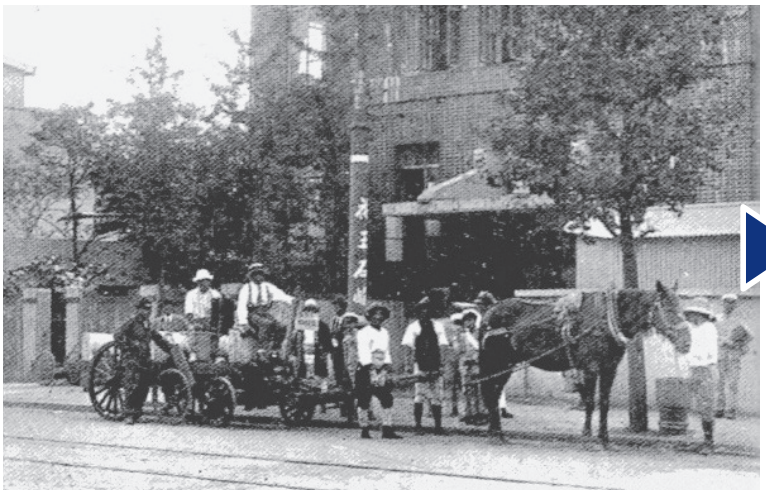
Medium to long-term Plan
5th period
2022-2027

National Research and Development Agency
Public Works Research Institute



the Civil Engineering Laboratory in the Ministry of Internal Affairs

now the Public Works Research Institute

the Civil Engineering Research Institute, Hokkaido Development Bureau

now the Civil Engineering Research Institute

~The fifth Medium to Long-term Plan has started in2022~

Message from President

Koichi Fujita President
National Research and Development Agency Public Works Research Institute

I am FUJITA Koichi, and was appointed President of PWRI on Apr. 1, 2022.

There is no doubt that the earth is irreplaceable to us humans. However, the earth is, in its original state, so unready to provide for us that we must have some kind of "interface" to access the planet, through which we can enjoy its bounty, develop our societies sustainably, and improve our living environment. Since the birth of civilization, we humans have been engaged for eons in the creation of such interfaces, i.e., social infrastructure, and it is civil engineering that has supported the foundation of this endeavor.

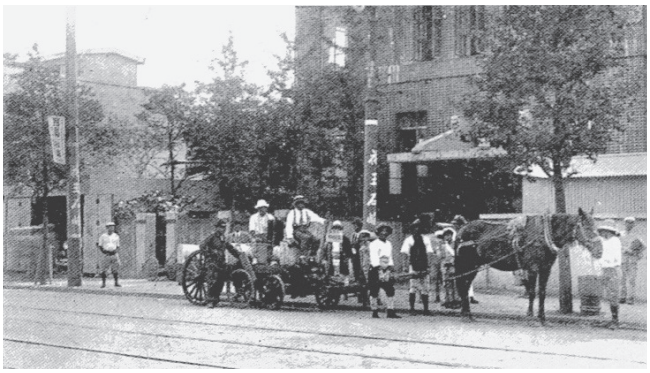
PWRI was initially established in 1922 as the Civil Engineering Laboratory of the Ministry of Home Affairs, taking an important part in social infrastructure development. Since then, for a century, it has contributed to the nation's growth as a core institute responsible for improving civil engineering.

We all agree that social infrastructure has been and will be indispensable in human society. However, what is expected from social infrastructure changes with the times. Over the past 100 years, PWRI has looked into the true social needs of the time and developed initiatives to fulfill them. This April, the institute has just turned a new page by starting its new medium- to long-term plan for the six fiscal years with three primary focuses as follows:

1) Contribution to the creation of national land where lives and livelihoods are protected against natural disasters
2) Contribution to the smart and sustainable management of social infrastructure
3) Contribution to the creation of vibrant and attractive communities and lifestyles

The new plan addresses these focuses in response to urgent issues that Japan faces today: increasingly severe and frequent natural disasters, a vast volume of aging infrastructure, and the fast shrinking working-age population. PWRI flexibly consider a path that extends existing technologies, breaks through barriers, and incorporates digital and other emerging technologies, while crossing and fusing disciplines, without being bound by conventional thinking or frameworks, to achieve the goals expected by the public.

Since its establishment, the strength of PWRI has always been based on the two-way process between the laboratory and the field. Its engineers look into the needs on site by themselves and identify what they need to study. They always give back the results of research and development to the field and provide engineering support to those working on site. This mindset and behavior are deeply rooted in the institute's DNA and passed on from generation to generation. Systems are in place to sustain and develop this strength, including close cooperation with MLIT, thereby providing a place where the next generation of engineers can develop proactively. PWRI will maximize this strength and further contribute to the efficient development of high-quality social infrastructure.



① **Civil Engineering Laboratory in the Ministry of Internal Affairs**
Firstly built in Komagome, Bunkyo Ward, Tokyo

② **Snow Avalanche and Landslide Research Center**
Conduct various research and development related to prevention against avalanche and landslide

③ **Civil Engineering Research Institute**
Only experimental research institute for cold engineering in Japan

100 years' History of the Public Works Research Institute

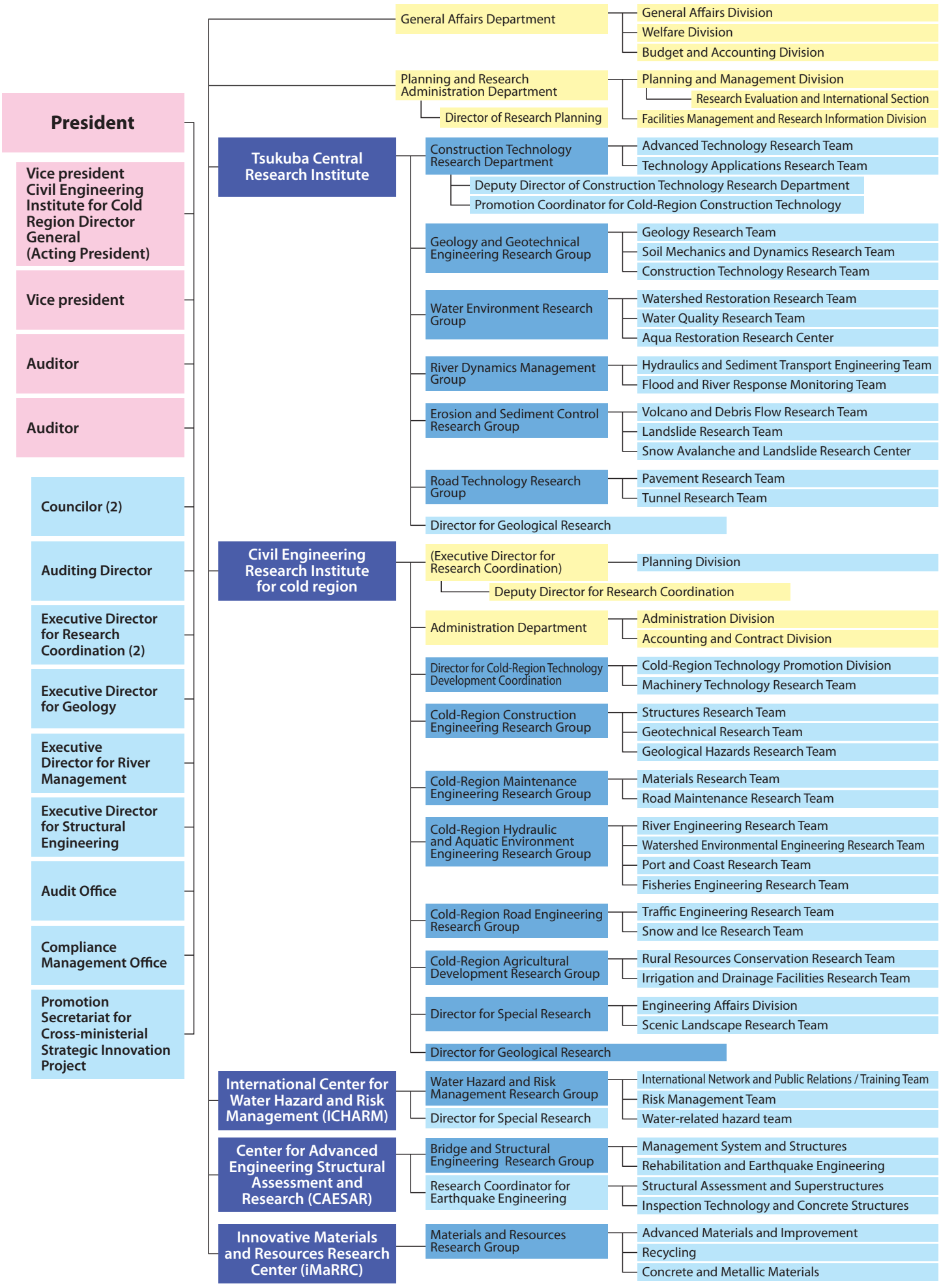
	Public Works Research Institute	Civil Engineering Research Institute for Cold Region
1922	Reorganized as the Civil Engineering Laboratory in the Ministry of Internal Affairs ①	
1937		1937 Founded as the Testing Laboratory of the Civil Engineering Department, Hokkaido Agency, Ministry of Internal Affairs
1947		Reorganized as an independent office, the Hokkaido Civil Engineering Institute
1948	Renamed as the Public Works Research Institute, Ministry of Construction	
1951		Renamed as the Civil Engineering Research Institute, Hokkaido Development Bureau
1960	Established the Niigata Experimental Laboratory (now the Snow Avalanche and Landslide Research Center) ②	
1979	Relocated and integrated in the Tsukuba Science City	
1988		Renamed as the Civil Engineering Research Institute ③
1998	Established the Aqua Restoration Research Center ④	
2001	Reorganized as the Independent Administrative Agency Public Works Research Institute(succeeding the operation of the Niigata Experimental Laboratory and the Aqua Restoration Research Center) (The National Institute for Land and Infrastructure Management was established by taking over part of the work of Public Works Research Institute)	Reorganized as the Independent Administrative Agency Civil Engineering Research Institute of Hokkaido
2006	Established the International Center for Water Hazard and Risk Management(ICHARM) ⑤	
	Integrated the Public Works Research Institute and the Civil Engineering Research Institute of Hokkaido into the Independent Administrative Agency Public Works Research Institute ⑥	
2008	Established the Center for Advanced Engineering Structural Assessment and Research(CAESAR)	
2015	Reorganized as the National Research and Development Agency Public Works Research Institute, and established the Innovative Materials Resources Research Center (iMaRRC)	
2022	**The 100th anniversary of the foundation**	

④Aqua Restoration Research Center
Three experimental streams that draw the water from the river

⑤ International Center for Water Hazard and Risk Management
Established under an agreement between the government of Japan and UNESCO (adjacent to the main building)

⑥ Public Works Research Institute (main building)

Organization of Research Division



Research of the fifth Medium to Long-term Plan from 2022-2027

detail »

PWRI will work on research and development by establishing 15 specific R&D programs based on three R&D themes in order to focus on issues with high social demands while looking to the future.

Research and Development 1

A. Contribution to the creation of national land where lives and livelihoods are protected against natural disasters

Due to the climate change and others, natural disaster has become severe and occurred frequently. To tackle these issues, we will work on a development of disaster prediction technology, a development of facilities persistent to a massive external force and R&D on technology that can promptly cope with new technical issues.

▶R&D Program (1)～(4)

Research and Development 2

B. Contribution to the smart and sustainable management of social infrastructure

We face an accelerated deterioration caused by an aging infrastructure and a shortage of workforce for an infrastructure management associated with the fast shrinking working-age population. To deal with these issues and dramatically innovate how to work for infrastructure, we will work on research and development of technology for more efficient facility management by utilizing 3D data and digital technology such as AI, transformation to preventive maintenance, and productivity improvement on construction sites. New value and increased sustainability of infrastructure are expected through these efforts.

▶R&D Program (5)～(9)

Research and Development 3

C. Contribution to the creation of vibrant and attractive communities and lifestyles

Vibrant and attractive communities and lifestyles are essential to establish emotionally enriched and comfortable society and to improve the quality of life.
We will work on promoting adaption measures against climate change, technology development on carbon neutral, and research development of technology for a maintenance of beautiful landscape and for a maintenance and a prevention of agricultural and fisheries infrastructure that can sustain the earning power.

▶R&D Program (10)～(15)

Research and Development Program

R&D Program

R&D1	(1)	Development of Technologies for Promoting "River Basin Disaster Resilience and Sustainability by All"
	(2)	Development of Risk Reduction Technologies for Emerging Sediment-related Disasters
	(3)	Development of disaster prevention and mitigation technologies for extreme snow and ice disasters
	(4)	Development of Advanced Technologies to Ensure the Functions of Infrastructure from Large Earthquake
R&D2	(5)	Development of Technologies for Continuous Monitoring and Management of Rivers and River Basins under Climate Change
	(6)	Development of Technologies for Infrastructure Improvement
	(7)	Development of Technologies for Preventive Maintenance of Infrastructure
	(8)	Development of Efficient Maintenance and Management Technologies for Infrastructure under Snowy and Cold Environment
	(9)	Research and Development to Improve Productivity in Infrastructure Construction and Maintenance
R&D3	(10)	Development of Methods for Sustainable Management of Water Resources and Environment to Cope with Climate Change
	(11)	Research and development on providing winter road services that support regional communities
	(12)	Development of Technologies for the Better Use of Local Resources and the Reduction of Environmental Load
	(13)	Research and development on redesign of public spaces for comfortable and high-quality of life
	(14)	Development of Technologies for Maintenance and Management of Agricultural Infrastructure in the Snowy Cold Regions Contributing to being Growth Industry and Resilient
	(15)	Study on the development and conservation of fishery infrastructure of cold waters that contribute to increasing productivity of fishery resources

(1) Development of Technologies for Promoting "River Basin Disaster Resilience and Sustainability by All"

ICHARM aims to prevent and mitigate water-related disaster damage by promoting Japan's new flood management policy, "River Basin Disaster Resilience and Sustainability by All," through the development of technologies that support all aspects of disaster management - prediction, implementation, evaluation, communication, and preparation.

Climate change and other factors have intensified natural hazards, resulting in more severe and frequent water-related disasters. This has caused significant disaster damage almost every year.
In order to minimize such damage, it is essential to promote the new flood management policy and initiate a drastic shift toward a risk-conscious society prepared to face water-related disasters, which requires sharing knowledge and information about water-related disasters among community members and encouraging all stakeholders to voluntarily participate in basin-wide efforts.

ICHARM will contribute to the prevention and mitigation of water-related disaster damage by promoting Japan's new flood management policy through the development and improvement of the following technologies:
- Systems for predicting future water-related hazards, such as flooding;
- Methods for effectively implementing and accurately evaluating solutions introduced under the new flood management policy;
- Methods for accurately assessing flood inundation risk; and
- Systems for assisting communities in increasing their disaster resilience.

Flood disasters due to natural hazards intensified by climate change

(2) Development of Risk Reduction Technologies for Emerging Sediment-related Disasters

We are committed to contributing to disaster prevention/reduction against sediment-related disasters through the research for the identification and the hazard zoning of emerging sediment-related disaster hazard areas, and the implementation of proper proactive countermeasures.

Our research and development have advanced disaster risk reduction and emergency response against sediment-related disasters caused by rain or snow. It is essential to research further to address emerging concern about increasingly serious damage from sediment-related disasters caused by heavy rain or snow, imminent volcanic eruptions, and large earthquakes, which are becoming more intense and frequent.

We are committed to developing the technologies for the identification of emerging sediment-related disaster hazard areas, the zoning of sediment-related disaster hazard areas for rapid emergency response, and the evaluation method for countermeasures towards high-energy rockfalls.


The eruption of Mount Ontake at 4p.m, September 27, 2014


Debris flow

(3) Development of disaster prevention and mitigation technologies for extreme snow and ice disasters

This project contributes to the prevention and mitigation of disasters caused by snow and ice by facilitating appropriate decision-making on winter road management in extreme weather conditions, the effective and efficient installation of blowing-snow control facilities, and the estimation of the force exerted by tsunami-borne sea ice.

In recent years, measures have been called for against snow and ice hazards from extreme winter weather, such as snowstorms and heavy rainfall in mid-winter, in snowy cold regions. It is necessary to establish techniques for forecasting poor visibility so as to keep vehicles from being stranded due to snowstorms and methods for quantitatively evaluating the snow control effectiveness of blowing-snow control facilities.

The project is designed to include the development of techniques to support decision-making on winter road management at times of extreme weather, the development of techniques for evaluating the performance of blowing-snow control facilities and ensuring their snow control functionality in consideration of snowstorms, and the development of techniques for tsunami prevention and disaster risk reduction in snowy cold coastal areas.


Snowstorms and avalanches in Hokkaido

Blowing-snow control facilities

Research and Development Program

(4) Development of Advanced Technologies to Ensure the Functions of Infrastructure from Large Earthquake

We contribute to the mitigation of damage and early functional recovery of road bridges and earthwork structures from major earthquakes by strategically reducing the risk of damage through seismic performance evaluation, minimizing damage through seismic reinforcement technology, and realizing structures that are less likely to suffer catastrophic damage and allow for rapid emergency restoration.

The Government of Japan and the MLIT have set a goal of "securing the passage of emergency vehicles within approximately one day, and of general vehicles within approximately one week after a disaster strikes" by constructing a robust and highly reliable national trunk road network. PWRI is expected to develop technologies and take other measures to achieve rapid recovery.

We will develop earthquake-resistant technologies to secure the functionality of road bridges, earthwork structures, and liquefaction prediction technologies with high accuracy for the evaluation of seismic performance.

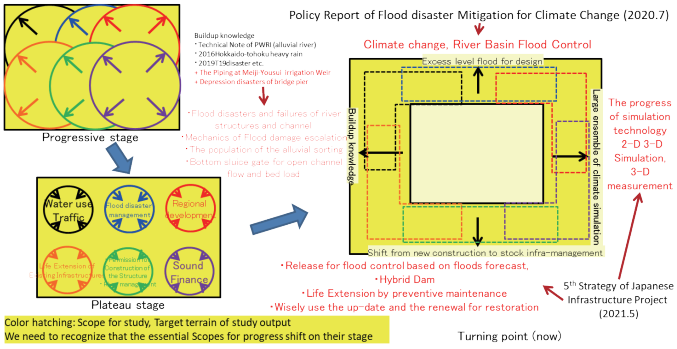
Road bridges damaged by the Kumamoto earthquake in 2016, which took a long time to restore.

(5) Development of Technologies for Continuous Monitoring and Management of Rivers and River Basins under Climate Change

This program contributes to the river managements, especially sustaining the functions of river channels and river structures. River channels are natural infrastructures, which are affected by the interaction with flood dynamics, vegetation activities, and human improvement activities etc.

The new technologies of river management need to innovation of DX technologies, adaptation to climate change and shift from new construction to management, and the insight gained through the accumulated studies on the responses of river channel and structures against floods..

This program develops technologies of the river management. 1) 2-D or 3-D monitoring for the river-basins/channels and evaluation of their condition. 2) maintenance, operations, renewal and up-date design for river channels and existing structures. The operations and design innovate the state of damage and destruction and its interpretations based on dynamics of floods and sediment transportation, social histories.



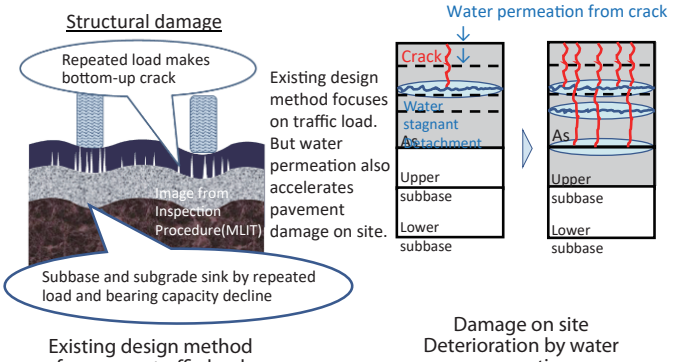
(6) Development of Technologies for Infrastructure Improvement

This program contributes to the longevity and reliability of road structures and sewerage facilities by improving design and materials.

Under severe financial situation in Japan, it is important to renovate existing infrastructure and construct durable social infrastructure by utilizing the knowledge acquired from the past development and maintenance.

This program comprises development of technologies as follows:

1) Technologies for renovation and construction methods dealing with recently clarified failure and damage mechanisms.
2) New materials and construction methods to realize longer-lasting structures that take into account the observed damages.
3) Technologies to appropriately address geological and geotechnical risks for improving reliability of infrastructure from planning to management.

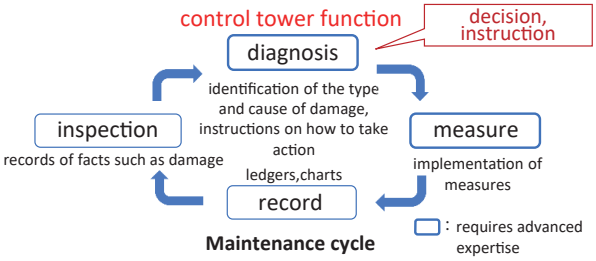


(7) Development of Technologies for Preventive Maintenance of Infrastructure

We will contribute to the realization of preventive maintenance by improving the reliability of inspection, diagnosis, and measure technologies for road bridges, tunnels, sluiceways and sluice pipes, as well as concrete structures, and by reducing labor required for maintenance work.

As infrastructure continues to age, it is important to promote preventive maintenance to extend the service life of infrastructure in order to reduce maintenance and renewal costs as much as possible and ensure sustainable functionality in the future.

In order to enable appropriate diagnosis, we will develop inspection technologies that accurately and rationally captures damages, diagnostic technologies and support systems that evaluate conditions and provide measure policies according to the damage mechanism, and effective measure technologies that respond to the installation environment and construction constraints of the structure.



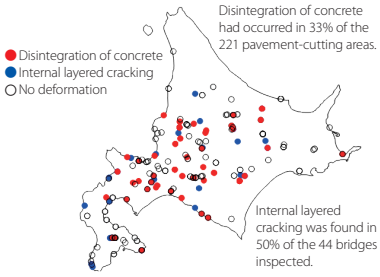
Research and Development Program

(8) Development of Efficient Maintenance and Management Technologies for Infrastructure under a Snowy and Cold Environment

We contribute to the efficient maintenance and management of infrastructure in cold, snowy environments by identifying the state of infrastructure deterioration, making accurate predictions and diagnoses, and taking effective countermeasures.

Infrastructure in cold, snowy regions requires the development of efficient maintenance and management technologies to address deterioration and damage that are unique to the regions because of their severe environment of low temperatures, frost-heaving, freeze-thaw, salinity, and other factors.

We will develop efficient methods for inspecting and diagnosing the deterioration of infrastructure in cold, snowy environments, develop highly accurate forecasting and diagnostic techniques for infrastructure deterioration in cold, snowy environments, and develop highly durable and effective techniques (preventive and breakdown) against infrastructure deterioration in cold, snowy environments.



Sites of bridge RC slabs with disintegration of concrete or internal layered cracking

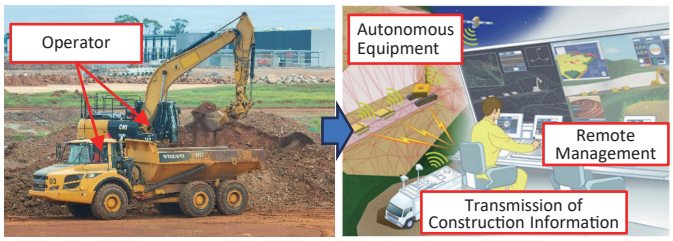
Potholes

(9) Research and Development to Improve Productivity in Infrastructure Construction and Maintenance

We aim to enhance productivity by reducing manpower in the three sectors
- **Autonomous construction (Earthworks) based on an open platform.**
- **Infrastructure facility management (Watergate and drain pump) using advanced technologies such as AI and VR.**
- **Quality management process innovation through the utilization of data acquired at work-sites.**

With the declining working-age population and the rapid evolution of various digital technologies, it is necessary to improve productivity at construction sites through efficiency and labor-saving of infrastructure construction and maintenance by promoting i-Construction.

We will develop labor-saving technology and process transform technology using advanced digital technologies.



Ride-on Operation (currently) Autonomous Operation (future)

Autonomous Construction System

(10) Development of Methods for Sustainable Management of Water Resources and Environment to Cope with Climate Change

We will contribute to social activity, environmental conservation and others through proper management of water resources and environment and implementing effective mitigation measures on natural ecosystem to cope with climate change.

Due to the concern about the impact the climate change has on water resources, it is necessary to secure a healthy and comfortable living environment and maintain the water environment, which is the foundation of human beings, and water infrastructure, which supports the people's life and industrial activity for the future.

We will promote
- Development of prediction technologies of river flow condition and water temperature under climate change
- Impact and risk evaluation of changes in river flow condition and water temperature on water resources, water environment and natural ecosystem
- Development of monitoring technologies
- Development of effective climate change adaptation measures for water resources, water environment and natural ecosystem

Rivers losing streamflow

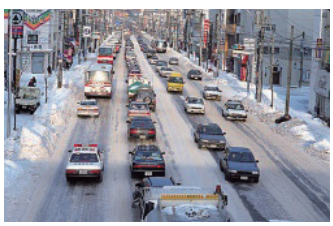
Water shortage of dam reservoir due to a drought

(11) Research and development on providing winter road services that support regional communities

We help to improve the safety and ensure the reliability of winter road traffic through appropriate winter road management decisions, labor-saving operations including snow removal, and the optimization of snow removal equipment maintenance.

In snowy, cold regions, daily snowfall, snow accumulation, and icy road surfaces adversely affect local socioeconomic activities, such as by leading to traffic congestion and skidding accidents; thus, the development of technologies that help to ensure safe and reliable winter road traffic is required.

We will develop methods that utilize advanced technologies to help ensure the reliability of winter road traffic and contribute to improved winter road traffic safety.



Traffic congestion due to a slowdown resulting from deteriorated road surface conditions

Snow removal to prevent traffic problems caused by heavy snowfall

Research and Development Program

(12) Development of Technologies for the Better Use of Local Resources and the Reduction of Environmental Load

We will contribute to the utilization of unused resources and materials and the reduction of environmental load in response to changes in social structure. Our research covers a wide range of civil engineering fields, for instance, asphalt pavement waste, recycled concrete aggregate, excavated soil and rock, environmentally friendly steel structure coating and municipal wastewater treatment plants.

It is important to recycle waste materials into construction materials of higher added-value, maintain the recycling rate, and effectively utilize unused local resources and materials. It is also necessary to reduce the environmental impacts by reducing greenhouse gases such as CO_2 and environmental pollutants emitted from social infrastructure development and operation.

We will develop technologies for effective utilization of local resources and materials, and technologies for reducing environmental impacts in social infrastructure development.

Examination of technologies to reduce CO_2 emissions from sewage sludge incinerators by co-combustion with pruned branches, etc.

Promote recycling into value-added recycled materials

(13) Research and development on redesign of public spaces for comfortable and high-quality of life

Through the combined multilateral utilization of local infrastructure and the development of favorable environments with scenic beauty, this project will contribute to comfort and to a high quality of life.

The Japanese government prioritizes quality-of-life improvements through the combined multilateral utilization of infrastructure space. To improve the attractiveness of production spaces, it is necessary to continue efforts to landscape and develop attractive townscapes. Toward these goals, it is required that public spaces be optimized or redesigned according to various needs, instead of just conforming to conventional requirements.

We develop plans and techniques for designing pedestrian spaces that will enrich the comfort of local areas, for designing and maintaining suburban road spaces that meet diverse needs, and for evaluating landscapes to facilitate landscape improvement.

Pedestrian-oriented spaces that enrich local life

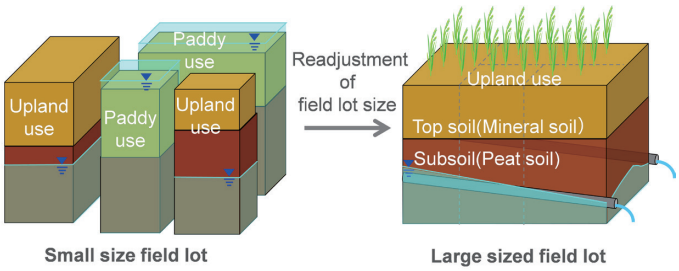
Road spaces that are easy to access and drive, offering beautiful roadscapes

(14) Development of Technologies for Maintenance and Management of Agricultural Infrastructure in the Snowy Cold Regions Contributing to being Growth Industry and Resilient

We will contribute to the stable supply of food and the transition of agriculture to a growth industry by promoting the advanced use of large-scale fields, appropriately maintaining and managing agricultural irrigation facilities in cold regions, and developing farmland and agricultural irrigation facilities that are resilient to natural disasters.

Hokkaido, where large-scale farming is practiced, needs to promote the development of farming infrastructure that is resilient to climate change and disasters, such as by preserving and renewing the functionality of key agricultural irrigation facilities, and upgrading farmland drainage, in addition to developing infrastructure, including large-scale fields and multipurpose farmland, that is suited to smart farming technologies and others.

We will work on technology development for consolidation and utilization of profitable large-scale farmland, for the strategic use and the conservation and management of agricultural irrigation facilities, and for the strengthening of farmland and agricultural irrigation facilities against natural disasters and climate change.



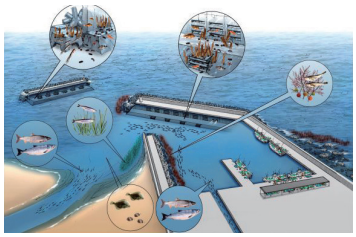
Addressing irregular subsidence at large-scale fields that were turned into larger fields by consolidating fields with different land-use histories

(15) Study on the development and conservation of fishery infrastructure of cold waters that contribute to increasing productivity of fishery resources

We will contribute to the stable supply of food and the growth of the fisheries industry through the development and preservation of the fisheries infrastructure in cold waters, including the promotion of the effective utilization of fishing ports and other facilities and the improvement of the productivity of fisheries resources through the improvement of the fisheries environment.

Hokkaido is an important hub that accounts for nearly 30% of the total catch in Japan; however, in recent years, it has decreased to half of its peak. It is necessary to utilize, develop, conserve, and manage fishing ports and grounds in consideration of fishery resource growth to ensure a stable supply of marine products.

We will develop technologies for utilizing fisheries infrastructure to increase and cultivate fisheries resources in response to environmental changes in sea areas, and develop technologies for improving the fisheries environment to nurture fisheries resources and increase productivity.



Development of technology to improve the fisheries environment using fishing ports in cold waters

Improving habitat and feeding ground for aquatic organisms through introducing macroalgal bed

Maximization of Research and Development Results

PWRI Lecture

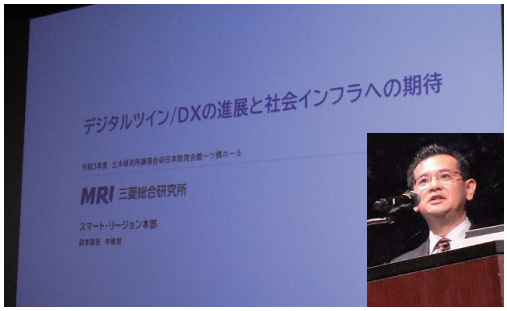
■ PWRI Lecture

The lecture is annually held to extensively introduce our research result and the research status to the public through a presentation of a trend on each research area by PWRI researchers. The program also includes a "Special Lecture" by a prominent learned person.

collection of lectures, presentation materials, video of 2021 PWRI Lecture

■ CERI Lecture

The lecture is annually held to extensively introduce research result of civil engineering related to snowy cold regions, the latest civil engineering technology and a subject dealing with social challenges to engineers, researchers and to the public as well.



PWRI Lecture in 2021
(Special Lecture by Nakajyo Satoru)

PWRI New Technology Showcase

■ PWRI New Technology Showcase

The "PWRI New Technology Showcase" is a seminar event for engineers involved in an infrastructure and management to explain an on-site construction technology and a new technology developed by our research highly effective for an implementation to a wide variety of operations. The presentation posters and models are also exhibited at the venue while consultation about the adoption of technology is provided to visitors. The showcase is held annually in Tokyo and every other year in other cities.

The program includes not only the introduction of new technology but also "Special Lecture" by a prominent learned person or our researchers and a lecture by a staff of Regional Development Bureau.

Presentation material of 2021

Lectures by PWRI staff members

Poster exhibition and technology consultation

■ Others

Various kinds of seminars and lectures such as PWRI New Technology Seminar, CAESAR Lecture, iMaRRC Seminar, CERI New Technology Seminar, Engineer Exchange Forum, On-Site Workshop, CERI Technology Seminar are held to disseminate our research result. We also actively participate in technology exhibitions hosted by other institutions.

Technical Support and Technical Consultation

■ Technical Support at the time of disaster

After receiving a request for a support from the Ministry and local public agencies at the time of disasters, PWRI experts in various fields are dispatched to affected areas to investigate a damage, provide a technical support for a prompt rehabilitation and reconstruction, and life-saving.
The total number of about 800 PWRI researchers have been dispatched to affected areas during 2016 to 2021 or our Fourth Medium to Long term period.
Technical advice and support are mainly provided directly at affected sites and remotely in some research areas through CIM model as a new attempt, which is capable of reproducing a damage situation by reading color point cloud data from pictures taken by UAV.

Inspection on a damage of bridge
(Typhoon Hagibis)

BIM/CIM model as a countermeasure against landsiled disaster

site image taken by UAV

Remote Technical Support
(reproduce a virtual field site)

■ Technical support during the normal times

Technical support is provided at the normal time as well, followed by a request from the national and local public organizations, to assist engineering technology and problem solution related to agriculture, fisheries and harbors in cold region.

Examples of Developed Technologies Utilized at Construction Sites

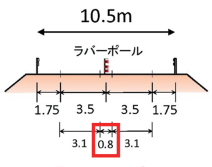
Widespread adoption of wire rope barriers has reduced fatal and injury accidents

Fatal accidents due to head-on collisions and the like can occur on sections of temporary two-lane roads with rubber poles installed at the center, where the rubber pole sections are not wide enough to install barriers.

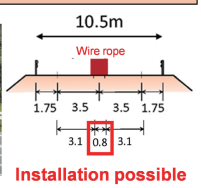
We researched and developed a "wire rope barrier" to prevent head-on collisions caused by vehicles entering into the opposite lane. It excels at mitigating impacts, can be installed in narrow widths, and can be removed and restored in a short time in case of emergency.

We conducted crash tests, test construction, and improvements of structural specifications, and we compiled the results of the R&D into a maintenance guideline (draft). The barrier has been reflected in measures including those of MLIT, which decided on a policy of installing the barriers. By FY 2020, the barriers had been installed on approximately 990 km of road, and their effectiveness in reducing fatal and injury accidents was confirmed, contributing to improved road safety.

[Conventional] rubber poles + curbs → R&D → [Developed method] Wire rope barriers

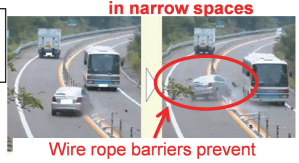


Too narrow for barrier installation



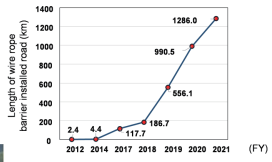
Installation possible in narrow spaces

Accidents before installation*		Accidents after installation (up to Dec. 2020)*	
Total	157	Total	5
Fatal	9	Fatal	0
Injury	28	Injury	0



Wire rope barriers prevent collisions with oncoming vehicles.

In June 2018, MLIT decided on a policy of installing wire rope barriers on temporary two-lane expressways.



Cumulative length of road installed with wire rope barriers

- Examples of roads installed with wire rope barriers
  Hokkaido Expressway
  Tempoku Pass on National Highway 275
  Obihiro-Hiroo Expressway
  Ban-etsu Expressway
  Hamada Expressway

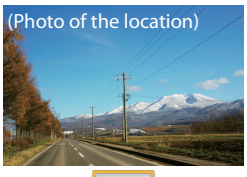
*"Accidents" refers to those caused by vehicles entering oncoming traffic on expressway sections where wire rope barriers were installed by Dec. 2020. "Accidents before installation" refers to those during 2016. "Accidents after installation" refers to those from Apr. 2017 to Dec. 2020.

Development of low-cost methods for undergrounding utility lines in snowy cold regions and suburban areas

On suburban roads with open, attractive landscapes like those in Hokkaido, the undergrounding of utility lines is expected to provide better landscapes and thus to promote local tourism. Another reason that the need for pole-free roads has been increasing is that roads free of utility poles help mitigate secondary damage from disasters, such as from toppled poles, and improve snow removal efficiency in winter.

Undergrounding Utility Lines in cold regions, however, requires deep burial to prevent conduits from freezing. The additional cost from this has been a problem.

This project successfully cut the costs by reducing the undergrounding depth and by using trenchers to significantly shorten the work schedule, both of which are suitable for cold-region conditions. These actions were reflected in the new Plan for the Undergrounding of Utility Lines (2021-2025) of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), which has enabled practical onsite operation. CERI first used this method on public roads in FY 2021, in cooperation with the Hokkaido Regional Development Bureau of MLIT.



A landscape improved by the undergrounding of utility lines

■Proposed efficient, low-cost design for the undergrounding of utility lines that is suitable for suburban areas in cold regions

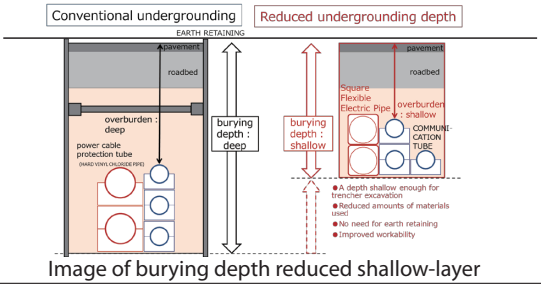


Image of burying depth reduced shallow-layer

Cost reductions from a drastically reduced area of construction
⇒ Significantly improved construction efficiency
⇒Cost estimate (for a frost-heave depth of 120 cm)
EX) about 110M JPY/KM⇒about 60M JPY/KM

■PA trencher considerably shortens the work schedule.

▲Trencher digging is at least five times as fast as conventional backhoe digging.

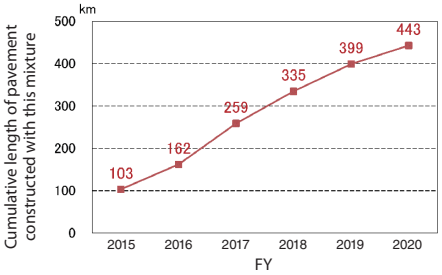
Examples of Developed Technologies Utilized at Construction Sites

Development of pavement with improved durability against freeze-thaw damage, ensuring smoother driving

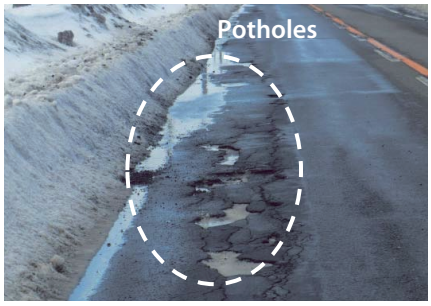
Pavement with excellent drainage ensures safety in rainy weather, but in cold, snowy regions, the repeated freezing and thawing of moisture that penetrates the pavement causes potholes and other damages, which adversely affects driving.

We developed an asphalt pavement mixture (crushed stone mastic asphalt) for cold, snowy regions that combines the advantage of porous pavement which is afforded excellent trafficability in rainy weather, and the advantage of excellent durability.

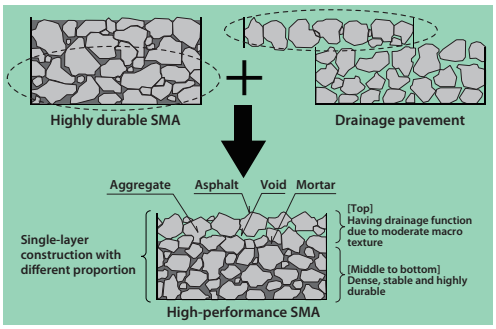
Pavements in snowy regions that are constructed with this mixture are afforded excellent durability and water-resistance, and ensure smoother driving by reducing pavement damage such as potholes.



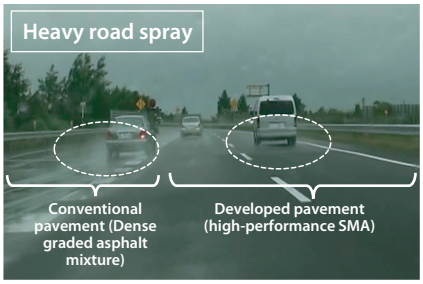
The mixture is commonly used for high-standard highways in Hokkaido



Pavement damaged by freeze-thaw cycles that occurs during the snow-melting season



A high-performance SMA that affords both durability and drainage was developed



A site where the pavement was constructed

Next-generation disaster response method with a virtual disaster site

In landslide disaster response, it is important that you see an overall picture of the disaster and share it among relevant organizations.

We developed a method to create a BIM/CIM model for landslide disaster response in a short time, about a day. The model recreates a disaster situation as a virtual disaster site, using 3D point cloud created from pictures taken by UAVs, and you can see an overall picture of the disaster and share it quickly by using the model.

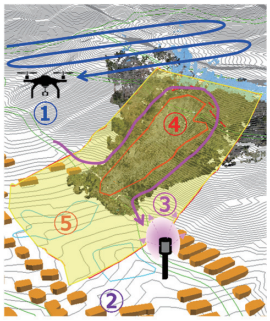
During the rainfall disaster in July 2020 and the COVID-19 pandemic, we contributed to improve regional safety by providing remote technical support without leaving PWRI. The model has been applied to the "BIM/CIM Utilization Guidelines (draft)" by MLIT in 2021. This technology facilitates information sharing between remote locations and situation grasping by relevant parties of disaster response, and contributes greatly to rapid technical support, efficient and low-cost survey and meeting, being expected to lead to next-generation disaster response.

A press conference using BIM/CIM

Using BIM/CIM for press conferences, meetings or residents briefings enables improving understanding about the disasters and speedier communication

①Point cloud (SfM analysis with UAV photos)

②Open data (terrain, river, structure, etc.)

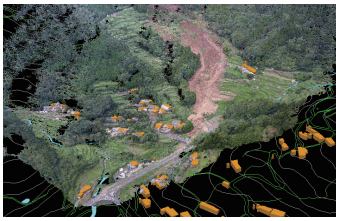


③High-density point cloud (laser scanner)

④Emergency survey results (field survey)

⑤Emergency measures (warning area)

A framework of a BIM/CIM model for landslide disaster response



Macro perspective

Provides an overall picture, even when it's difficult to get a higher view in field survey

Micro perspective

Provides details of each parts, even when it's dangerous to enter a disaster field

A virtual disaster site on PC

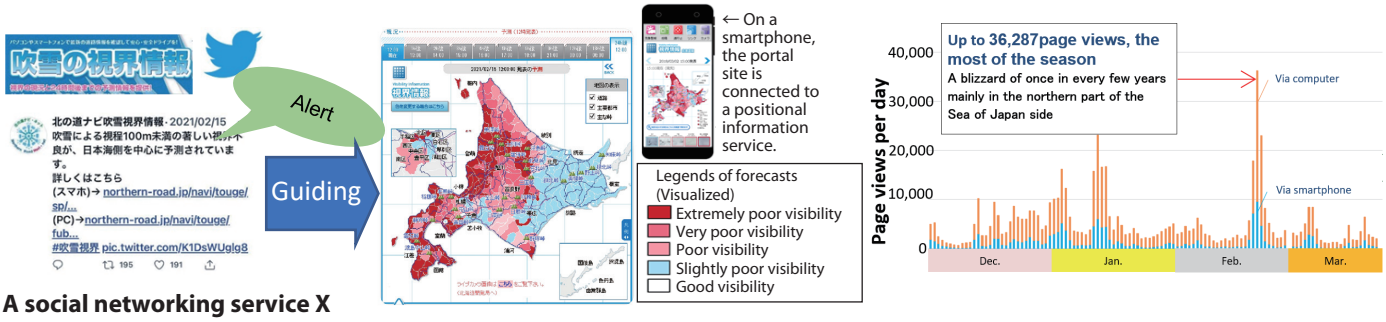
Examples of Developed Technologies Utilized at Construction Sites

Information dissemination through social media helps drivers avoid driving in snowstorms.

Extreme snowstorms and snowfall may lead to extended road closures and even to fatalities from vehicle stranding.

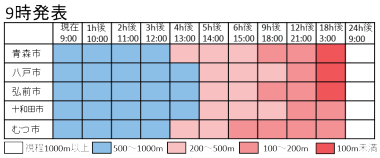
In response to those issues, the project team developed a method for forecasting snowstorm conditions up to 24 hours ahead based on weather data. The Snowstorm Visibility Information System was launched on the 'Northern Road Navi' website, in cooperation with the Hokkaido Regional Development Bureau, to encourage drivers to make appropriate decisions, thereby helping to reduce damages from vehicle stranding.

In addition, the team tweets snowstorm visibility forecasts on a timely basis to promote the use of the system, which has increased the number of tweet views and contributed to accident risk avoidance by drivers.



A social networking service X (former Twitter) used to reach out to followers in a timely manner
When extremely poor visibility is expected, alerts are tweeted, redirecting the viewer to the Snowstorm Visibility Information System website.

The Snowstorm Visibility Information System website
It provides current and expected visibility.
It helps drivers to make decisions.



Snowstorm forecasts in Aomori Pref. (image)
Meteorological observations and analyses have improved the system.
Trial information provision began in the winter of FY 2021.

Significantly improved construction efficiency of unmanned construction, contributing to rapid disaster recovery

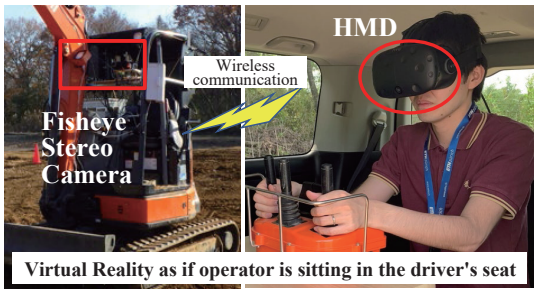
Restoration work immediately after a disaster occurs has a high risk of secondary disasters, and it is difficult to carry out the work with safety in mind. Therefore, "unmanned construction" is being developed as a technology unique to Japan, in which construction machinery that can be remotely controlled is operated by an operator from a safe location. This technology has been used at many disaster sites in Japan.

In unmanned construction, "improving construction efficiency" and "speeding up setup" are issues. We developed and verified new technology to solve these problems.

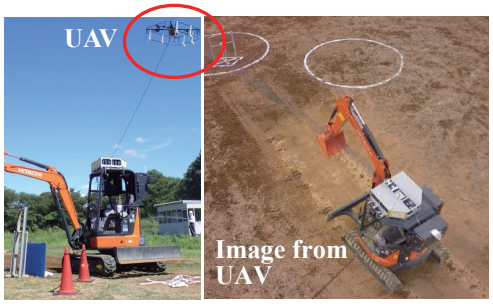
We have developed and verified technology that gives the operator a virtual reality as if he or she is sitting in the driver's seat of a construction machine, technology that uses a UAV instead of a camera trolley, and SLAM technology. As a result, it was found that the construction efficiency of unmanned construction can be improved by about 10 to 30% and that eliminating the processes including installation of external cameras will lead to a quick setup.

In 2021, we created the "Unmanned Construction New Technology Catalog" summarizing these research results and presented it to the regional development bureaus.

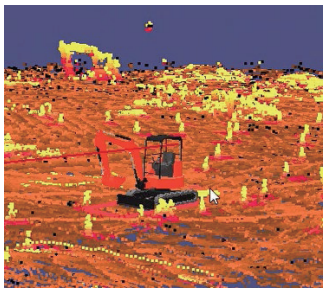
Additionally, a construction DX experimental field (26,000 m2, local 5G, etc.) has been established, and research and development of unmanned construction and autonomous construction are also being promoted.



Unmanned Construction with VR



Unmanned Construction with UAV



UC with SLAM

Examples of Developed Technologies Utilized at Construction Sites

Development of diagnostic AI System contributes to extending the service life of road bridges

As road bridges are aging, preventive maintenance is important to detect defects at an early stage and extend service life before serious damage occurs in order to equalize future maintenance costs.

Therefore, a bridge diagnosis supporting AI system (Diagnosis AI System) based on a diagnosis method of skilled engineers was constructed by organizing information on damage mechanisms and other information. The system aims to improve the reliability of diagnostic work. It can gain the trust of road administrators, because the reasons for the diagnostic results can be explained. It is expected to contribute to the efficiency of maintenance and management operations as well as to the improvement of technical capabilities of road administrators, including local governments.

■ Collecting information through inspections

Currently, inspection data is input by hand. In the future, automatic input data will be considered.

Moisture state classification results (AI-based estimation)

Electromagnetic radar to detect water stagnation and leakage paths (under development)

■ Diagnostic process

Input of data obtained from inspections

↓

All damage mechanisms are input into the expert system in advance. The type, extent, and area of damage are identified by matching the acquired data with the damage mechanisms, and the countermeasures are presented (diagnosis).

↓

Output of diagnostic results along with the data on which they were based for identification

■ Example of diagnostic output

☆**Identification of damage type and cause**
→ Disintegration, stagnant water over a large area

☆**Estimation of damage progression**
→ Only water stagnation is occurring at this stage, so it is possible to extend the service life.

Presented with supporting data

☆**Presentation of proposed countermeasures plan**
→ Installation of waterproof layer for longer service life

Application of environmental DNA technologies for standardizing biological investigation

To utilize environmental DNA survey technology in biological surveys, including the national census on river environments, we standardized a series of tasks related to environmental DNA surveys.

Field surveys were used to identify and examine standardization issues, and a draft was presented to implement the standard procedures; in addition, this draft was verified through trial surveys performed nationwide.

The use of environmental DNA survey technology is expected to address issues including the shortage of survey technicians, variation in survey accuracy among surveyors, and the cost of surveys, as well as improving the efficiency of surveys and sophistication of biological information.

Traditional capture survey
Capturing fish to identify the morphological characteristics of the species (identification).

Biota within the range of investigation

Environmental DNA survey
Comparing DNA information extracted from fish tissue in water to the DNA database to identify a list of species.

Biota in the inflow zone

Environmental DNA Investigation is

Without capturing fish
without harming fish, without disturbing the habitat

Only water sampling at site
Multi-point investigation is possible

High detection sensitivity
Detectable even with a small number of organism

Information and Enquiries

Technology consultations

We offer advice for inquiries about technical issues the national and local public organizations are dealing with, and about practical application of technology that private research organizations are working on.

<Contact>

• PWRI Homepage (HOME→Contact→Contact for Technical Assistance)
https://www.pwri.go.jp/eng/contact/contact-t.html

• CERI Homepage (HOME→Contact for Technical Assistance) *Japanese only
https://chouseikan.ceri.go.jp/suishin/soudan/

Web Magazine

We deliver timely information on research and various events.
https://www.pwri.go.jp/eng/about/pr/webmag/index.html

Industry-Academia-Government Collaboration (collaboration research)

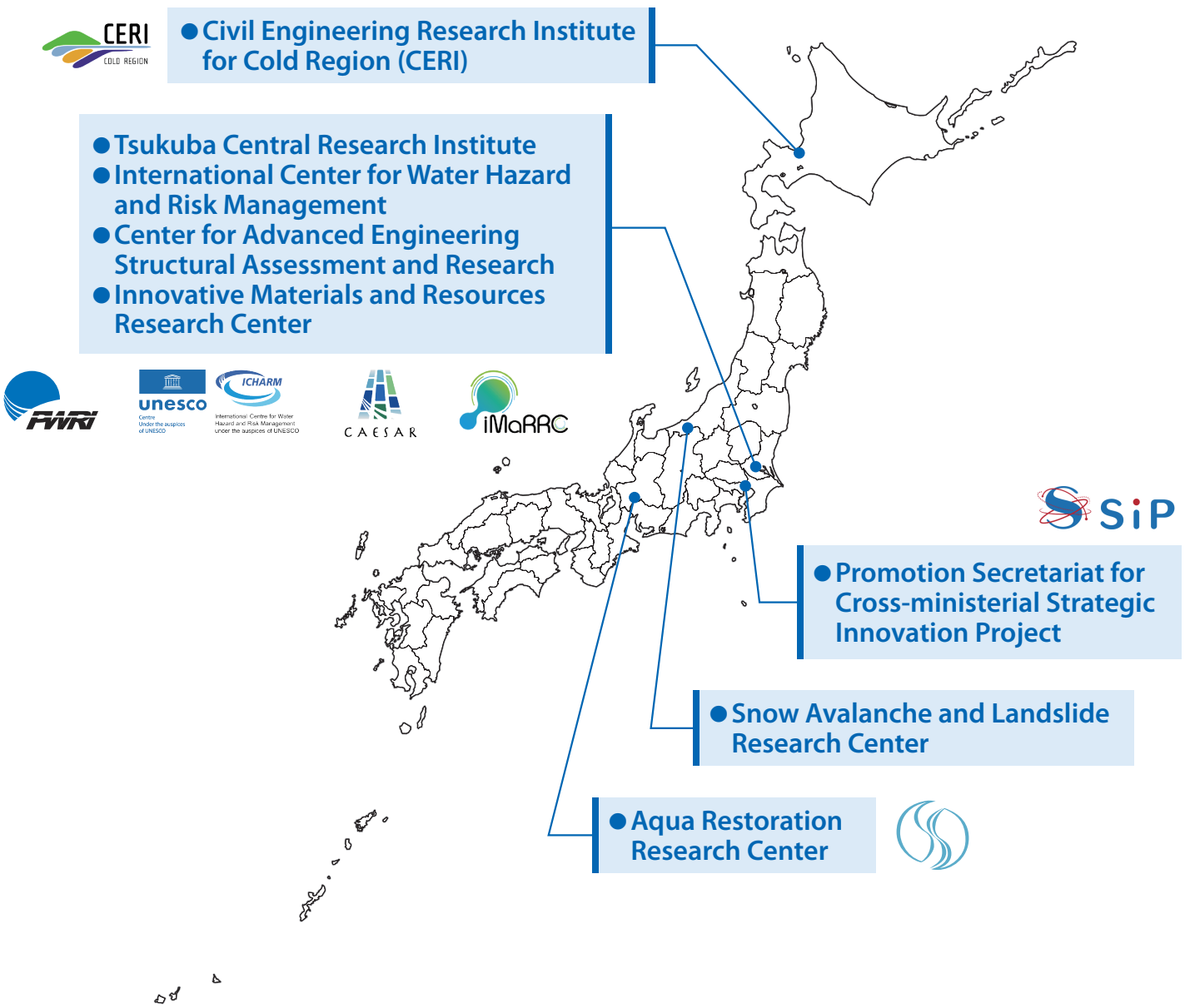
We collaborate with universities and private companies to incorporate wide range of knowledge and resolve any issues of infrastructure. Research Collaboration with PWRI as a third party will promote research and development for private companies and provide an environment where a developed technology is applied to an infrastructure.

<Details>

• PWRI Homepage (HOME→Research Activities→Joint Projects)
https://www.pwri.go.jp/eng/research/joint/index.html

• CERI Homepage (HOME→Research Activities→Research Cooperation and Technical Support)
https://www.ceri.go.jp/english/activities/cooperation.html

Facilities of PWRI



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