NARO 農研機構
National Agriculture and Food Research Organization

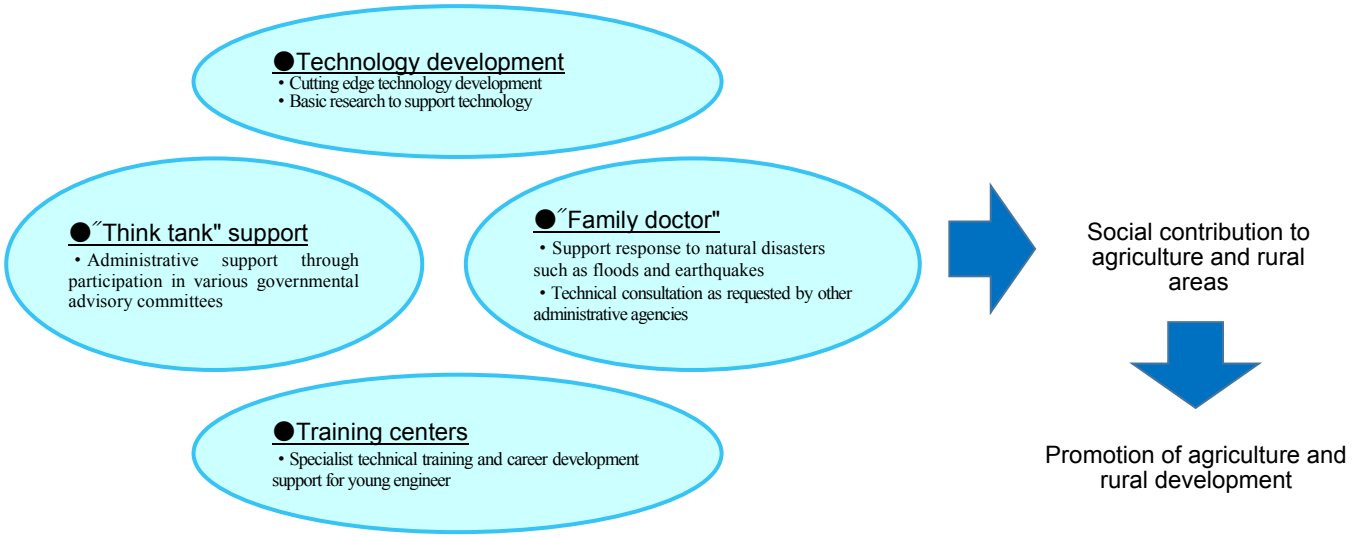
INSTITUTE FOR RURAL ENGINEERING, NARO

The Role of the Institute for Rural Engineering, NARO (NIRE) and its Research Activities

What is NIRE?

NIRE is one of several institutes that belong to the National Agriculture and Food Research Organization (NARO), a national research and development agency. Our focus is the development of technology that contributes to the achievement of a policy of "rural promotion" through prudent management of agricultural water and soil. Moreover, we provide technical assistance with hazard and disaster counter-measures for farmland and agricultural facilities.

NIRE's Broad Range of Activities



Technical Development Objectives Relevant to Our Mission

From April, 2016, in cooperation with other agencies, we will focus on the following eight objectives as part of the five-year mid-term plan of the NARO.

I. Improve on-farm production and farm management

1. Development of paddy field management technique which is low cost, highly efficient and sustain both rice and upland crop cultivation.

II. Promote resilient agriculture and new agri-businesses

2. Development of weather-proof greenhouses and its environmental control techniques.

III. Combat global environmental issues and manage regional resources

3. Development of agricultural land management technologies for profitable agriculture through farm-plot consolidation.
4. Development of disaster prevention/reduction and management technologies for irrigation facilities for strengthening rural areas.
5. Development of technologies for upgrading regional resource management/use in response to changing social structures and the environment of rural areas.
6. Development of integrated countermeasures for wildlife damage through prevention, capture, and environmental management with consideration to rural environment.
7. Development of technologies to mitigate radioactive Cs transfer from soil to plant and to support early initiation of agriculture after decontamination.

IV. Developing technologies that contribute to sustainable agriculture by protecting crops, managing soil, and making use of local resources.

8. Development of integrated weed management technology for alien weed and herbicide-resistant weed.

Implementation System of the 4th Mid-Term Plan

In order to meet the needs of society, we have arranged the mid-term plan into eight research projects. In each project, specialists from four fields cooperate to achieve a comprehensive execution of their project and the mid-term plan as a whole.

NIRE Organization and Division Keywords

Director-General

Department of Planning and General Administration
- Deputy Manager
- Planning and Cooperation Section
- General Administration Section
- Risk Management Section
- Disaster Management Section

Department of Technology Transfer
- Professor
- Transfer Promoting Section
- Technical Training Section

●To focus on the NIRE contribution to society, since April 2016, we have implemented a research unit system that emphasizes keeping a stable food supply, preventing or reducing effects of disasters such as earthquakes and floods in rural areas, and renewing and invigorating agriculture and rural area.

	Division Keywords
Division of Agricultural Environment Engineering Advanced Paddy Field Management Unit Soil Physics and Irrigation Unit Water Management Unit Controlled Environment Agriculture Unit Agricultural Land Management Unit	Farmland improvement, irrigation water management, greenhouse farming system, greenhouse environmental control, paddy-upland crop rotation, productivity improvement, quality improvement, GIS, land and resource management, effective use of farmland
Division of Facilities and Geotechnical Engineering Structural Engineering Unit Soil Mechanics Unit Facilities Maintenance and Management Unit Disaster Prevention Unit	Agricultural dams, reservoirs, pipelines, open channels, earthquake/torrential rain disasters, technologies for prevention/ mitigation, performance verification, technologies for maintenance, management and renewal
Division of Hydraulic Engineering Hydraulic Structures Design and Management Unit Irrigation and Drainage Systems Unit Coastal Hydraulics Engineering Unit Aquatic Environmental Engineering Unit	Irrigation systems, hydraulic performance diagnosis and performance verification, irrigation and drainage control, storm surge, tsunami, lowland drainage, agricultural water use, preserving water quality, biodiversity, environment- and ecosystem-friendly, ecological diversity
Division of Regional Resources Engineering Renewable Energy and Resources Unit Hydrology and Water Resources Unit Groundwater Resources Unit Resources Evaluation Unit	Biomass use and application, environmental burden reduction, small hydropower, renewable energy, agricultural water use, wide-area water allocation and management, climate change response, water cycle mechanism, cost-benefit analysis, impact assessment, resource use and application

NIRE's History

1950	Inauguration of the Department of Agricultural Engineering of the National Institute of Agricultural Science
	Inauguration of the Shore Reclamation Department of the Kyushu Agricultural Experiment Station
1959	Inauguration of the Experiment and Training Section of the Construction Department of the Farmland Bureau of the Ministry of Agriculture and Forestry (MAF).
1961	National Research Institute of Agricultural Engineering (NRIAE) established in Hiratsuka City, Kanagawa Prefecture under the MAF to oversee and combine the above three institutions
1977	NRIAE relocated from Hiratsuka City to Tsukuba Science City, Ibaraki Prefecture
1988	NRIAE reorganized into the National Institute for Rural Engineering (NIRE), under the Ministry of Agriculture, Forestry and Fisheries (MAFF)
2001	NIRE became an incorporated administration agency
2006	NIRE reorganized under the NARO
2016	NIRE reorganized into the Institute for Rural Engineering, NARO (NIRE)

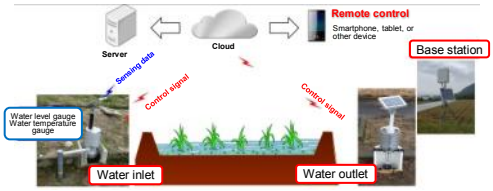
Division of Agricultural Environment Engineering

Improvement and Management Technologies Agricultural Facilities and the Efficiency of

Japan's agricultural infrastructures include 2,450,000 ha of paddy fields, 2,050,000 ha of upland fields, and 49,000 ha of greenhouses. We conduct pioneering technology development in five research fields to improve and promote the effective use of these infrastructures, which is directly involved in producing farm products. In this way, NIRE does its part to ensure a stable food supply while also taking climate change and environmental burdens into consideration.

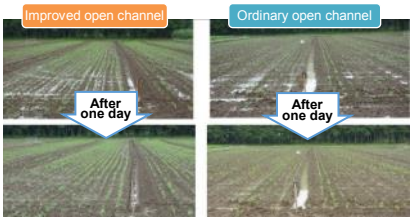
Water Management and Infrastructure Improvement Technologies for Raising the Food Self-Sufficiency Rate Through Enhanced Paddy Field Use and for Increasing Farmer Competitiveness

Advanced Paddy Field Management Unit



Smartphones and other devices:
• Remotely monitor field conditions (such as water depth).
• Remotely control water supply and drainage in response to crop and weather conditions.

■ Development of a Remote or Automatic Water Management System Controlled through Communications Devices



• Use fixed-point cameras or other devices to study drainage capacity, which influences crop production of converted paddy fields.
• Analyze study results and field conditions to encourage the use of appropriate remedial technologies.

■ Using visualization and other means to monitor the drainage capacity of upland fields converted from paddy fields

The growing number of large-scale rice-growing operations exceeding 100 ha has brought about the challenge of water management by just a few individuals. For that reason, we are developing technologies for remote and automatic water management. To support the stable production of barley, soybeans, and other upland crops in paddy fields, NIRE is working on new technologies for drainage and field management as well as visualization and other technologies to monitor drainage capacity.

New subsoil breaker which inserts no drainage material: "Cut Drain" (characterized by deep breaking and long-lasting drainage voids)

New subsoil breaker that inserts drainage material: "Cut Soiler" (forms drainage channels in the soil that are filled with crop residue and other materials from the surface)

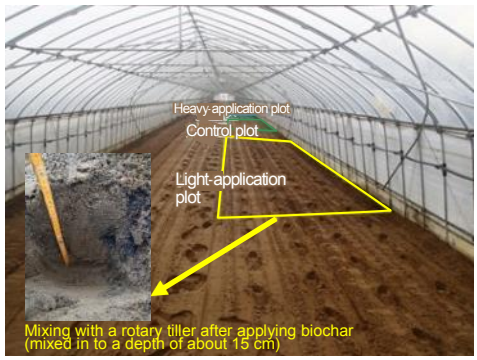
Labor-saving and precise field management technologies using highly accurate GPS (leveling requires about 40% less labor than before)

■ New Technologies for Field Drainage and Management

Intelligent Management of Soil and Water Resources in Upland Fields

Soil Physics and Irrigation Unit

■ Measuring crop water requirement using electromagnetic method.



■ Biochar amendment of soils according to their physicochemical properties

To create a suitable soil environment for high-quality agricultural products in upland fields, we seek to use state-of-the-art research facilities to promote intelligent management of soil and water resources to both sustain agricultural production and safeguard environmental quality.

that Boost the Functionality of Farmland and Water and Farmland Use

Water Management Technologies for Improving Agricultural Productivity

Water Management Unit

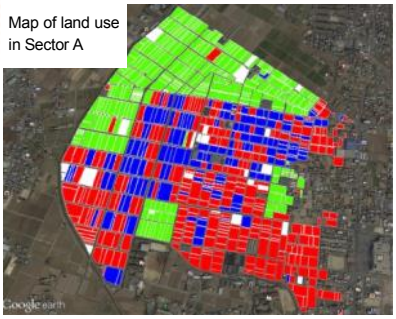
Monitor the EC by a sensor at the top of the intake pipe

Send the EC data-mail by solar powered e-mail transmitter

Check the data by cell phone and stop the irrigation when EC is too high

■ Appropriate irrigation management method for preventing salt damage of paddy rice

EC (Electric Conductivity) sensors monitor salinity and send the data to water management organizations such as Land Improvement Districts. The flow of irrigation water is controlled depending on salinity.



Blue: Paddies for direct seeding (with winter puddling)
Red: Paddies for rice planting
Green: Paddies converted to upland fields (wheat crop)
White: Other (vegetables and other crops)

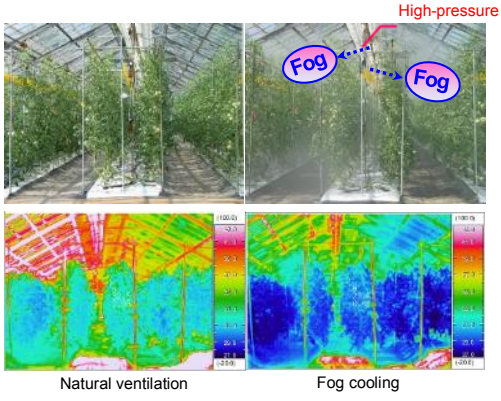
■ Changes in water demand due to the integration of paddy fields

Direct seeding with winter soil puddling is introduced to reduce labor, also changes water demand by shifting planting pattern.

In recent years, paddy fields are becoming integrated in the hands of leading farmers for improving agricultural productivity. In addition, more profitable crops and effective farming are being introduced. So, diversifying the demand for irrigation water are progressed. There are also new demands, such as water use for adapting to climate change and/or disaster prevention. NIRE is developing water management technologies to adjust agricultural water supply and demand with labor reduction.

Technologies for Enhancing the Weather-Resistance of Agricultural Facilities and Advanced Environmental Monitoring and Control

Controlled Environment Agriculture Unit



Natural ventilation

Fog cooling

■ Research of environmental control using fog evaporative cooling system toward year-round utilization of greenhouses

Picture below was the images using infrared camera

■ Visualization of air flow around a greenhouse

■ Large-scale wind tunnel testing for agricultural structure and environment

We are developing engineering technologies to keep greenhouse's structure safe and to improve controlling environment inside greenhouses for year round production. To control the environment inside greenhouses, we also research on the physical environment and the plant information with the technologies of heat transmission, acoustics, and so on. Additionally, we are developing technologies modified fruit tree supports, and livestock buildings with anti-spread pathogens and contamination. Large wind tunnels, growth chambers, and computational fluid dynamics and several techniques can lead us to development of agricultural structures.

Technologies for Wide-Area Collection, Visualization, and Utilization of Farmland Information

Agricultural Land Management Unit

■ Visualization of abandoned farmland with Google Earth

■ 3D modeling of terraced paddy fields based on UAV aerial photo images

To help make the best use of farmland, NIRE is developing a farmland survey technology using small UAVs (drones), a technology for collecting and visualizing farmland information using GIS and remote sensing, a planning method for wide-area farmland improvement, and a coordinating method for farmland use using farmland information.

Division of Facilities and Geotechnical Engineering

Technologies for Maintenance, Management, and Irrigation Facilities

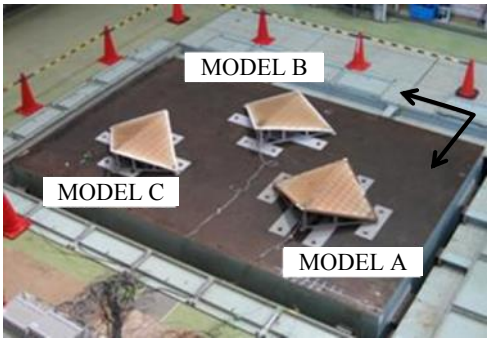
We have two main research targets. One is the technological development on stock management about the various irrigation facilities and the large rural area, which include hilly and mountainous areas, sea embankment, etc. The other is the development of comprehensive technologies for disaster prevention and disaster reduction for irrigation facilities and rural area.

The first target, including the technology about facility deterioration prediction, monitoring, life prolongation, is expected to be used for the irrigation and drainage canals with a total distance of almost 400,000 km, 200,000 irrigation ponds and 7,000 infrastructures such as irrigation high dam, irrigation water supply/drainage pumping stations and head works. The second target is against large-scale natural disasters such as Nankai Trough earthquake and serious heavy rain.

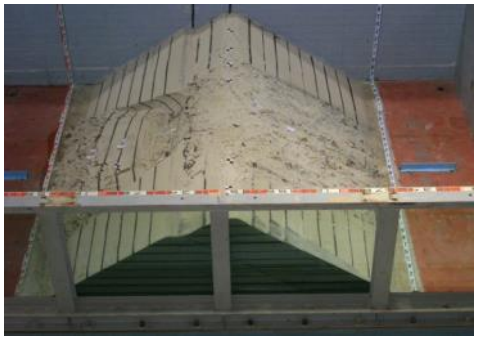
This division consists of 4 units; Structural Engineering Unit, Soil Mechanics Unit, Facilities Maintenance and Management Unit and Disaster Prevention Unit. All of us are aiming at the improvement of safety of irrigation facilities, the conservation of national land and the ensuring of safety and security in rural regions and working towards establishing a tough and flexible agriculture and rural area.

Ensuring the Safety of Key Irrigation Infrastructure

Structural Engineering Unit



■ Experiment to assess vibration characteristics



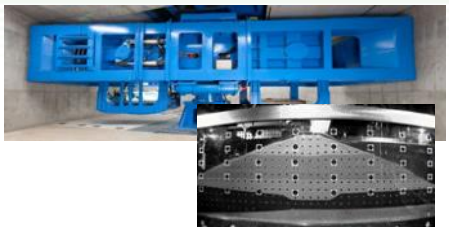
■ Experiment to verify the destruction mechanism of earthquakes

To ensure the structural safety of agricultural dams and other key irrigation facilities, NIRE develops non-destructive monitoring methods aimed at ensuring that older dams work properly and methods to assess earthquake-resistance for practical repair and reinforcement that make dams work better.

and Disaster Prevention and Mitigation for Rural areas

Developing a Real-Time Hazard Prediction Technology and a Disaster Information System for Earthen Structures

Soil Mechanics Unit



■ Centrifugal loading experiment with reservoir model

■ Liner pipe experiment with full-size model

To keep reservoir banks from bursting because of localized heavy rainfall and earthquakes, we perform reservoir aging diagnosis and develop improvement technologies based on full-scale model experiments and numerical analysis. We also investigate how earthquakes damage irrigation pipelines and develop technologies to make pipelines more earthquake-resistant and to verify long-term durability.

Developing Diagnostic and Repair Technologies to Maintain and Manage Irrigation Facilities

Facilities Maintenance and Management Unit

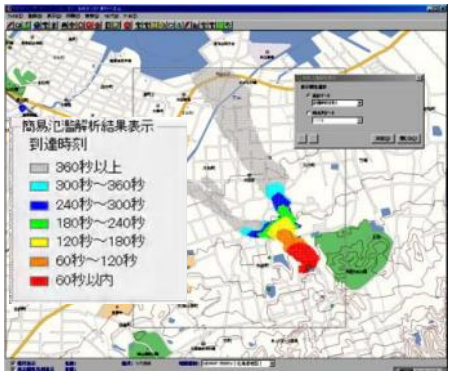
■ Field survey of repair material long-term durability

■ Deterioration promotion test of pump facilities

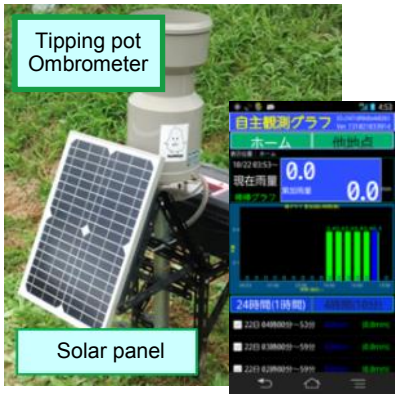
This research unit develops technologies to extend the service life of, maintain and manage various irrigation facilities such as channels, pipelines and pumps. We aim to develop quantitative technologies for diagnostic, design and quality assurance to ensure the durability of irrigation facilities.

Developing Maintenance and Management Technologies to Make Rural Areas More Disaster-Resistant

Disaster Prevention Unit



■ Predicting the flood area due to bank failure



■ NIRE-developed rainfall observation and display system

We aim at realization of rural area that are strong against disasters via hardware -software coordination. We improve the evaluation technique of methods for evaluating the risk of damage about heavy rains of lower basins and the slope where farmland or an irrigation facility is located. And we develop of methods for preventing and reducing damage by combining facility repair and improvement of control operation methods to realize this purpose.

Division of Hydraulic Engineering

Technologies for the Stable Supply and Reliable Drainage and Aquatic Environmental

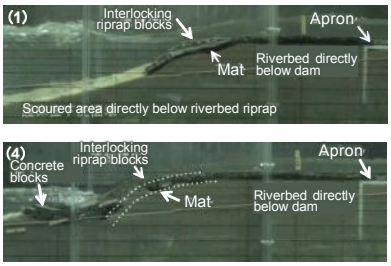
With a broad overview of rural areas from their water sources to downstream and coastal areas, NIRE aims to solve problems related to the deterioration of irrigation facility function because of aging; changes in water end-use demand owing to farming diversification; increased water-management workload due to the shortage in farmers; damage to low-lying farmland by heavy rain, tsunamis, and storm surges; and the deterioration of irrigation water quality and aquatic ecosystems. To that end, we work on lengthening the hydraulic service life of irrigation facilities, building next-generation irrigation systems, managing drainage to mitigate lowland disasters, and developing labor-saving management technologies for aquatic environments.

1. We develop technologies to extend the service life of irrigation facilities that no longer function as well as they should in terms of water intake, diversion, and supply. These technologies use hydraulic function diagnoses and performance verification to identify abnormalities in facilities and enable low-cost maintenance and management.
2. In response to the changing water use activities and local water demands in irrigated areas, we accurately analyze the current hydraulic performances in irrigation and drainage system and propose appropriate measures so as to upgrade existing system into next-generations system.
3. To lessen disaster damage to coastal farmland and their hinterlands, we develop methods to assess the risks of tsunamis, storm surges, and floods, as well as disaster-mitigation technologies that use existing facilities.
4. We develop maintenance and management technologies for the water environments and aquatic ecosystems of rural areas from the standpoints of preserving irrigation water quality, and of assessing, conserving, and restoring the biodiversity (ecosystem, species, and genetic diversities) of irrigation and drainage facilities.

Technologies to Extend the Hydraulic Service-Life of Irrigation Facilities

Hydraulic Structures Design and Management Unit

■ Identification of causes in pipeline rupture accidents



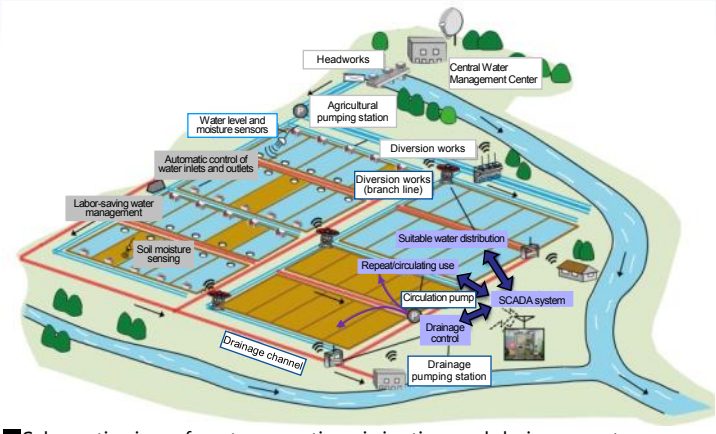
■ Use of reinforcement mat for riverbed riprap downstream from headworks

NIRE performs experimental research related to the suitable design and operation of dams, headworks, reservoirs, and other water resource facilities, as well as key facilities such as open channels, pipelines, and diversion works. We help ensure the long service life of irrigation facilities and the stable supply of irrigation water. We do this by using numerical analysis and hydraulic testing to analyze the hydraulic and supply/distribution performance of irrigation facilities, and by developing methods for hydraulic performance diagnosis, performance verification, and facility design.

Advanced Management of Irrigation Water and for Management

Developing Operation Technologies for Next-Generations Irrigation and Drainage System

Irrigation and Drainage Systems Unit



■Schematic view of next-generations irrigation and drainage system

Irrigation and drainage system is composed of various water control facilities such as headworks, division work, regulation reservoir, etc.
Primary mission of irrigation system has always been, and will continue to be, a matter of matching irrigation water supply and farmers water demand within the resource and environmental constraints in watershed. Drainage system improves farmland cultivation environment throughout hydraulic operation in association with irrigation system.
Water use activities and water demands in local irrigated areas in the system are changing rapidly and complicatedly in recent years. We accurately analyze the current hydraulic performances in irrigation and drainage system and propose appropriate measures so as to upgrade existing system into next-generations system by applying hydraulic and latest Information and Communication Technology (ICT) actively.

Technologies to Reduce Flooding Damage to Low-Lying Farmland

Coastal Hydraulics Engineering Unit

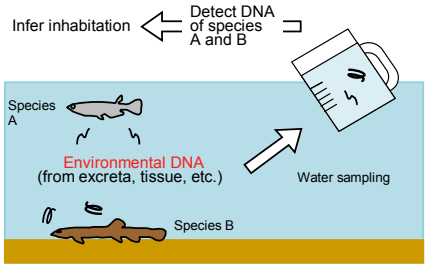
■On-site survey of tsunami damage

■Evaluation of tsunami mitigation methods by using hydraulic models

Japan's approximately 1780km of coastal farmlands zones are exposed to the threat of natural disasters such as storm surges and tsunamis. This and the increasing incidence of torrential downpours in recent years put low-lying farmland at a higher risk of flooding. In addition to analyzing the causes of disaster damage based on disaster studies, we assess the disaster risks to coastal farmlands by various means including numerical analysis and large-scale two-dimensional hydraulic experiments. In this way, we help efforts to promote effective disaster-mitigation measures.

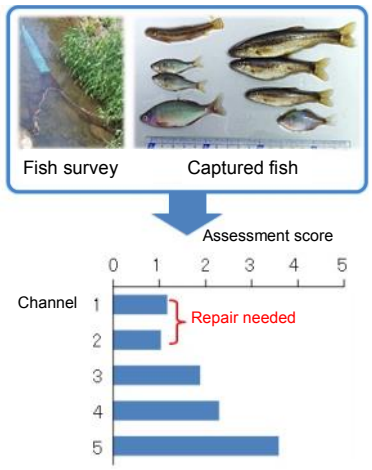
Developing Conservation and Management Technologies for the Efficient Restoration of Aquatic Ecosystems

Aquatic Environmental Engineering Unit



We are working on the development of this non-invasive monitoring method that does not require the individual collection.

■A method to infer the fish inhabitation using environmental DNA



■Assessment score for identifying places in need of repair

NIRE develops technologies for managing aquatic ecosystems; we use simple measuring instruments such as imaging devices to identify priority areas in need of repair. In addition, we develop technologies to assess plant and animal habitats without professional monitoring instruments as well as to restore aquatic network using bypass tools such as small fish ladders.

Division of Regional Resources Engineering

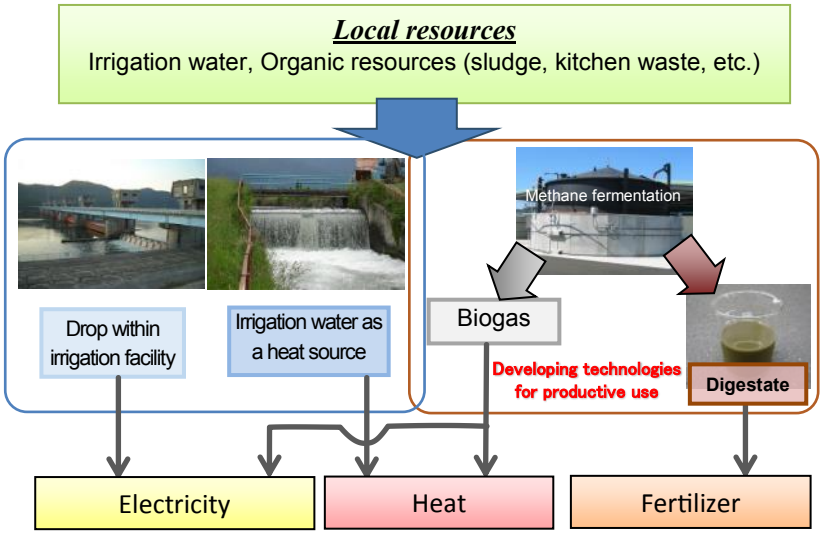
Assessment, Utilization, Maintenance, and

Rural areas have diverse resources including approximately 66% of Japan's annual water use (54.4 billion m^3/year), such as available renewable energy (equivalent to 45.8 billion kWh of hydropower), biomass resources (320 million tonnes of rural sewage treatment sludge, livestock waste, food waste, and others), and social capital. Our division assesses the sustainability of these resources on various scales from local, to watershed and global levels and actively develops technologies for their usage. In this way, we contribute to the creation of a recycling-oriented society, implement measures for climate change adaptation, conserve rural areas, bring out the capacity for cooperation in rural areas, and vitalize rural communities.

1. We develop methods and technologies to use, conserve, and manage renewable energy sources (biomass, small hydropower, etc.) in rural areas.
2. We develops systems for understanding the role of irrigation in hydrological cycles; for managing floods and droughts risks with the climate changes; and for predicting the dynamics of solutes and radioactive substances in agricultural watersheds.
3. We develop methods to understand groundwater behavior using environmental indicators and exploratory techniques, methods for the sustainable use of groundwater resources under climate change, and technologies to monitor the radioactivity of farmland and irrigation water.
4. We develop methods to effectively manage and use various local resources to vitalize communities. We also develop socioeconomic assessment methods that assist the improvement, conservation, and management of rural areas.

Rural areas that Produce Local Energy

Renewable Energy and Resources Unit



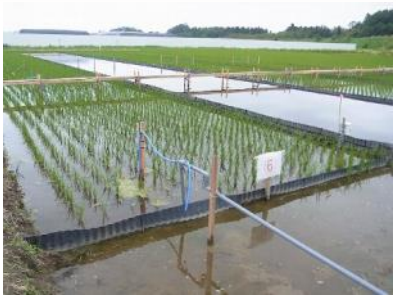
Living and agricultural production in rural areas are not possible without the use of electricty, fuel and other resources. To develop these sustainably, we need technologies for using organic resources as well as hydropower, heat, and other energy resources peculiar to a given location. The Renewable Energy and Resources Unit helps rural areas to develop infrastructure to produce their own energy. One way we do this is to develop methods to design and manage small hydropower systems for headworks, which are an important part of irrigation facilities. Another way is to develop management technologies for suitably operating methane fermentation facilities whose feedstock is rural sewage sludge etc.

Management of Regional Resources in Rural Areas

Developing Integrated Systems to Reduce Flood Risks and Manage Water Resources

Hydrology and Water Resources Unit

■ Hydrological observation in agricultural watersheds



■ In-situ monitoring of radioactive substances in paddy fields

We develop an integrated system that simulates natural hydrological cycles and human-related water flow in agricultural watersheds, including the assessment of flood mitigation function of paddy fields, estimation of return flows from irrigation networks and monitoring the transport of solutes and radioactive substances. With the increasing concerns of extreme floods and droughts due to climate changes, the developed system is used for reducing the risks and promoting better adaptation to the environmental changes.

Investigating Groundwater Dynamics and Developing Methods for Using Groundwater Resources Sustainably

Groundwater Resources Unit

■ Using a new exploratory method to check the distribution of available groundwater

■ Water sampling from a spring-fed pond to measure environmental isotopes

We conduct research using environmental indicators and exploratory technologies to clarify groundwater dynamics. We also develop methods to predict and assess the impacts of climate change on water resources and methods to use groundwater resources sustainably. Additionally, we develop technologies to measure the radioactivity of farmland and irrigation water. Through these activities, we aim to create environments that produce safe agricultural products and build robust water resources on the basin level.

Technologies for Vitalizing Rural areas by Using Local Resources

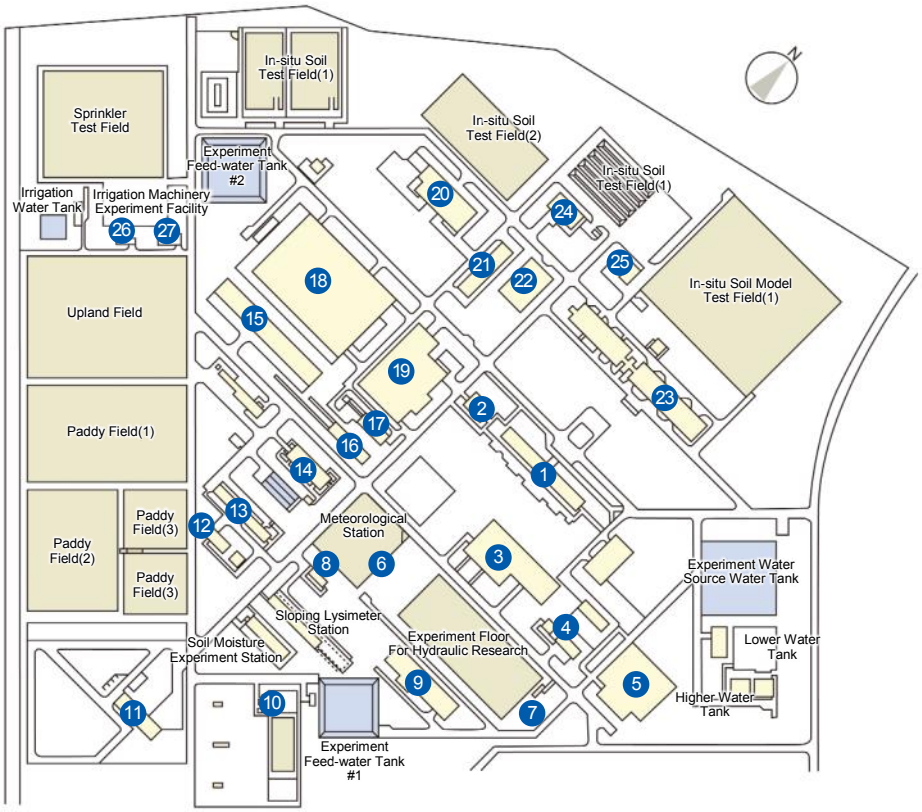
Resources Evaluation Unit

■ Water channel maintenance through cooperative action

■ GIS database system for infrastructure information

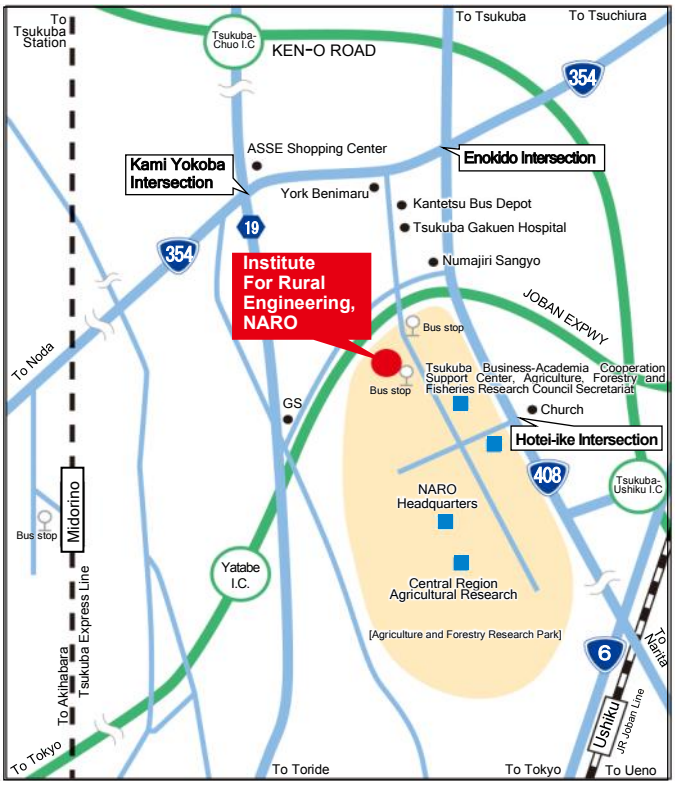
As the impact of climate change on agriculture and the influences of population decline and aging become increasingly apparent, NIRE develops methods to assess environmental functions that use rural resources, such as the land improvement infrastructure and renewable energy, by using econometric models. We also work on developing ways to maintain and enhance environmental functions on using these rural resources and strive to propose means to revitalize local economies and residents' cooperation activities.

Laboratories and Facilities



1 Main Research Building
2 Research Center for Disaster prevention
3 Canal Works Laboratory
4 Scale Model Workshop
5 Dams Laboratory
6 Meteorological Observatory
7 Headworks Laboratory No.2
8 Variable Slope Lysimeter
9 Headworks Laboratory No.1
10 Groundwater Laboratory
11 Groundwater Resource Laboratory
12 Paddy Field Laboratory
13 Rural Resource Research Laboratory
14 Paddy Field Irrigation Laboratory
15 Laboratory for Open Channel Flow with Wave Generator and Wind Tunnel
16 Wave Laboratory for Preliminary Testing
17 Multi-phase Flow Laboratory
18 Laboratory of Disaster Reduction for Coastal Areas
19 Laboratory for Sea-waves with Fan-shaped Water Tank
20 Controlled Environment Agriculture Center
21 Twin-span Glasshouse
22 Three-dimensional Vibration Laboratory
23 Construction Engineering Laboratory
24 Laboratory of Disaster Reduction for Irrigation Facilities
25 Soil Mechanics Model Test Laboratory
26 Crop Environment Control Laboratory
27 Upland Field Irrigation Laboratory

Area map



(1)Via Tsukuba Express (TX) train, Midorino Station:
Take Kanto Tetsudo circuit bus for Norin Danchi, and get off at “Noson Kogaku Kenkyusho Mae” bus stop. (takes about 13 min from the station)

(2)Via Tsukuba Express (TX) train, Tsukuba Station:
Take Tsuku-Bus Nanbu Shuttle and get off at “Norin Danchi Chuo” bus stop. (takes about 30 min from the station)

(3)Via JR Joban Line train, Ushiku Station:
At West Exit of the station, take Kanto Tetsudo Bus for Tsukuba Center or Yatabe Shako or Tsukuba Daigaku Byoin, and get off at “Noson Kogaku Kenkyusho Mae” bus stop. (takes about 25 min from the station)

(4)By car (via JOBAN EXPWY):
Exit at Yatabe Interchange, and follow the above map. (takes about 10 min from the IC)

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