of diagnosis

(2) Diagnosis: determining methods to identify area/parts where countermeasures are needed and the degree of urgency (priority)

(3) Countermeasures: optimal maintenance and repair method (evaluation of new technologies) appropriate for previous events and on-site conditions

We also work on the development of maintenance technology appropriate for the various management levels, such as consideration for the service level of properties that the municipality managements control.

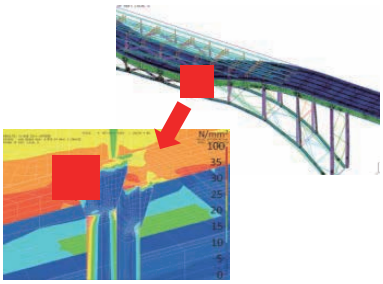
Thus, we will continue to contribute to the health of the social capital in order to achieve a spiral up in the technical aspects of the maintenance cycle.

(7) Research on renewal and new construction technology aiming at longer-life and efficiency of maintenance for public infrastructure

Research Summary

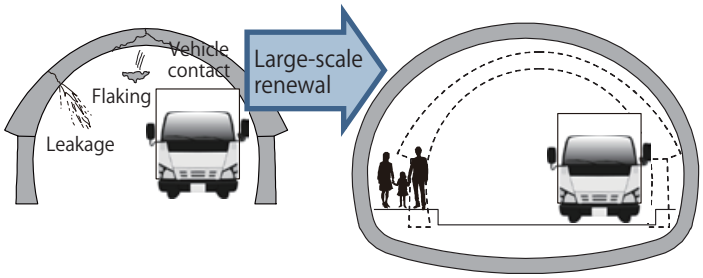
Research period: FY2016-2021
Program leader: Director of Materials and Resources Research Group

Development and evaluation of structural design methods and advanced materials for the structures that exhibit high durability



Review on close examination method of fatigue cracks in steel bridges

Development and evaluation of structural design methods and advanced materials that achieve renewal of existing infrastructures without interrupting the services

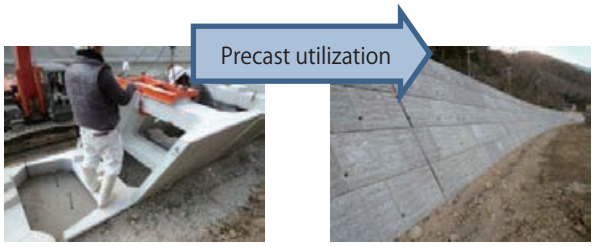


Study of large-scale renewal method for tunnels

Development and evaluation of structural design methods and advanced materials that suggests the optimum timing and part of the structures for strengthening and repair with simplified inspection methods

Example of outflow of reinforced-back-surface soil (a simple maintenance method is required)

Development of effective utilization of precast concrete products for both high productivity of construction work and long term durability of concrete structures



Consideration of a reasonable selection method of pre-cast materials

Japan's stocks of public infrastructure were intensively improved during the period of rapid economic growth and now the increasing aging infrastructures are concerned. It is important to renew or enlarge the service life for these existing infrastructures without interrupting their service. Under the severe fiscal situation, in order to ensure renewal or repair of infrastructure and, it is essential to conduct strategic maintenance work with consideration of priority and consequences of the infrastructures. For structures which have high priority, we need to achieve high durability to reduce their lifecycle costs. On the other hand, management level is not really high but for a huge number of simple structures, it will be advantageous to achieve structures that can clearly show you timing of renewal and locations needed for renewal using simple inspection methods.

In addition, decline of working-age population has affect the construction sector. Even if workers engaged in the construction industry is declined, we need to realize an improvement of productivity in order to efficiently renew public infrastructure. For example, we will need engineering development to build high quality structures efficiently using the precast concrete products.

This research program aims to establish evaluation methods necessary for development of material and construction in order to commercialize the new technology that can adapt to society's needs. We will also propose such research results reflected in the standards of various design guidelines.

(8) Research on the maintenance and reconstruction of the infrastructure subject to frost damage and combined effect of deterioration

Research Summary

Research Period: FY2016-2021
Program leader: Director of Cold-Region Maintenance Engineering Research Group

For the aging of public infrastructure, we need to understand the conditions of deterioration according to various effects such as environmental conditions and make a plan of maintenance and renewal based on the importance of facilities. We also need to establish a series of systematic engineering. Particularly for the public infrastructure in the snowy and cold regions, frost damages and deterioration by combined effect such as low temperature, snow, frost, frost heave, freeze-thaw, snowmelt water, salt occur due to harsh environments. However, countermeasures for these deterioration caused by combined effect has not fully developed yet.

For bridges, rivers and coast of concrete structures, paving, heave cut slope, in this research we develop structure-specific technology and common technology targeted at frost damage and its deterioration by combined effect/damage mechanism with related to the following 4 items;

(1) Establishment of efficient inspection, diagnosis and evaluation methods of frost damage/deterioration by combined effect
(2) Establishment of a reliable repair/reinforcement technology for frost damage/deterioration by combined effect
(3) Establishment of technology of durable reconstruction and new construction for frost damage/deterioration by combined effect
(4) Systematization of inspection, diagnosis, assessment, repair/reinforcement, reconstruction/new construction related to infrastructures due to frost damage/deterioration by combined effect.

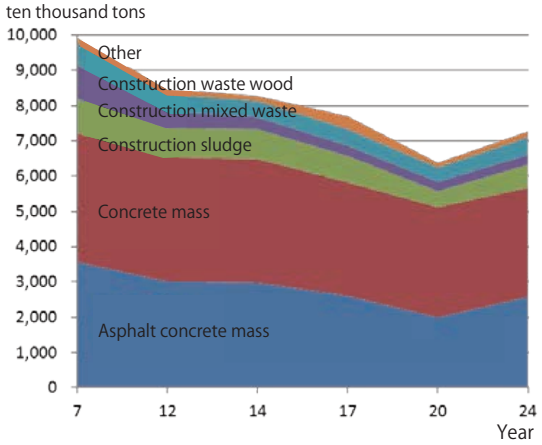
We support to help maximize and extend the life of infrastructures in the snowy and cold environment by applying these technologies to the infrastructure, which will contribute to maintenance, development and utilization of the land structure to support the safety and security and economic growth.

(9) Development of technology for public infrastructure construction to achieve sustainable construction recycling

Research Summary

Research period: FY2016-2021
Program leader: Director of Materials and Resources Research Group

Changes in emissions of construction waste



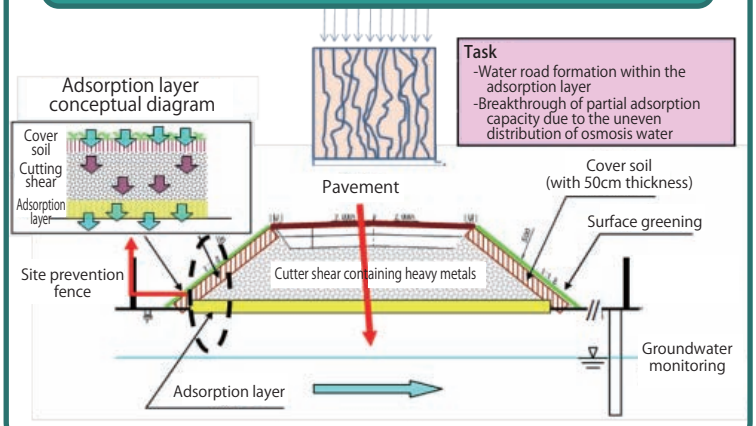
Source: construction product survey results by Ministry of Land, Infrastructure and Transport (2012)

Example of utilization of recycled aggregate

L-shaped retaining wall using recycled aggregate (provided by Prof. M. Kitatsuji, Miyagi University)

Clarification of applicable conditions of recycled asphalt admixture containing a large amount of recycled aggregate

Development of inexpensive and efficient countermeasures for surplus soil including natural heavy metals



Conceptual diagram of the adsorption layer construction method

Establishment of a sustainable society has become an important proposition that we are responsible on a global scale. Among other things, our nation with poor natural resources needs to effectively use the wastes and strive to build a recycle-oriented society.

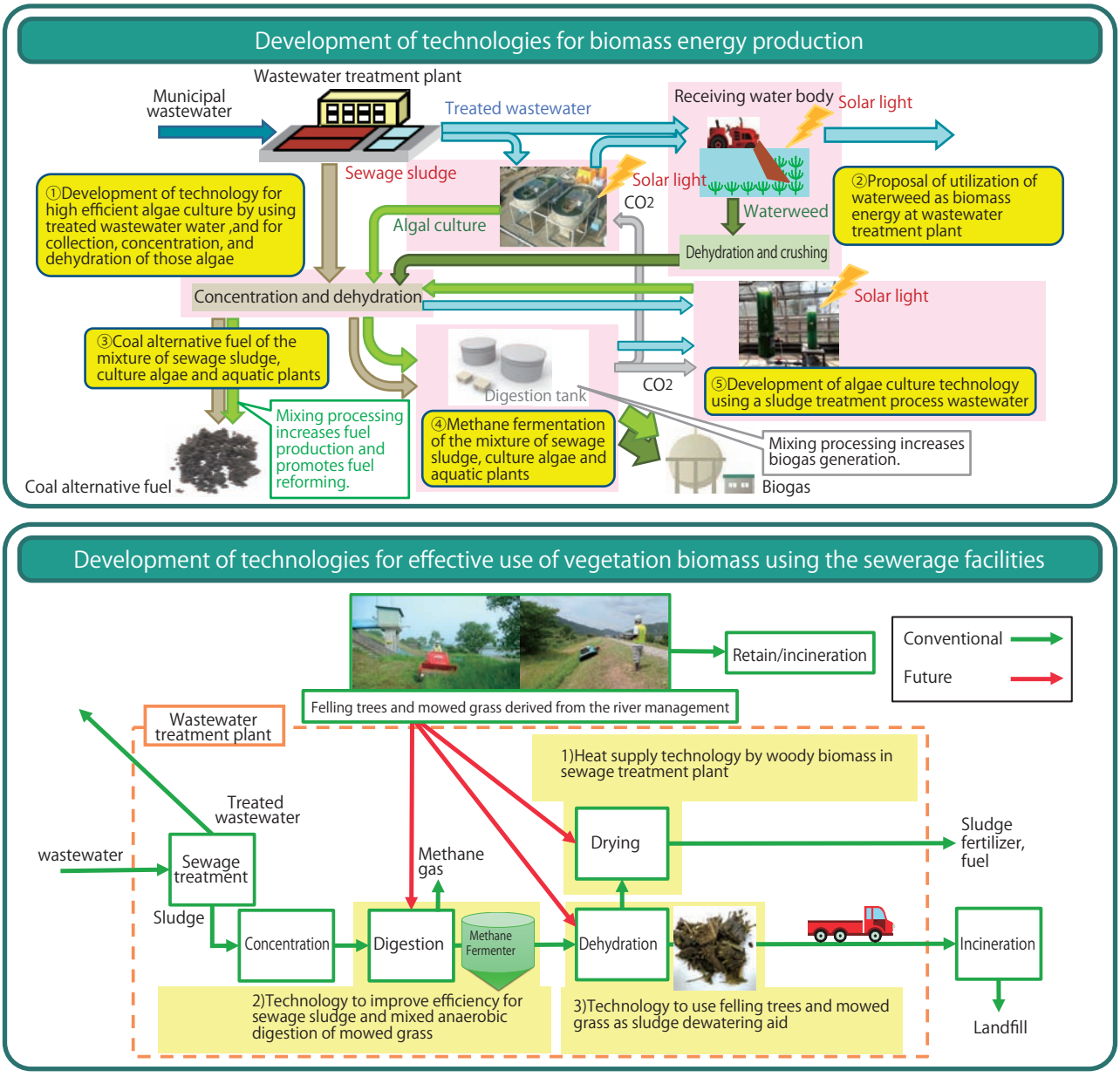
The construction sector generates construction by-products due to update of the structures, such as concrete blocks, asphalt blocks, and surplus soil. Efficient use of these construction by-products without disposal reduces burden of the disposal sites and also helps conservation of natural resources. So far, such construction by-products have been utilized and we have obtained certain results, however, the amount of construction by-products will continue to increase in the future along with the full-scale constructions of the 2020 Summer Olympics and Paralympics in Tokyo and full-fledged maintenance and renewal work for existing structures. Further expansion of utilization is expected in order to properly maintain the resource circulation including the construction by-products. Specifically, we conduct research on further expansion of utilization of concrete recycled aggregate, clarification of applicable conditions in case of using a lot of recycled aggregate, and expansion of utilization of warm mix asphalt pavement technology for recycled asphalt pavement.

On the other hand, due to the large-scale tunnel construction, surplus soil occurrence from construction is expected. It is necessary to enhance environmental safety assessment and countermeasures for surplus soil. We conduct research on development of regulations for surplus soil including natural heavy metals, evaluation for sources in accordance with the environmental characteristics of the element type, and practical use of efficient countermeasure at low costs.

(10) Research on effective use of resources/energy focusing on sewage facilities

Research Summary

Research period: FY2016-2021
Program leader: Director of Materials and Resources Research Group



There is a growing expectation for renewable energy towards building of a recycle-oriented society. "Basic Energy Plan" that was approved by the Cabinet in 2014, shows the promotion policy of effective use of the sewage sludge as one of the renewable energy. The Ministry of Land, Infrastructure, Transport and Tourisum has set "New sewage works vision" and it shows resource-intensive, energy supply base and self-reliance sewage treatment plants as a medium-term goal. It includes facilitation of new technological development such as mixing process of sewage sludge and other biomass and extraction methods of useful algae using nutrients in the sewage. On the other hand, for example, biomass such as mowed grass and logging produced in rivers are required to be used without simply disposing.

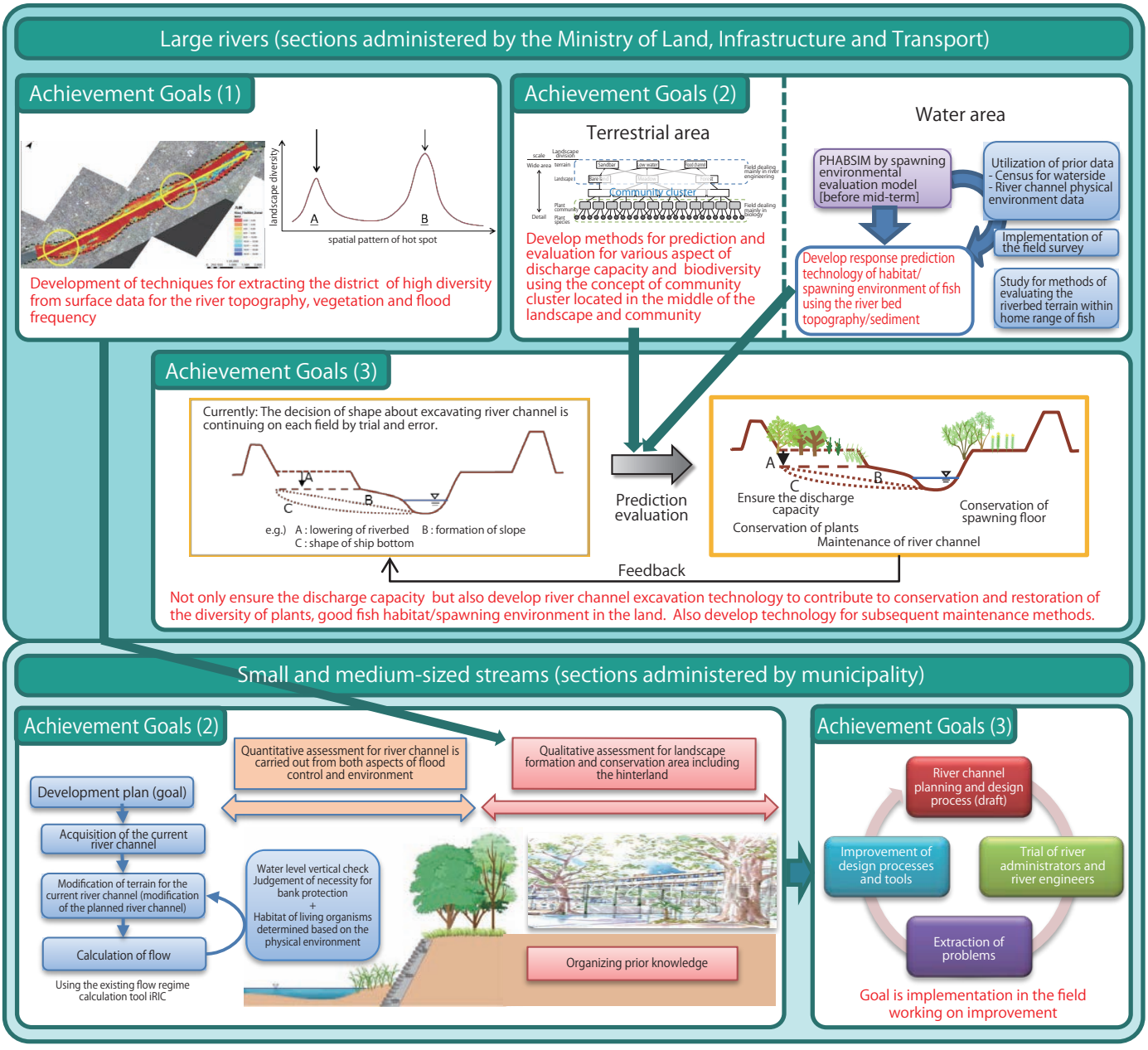
In particular the sewage treatment facilities are expected to accept biomass and use as energy required for sewage treatment.

In this program, in light of these circumstances, we develop production methods for biomass energy and aim to achieve highly efficient alga culture using the treated wastewater and embark on the studies in advanced technologies for collection, concentration and dehydration for algae culture. We also examine the applicability of mixture of algae culture/water plants and sewage sludge to the coal alternative solid fuel. Technology for utilization of wood chips and pellets as dehydration agent for sewage sludge is also a part of our research.

(11) Development of river channel management technology that satisfies both flood control and environmental sustainability

Research Summary

Research period: FY2016-2021
Program leader: Director of Water Environment Research Group



Water system such as rivers and lakes is an important foundation of biodiversity and its loss has continued. In the future we need to set the management objectives of the specific river environment. The urgent tasks are recovery of biodiversity from the losses and maintenance of good conditions. On the other hand, a huge increase of risks resulting from water disasters are also expected. So, it is necessary to promote the river management by taking disaster prevention/mitigation and the natural environment as an integral part while clarifying management objectives.

This research consists of the following three segments for the purpose of development of planning, design, maintenance technology for river channels based on a set of conservation/ formation area of the river environment.

(1) Development of space management technology with a focus on the river landscape, biological growth and habitat.

(2) Development of response/prediction techniques for vegetation and fish towards for human alteration such as a river channel excavation

(3) Development of river channel excavation technology that satisfies flood control and environment as well as maintenance technology

Through these, we aim to satisfy both flood control and environment and propose river channel planning/design for easy maintenance and maintenance/management techniques to maintain the river environment in good condition. Research results will be reflected in basic guidelines and technical standards to disseminated to the sites.

(12) Development of sustainable sediment management technology in sediment transport system

Research Summary

Research period: FY2016-2021
Program leader: Director of Hydraulic Engineering Research Group

Example of cases required resolutions through comprehensive sediment management

Dam sedimentation

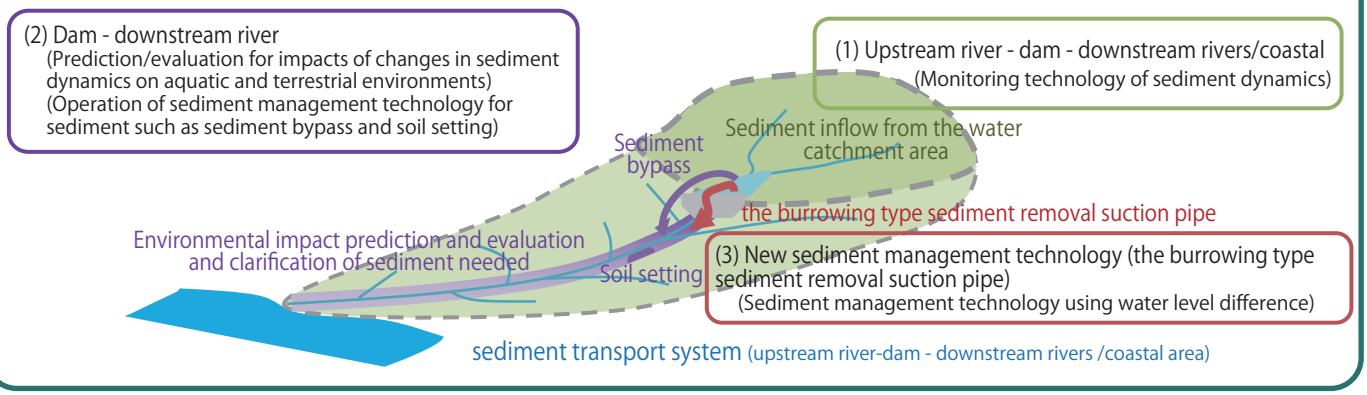

Armor of the riverbed (coarse-grained)


Lowering the riverbed/exposed bedrock

Local scour around bridge piers

Loss of coastal sand

For a sustainable sediment management



Consistent comprehensive sediment management from the mountains to the coast is required to solve the safety and operation issues caused by the flow of sediment, and preserve the natural environment and landscape formed by sediment.

The development of technology that contribute to the realization of the development and effective sediment management of technology to contribute to the collection and analysis of data related to sediment transport can be found in the still developing stage. For promotion of comprehensive sediment management, we are still in the process of developments of technology for data collection/analysis about sediment movement and technology for realization of efficient sediment management.

(1) Development of technology for monitoring sediment dynamics

(2) Development of technology for prediction and evaluation for impacts of changes in sediment dynamics on aquatic and terrestrial environments and development of the sediment management technology with these prediction and evaluation

(3) Development of technology for sediment management technology using water level difference

With the development of technology, we aim to contribute sediment dynamics monitor, survey and prediction of sediment production source, prediction and evaluation for impacts of changes in sediment dynamics on river environment, sustainable sediment management by sediment supply.

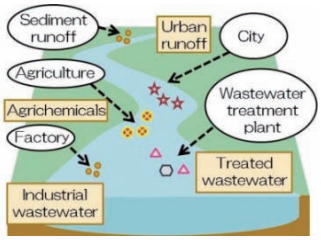
(13) Development of water quality management and control techniques for regional water use and aquatic ecosystem conservation

Research Summary

Research period: FY2016-2021
Program leader: Director of Water Environment Research Group

(1) Develop a quick and accurate assessment strategies for basin water environments

Develop assessment and monitoring techniques for water usage, the living environment and aquatic ecosystems



Locating sources of pollutant emissions in the water environment

Next-generation high-speed sequencer

Algal bloom occurrence

Investigate current impact mitigation strategies for water environments
- Inflow from urban areas and agricultural land
  → Countermeasures against non-point source pollution
- Inflow from wastewater treatment plants
  → Controlled by improving the treatment performances

Develop a simple algae surveillance using DNA sequencing
- In present conditions, specialized skills are required to identify musty odor-producing planktons
- Implement surveillance using new DNA sequencing technology

With developed techniques, monitoring and evaluation methods, we aim to preserve water usage in basins, living environments and aquatic ecosystems

Proposing management plans to improve the water environmental quality

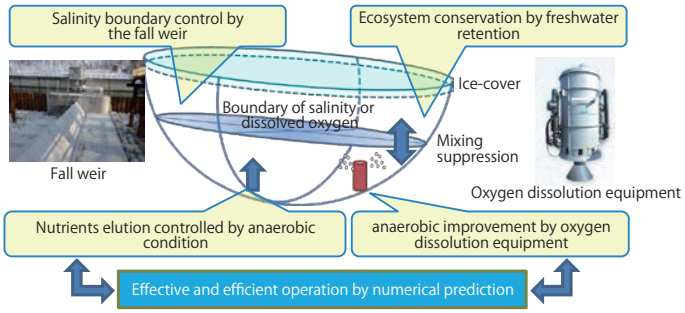
(2) Develop adequate water treatment techniques to mitigation water quality risks

Efficient chemical contaminant removal and pathogenic microbe disinfection

- Develop technology to remove micro pollutants (e.g. pharmaceuticals, surfactant) in treated wastewater through microbial carrier processes. In particular use of low cost and energy conservation technologies to optimize the process conditions
- Aim to improve the inactivation and removal of pathogenic microorganisms in chlorine treated water through applications such as complex disinfection technology

(3) Develop more efficient and effective water quality control strategies

Investigate measures focusing on the changes in bottom layer environments and inflow load



- Develop a prediction method and measures to improve anaerobic conditions such as freezing brackish lakes and dam reservoirs
- Propose measures to adapt to the impact of climate change on water environment quality

Although various improvement measures for water quality have been implemented, serious issues are still found in water environments, such as infectious diseases that influence social activities, ecological effect of chemical substances derived from products for daily use, and occurrence of algal bloom and musty odor in reservoirs. Therefore, new strategies for evaluation, monitoring and management are required to respond to these issues. In addition, it is important to apply these techniques to the basins in an integrated manner to improve environmental quality.

In this R&D program, in order to respond to these challenges we will promote researches towards achieving the following 3 goals:

(1) Development of assessment and monitoring methods to understand the water environments of basins with accuracy and speed.

(2) Development of adequate water treatment technology for the mitigation of water quality risks.

(3) Development of water quality management focused on the bottom layer environment and the inflow change in stagnant water areas.

We aim to reflect these developments to the planning of the administrative measures and technical standards by the national government towards the improvement of water environmental quality, conservation of regional water use in basins, living environment and the aquatic ecosystem.

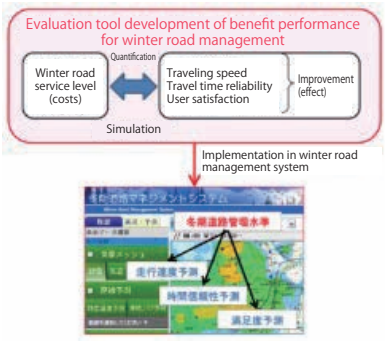
(14) Research on ensuring the safety and reliable road transport services in winter

Research Summary

Research period: FY2016-2021
Program leader: Director of Cold-Region Road Engineering Research Group

Development and establishment for the reasonable level of the winter road service based on the cost-benefit performance evaluation

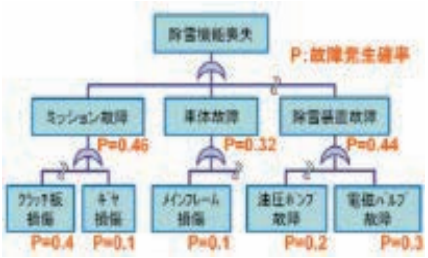
- Establishment of the quantitatively assessment method for cost-benefit performance of the winter road management
- Development of supporting technology of work plan for snow disposal



Evaluation tool for cost-benefit performance for the winter road management

Development of labor-saving operation technique using ICT and efficient maintenance technology for winter maintenance equipment

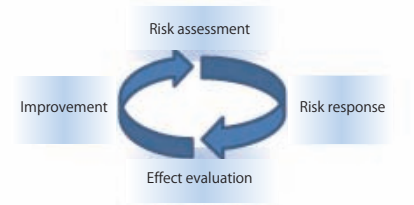
- Development of supporting technology for spraying anti-freezing agent using ICT
- Establishment of effective and efficient maintenance methods based on quantitative assessment of deterioration of snow removal machines



Analysis of probable failure of snow removal machines using FTA

Development of effective and efficient countermeasures for winter traffic accidents using risk management

- Using the traffic big data, establishment of risk management method for winter traffic accident analysis, systematizing accident factor analysis methods, accident risk assessment methods, and accident responding menu.



＊Evaluate winter traffic accident risk and quantify the risk response measures from the countermeasure method (loss and the calculation of the cost-benefit) and maximize the effect of the measures

Risk management approach of winter traffic accident

Improvement of safety and reliability for winter road traffic service

Japan is facing the nationwide problems such as population decline, aging population, large-scale disasters, and financial shortage. In the snowy and cold regions, it has been more difficult for the government to continue to provide the same winter road services due to the financial deterioration. Therefore, the Ministry of Land, Infrastructure and Transport, has launched a compact + network of the national land structure (National Spatial Planning approved by the Cabinet, August 2015).

We must have the inter-regional cooperation and sharing functions by strengthening of the transportation network in order to realize this national land structure in the cold and snowy region. We also need to ensure the safe and reliable winter road traffic service.

In this research program, we have 3 achievement goals and set the "development of management technology techniques contributing to the safety and reliability of the winter road traffic services" as a program goal.

(1) Development and establishment for the reasonable level of the winter road management based on the cost-benefit performance evaluation
(2) Development of labor-saving operation using ICT and efficient maintenance technology for winter road management
(3) Development of countermeasure technology for effective and efficient winter traffic accident by risk management

By giving these research result back to society we will support safe and reliable winter load traffic services in the snowy and cold regions.

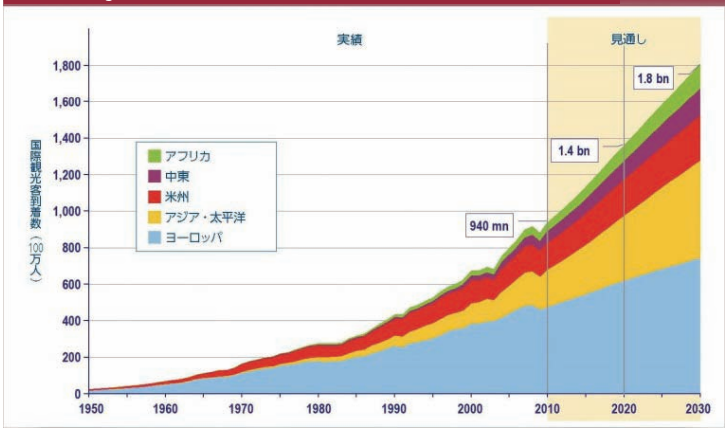
(15) Study on improving landscapes and the efficient use of infrastructure for attractive local development

Research Summary

Research period: FY 2016 - FY 2021
Program leader: Director of Special Research.

The importance of attracting growing numbers of international tourists

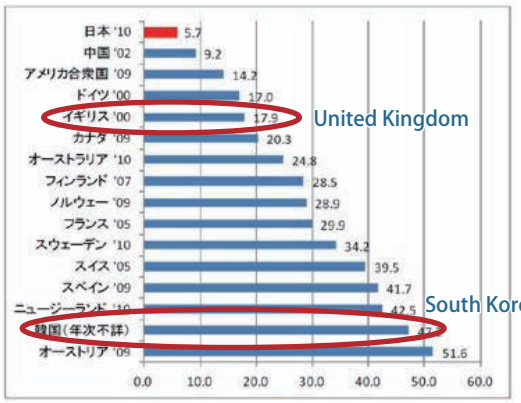
UNWTO Long-term forecast: Trends and forecasts for 1950-2030



Source : United Nations World Tourism Organization (UNWTO), "Tourism Highlights 2015 Edition, Japanese version"

▲ The number of international tourists continues to rise worldwide, and Asia is expected to account for a 30% share of the world by 2030.

Domestic tourism expenditures by inbound tourists as a share of all domestic tourism expenditures

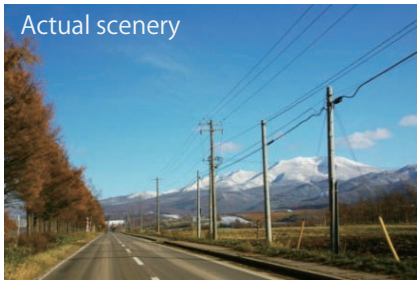


Source : Research study on economic impacts of tourism in Japan, Japan Tourism Agency

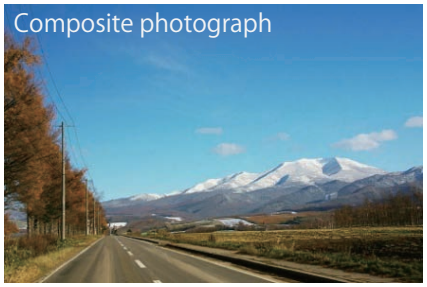
▲ In Japan, inbound tourism accounts for much lower share of all tourism revenue than in South Korea and UK, two geographically analogous counterparts to Japan.

The development of suitable landscapes for globally competitive tourist areas

The necessity of creating attractive public spaces to make globally competitive tourist sites.



▲ Electric wires and poles obstruct the view of background mountains at this World Natural Heritage site.



▲ Landscape improvement can be brought about by burying cables underground with costs, or simply rerouting them through forest.

Attractive landscapes are indispensable for the rich living environment; they also increase the appeal of a region and play an important role in promoting the tourism industry and interregional exchanges. Thus, such attractive landscapes must be preserved, created and utilized well from the viewpoint of distinctive regional revitalization. The followings are three goals set in this project.

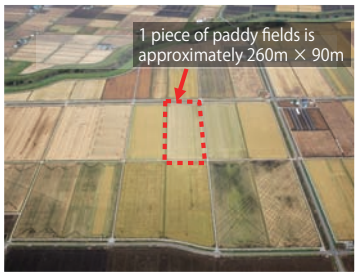
(1) The development of a landscape evaluation technique for infrastructure in public works
(2) The development of planning, design and management techniques to promote the landscape improvement of outdoor public spaces which enhance regional attractiveness
(3) The development of technical support for the application and use of utility infrastructure in light of regional revitalization

(16) Research on maintenance and management of agricultural infrastructure in the snowy cold regions contributing to improving food supply

Research Summary

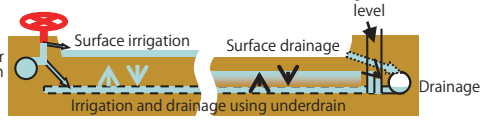
Research period: FY 2016-2021
Program leader: Director of Cold-Region Agricultural Development Research Group

(1) Development of technology for maintenance and management of large-sized paddy fields



Example of large-sized paddy field after improvement: the size of 1 paddy field is about 8 times that of the traditional field.


Water is brought up to topsoil from underdrain.



Mechanism of groundwater level control system


Construction of large-sized paddy field: Decision on selection of machinery and construction timeframe based on the soil diagnosis is required.

(2) Development of maintenance and renewal technology for irrigation facilities


Example of deterioration of irrigation facilities: pier of the headworks with wear and frost damage, and gate with wear and corrosion


Example of waterway repair

(3) Development of irrigation and drainage technology balanced with surrounding environment


Storage facilities of adjusted dairy cattle manure slurry


Scattering dairy cattle manure slurry on pasture


Large-scale dairyland: appropriate circulation of organic resources and preservation of water environment are required.

The target of the self-sufficient rate was set a 45% with the calorie-base in the "Food, Agriculture and rural basic plan (March 2015)" of Japan while the relationship between food supply and demand has become tight.
The importance of the agriculture in Hokkaido, with the large food supply capacity, is increasing to achieving this. The urgent need of the development of food production infrastructure using the new technology is required. For this reason, we develop technology for the following topic related to implementation and maintenance of the agricultural infrastructure.

(1) Development of technology for maintenance and management techniques for large-sized paddy field
Accommodating with decline of workforce/aging population and expansion of the farming scale, we propose the following technologies; improvement of large-sized paddy field in accordance with the soil properties, advanced utilization technology of groundwater level control system in large-sized paddy field, irrigation and drainage technology harmonized with the surrounding hydrological environment in the maintenance section of large-sized paddy field.

(2) Development of maintenance and renewal technology of irrigation facilities
Deterioration of irrigation facilities have been progressing and now appropriate maintenance for these facilities are required. We develop methods of diagnosis and evaluation for deterioration by combined effect of freezing damages and wear occurred in the irrigation facilities in the snowy and cold regions. We also develop methods of repair and reinforcement appropriate for these problems, and planning technology for disaster response to risks needed for large-scale disasters.

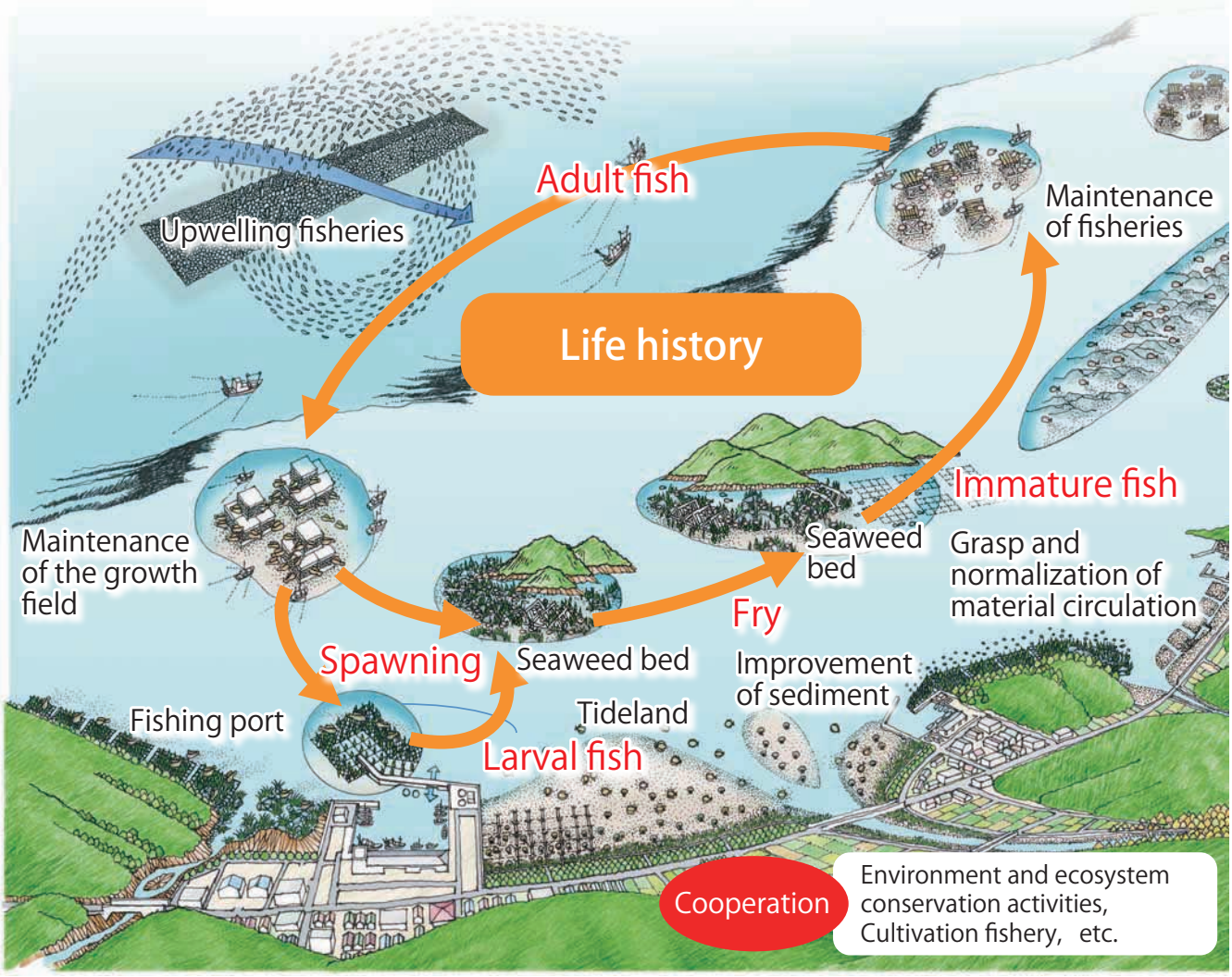
(3) Development of technology for irrigation considering harmony with the environment
With requirement of agriculture in harmony with the environment, we propose the energy-saving type of treatment technique for dairy cattle manure slurry in slurry irrigation facilities, and evaluation technology and measures of water quality environment in dairy farming area.

(17) Study on the development and conservation of fishery infrastructure of cold waters that contribute to strengthening food supply capacity

Research Summary

Research period: FY2016– 2021
Program leader: Director of Cold-Region Hydraulic and Aquatic Environment Engineering Research Group

The creation of favorable habitat space by promoting fishery environmental improvement (long-term plan for maintenance of fishing port and fishing ground)



Reference from the Fisheries Agency website

With increase of the world population, dietary changes and the frequent occurrence of abnormal weather, there is a possibility that the relationship of food supply and demand in the world is tightening. In the future, the role of the fishery industry in Hokkaido, which has the country's largest food supply capacity, increases even more than ever before. It is essential to improve resource productivity of Hokkaido in surrounding waters and strengthen fishery products.

For this reason, in rivers, coastal areas and surrounding ocean of Hokkaido, we will improve the protection/nurturing function of coastal structures and develop the technology to support the sustainable use of fishery resources. We also promote cultivating fisheries by aquaculture that takes advantage of the quiet fishing port harbor waters, and maintain and improve productivity of the fisheries by large-scale fisheries development. This makes it possible to raise the productivity of the entire ecosystem and promote the fishing area by support of cultivating fisheries.

We work in the following research topics to achieve these objectives.

(1) Develop and maintain assessment technology for the protection/nurturing function of fishery living organisms in coastal facilities.
(2) Create comprehensive assessment methods concerning the development effectiveness of large-scale fisheries
(3) Develop effective use and maintenance technology of the fishing harbor to strengthen support of the firming fishery
(4) Create impact assessment and improvement methods concerning the river structures and costal structures by understanding of swimming behavior of high-valued fish.