CIVIL ENGINEERING

Kyoto University

Structural Engineering Laboratories

Katsura Campus

Applied Mechanics (応用力学講座)

Structural Materials Engineering (構造材料学分野)

Structural Mechanics (構造力学分野)

Bridge Engineering (橋梁工学分野)

Structural Dynamics (構造ダイナミクス分野)

International Management of Civil Infrastructure (国際環境基盤マネジメント分野)

Structures Management Engineering (構造物マネジメント工学講座)

Earthquake and Lifeline Engineering (地震ライフライン工学講座)

Uji Campus

Dynamics of Foundation Structures (耐震基礎分野)

Urban Flood Control (都市耐水分野)

Hydraulics and Hydrology
River, Coastal, and Water Resources Engineering Laboratories

Katsura Campus

Applied Mechanics (応用力学講座) **(See page 4)**

Environmental Hydrodynamics (水理環境ダイナミクス分野)

Hydrology and Water Resources Research (水文・水資源学分野)

Urban Coast Design (沿岸都市設計学分野)

River System Engineering and Management (河川流域マネジメント工学講座)

Uji Campus

Erosion and Sediment Runoff Control Engineering (砂防工学分野)

Hydroscience and Hydraulic Engineering (防災水工学分野)

Hydrometeorological Disasters Engineering (水文気象工学分野)

Coastal Disaster Prevention Engineering (海岸防災工学分野)

Innovative Disaster Prevention Technology and Policy Research (防災技術政策分野)

Waterfront and Marine Geohazards (水際地盤学分野)

Regional Water Environment Systems (地域水環境システム分野)

Water Resources Engineering (水文循環工学分野)

Socio and Eco Environment Risk Management (自然・社会環境防災計画学分野)

Yoshida Campus

Computational Engineering (計算工学講座)

Geotechnical Engineering Laboratories

Katsura Campus

Geomechanics (地盤力学分野)

Infrastructure Innovation Engineering (社会基盤創造工学分野)

Construction Engineering and Management (土木施工システム工学分野)

Geofront System Engineering (ジオフロントシステム工学分野)

Urban Management Systems (都市基盤システム工学講座)

International Urban Development (国際都市開発分野)

Uji Campus

Geotechnics for Hazard Mitigation (地盤防災工学分野)

Yoshida Campus

Environmental Infrastructure Engineering (社会基盤親和技術論分野)

Planning Laboratories

Katsura Campus

Geoinformatics (空間情報学講座)

Urban and Landscape Design (景観設計学分野)

Planning and Management Systems (計画マネジメント論分野)

Urban and Regional Planning (都市地域計画分野)

Intelligent Transport Systems (交通情報工学分野)

Travel Behavior Analysis (交通行動システム分野)

Uji Campus

Disaster Risk Management (災害リスクマネジメント研究分野)

Integrated Disaster Management Systems (総合防災情報システム分野)

Integrated Disaster Reduction Systems (巨大災害情報システム分野)

Crisis Information Management Systems (危機管理情報システム分野)

APPLIED MECHANICS

Associate Professor **Abbas Khayyer**

Associate Professor **Jun Saito**

Assistant Professor **Tomohiro Tanaka**

Modeling of mechanical behavior and numerical simulation

Safety evaluation of structures from the viewpoint of mechanics is the most important issue at every stage of the infrastructure development. "Comprehensive and reliable modeling of fundamental mechanical behavior" is a key point in applied mechanics and development of a numerical prediction method is necessary in order to explain a measurement of observation or a laboratory experiment, scientifically. Our laboratory studies mechanical theory and its application, and aims to cultivate human resources who can develop studies and pass research achievements to the next generations.

Lagrangian particle methods for multi -physics simulations

The main target is to develop advanced multi-physics multi-scale particle-based computational methods for practical simulation of ocean/coastal engineering problems. The main areas of interest include violent fluid flows, multiphase flows and fluid-structure interactions.

The so-called particle methods or Lagrangian mesh-free methods are appropriate candidates for fluid flow simulations (and their interactions with the environment) in view of their flexibility and potential robustness in dealing with complex moving boundaries. However, since particle methods are relatively new computational techniques there have been several issues corresponding to non-exact momentum/energy conservation, unphysical pressure fluctuations and numerical instability. These issues have almost been resolved by development of accurate schemes for discretization of the constitutive governing equations. The main future/ongoing studies are focused on:

1. further enhancement of accuracy and stability of particle methods by development of further accurate numerical schemes/algorithms
2. further enhancement of the developed multiphase particle-based method by a more meticulous modeling of the governing physics
3. extension of developed particle methods to model hydroelastic fluid-structure interactions (FSI) as well as fluid-porous media interactions (FPI) with rigorous treatment of interface boundary conditions

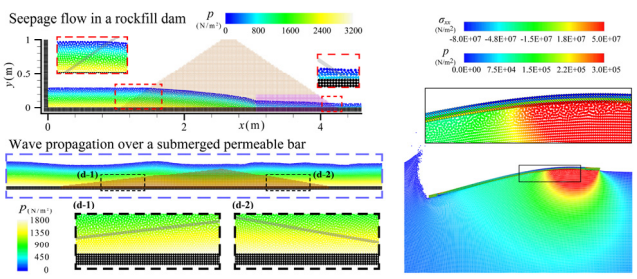


Fig. 1: Multi-physics simulations by particle methods (FPI and FSI) in coastal and ocean engineering

Rigid plastic finite element method for soil structures

Bearing capacity and slope stability problems are often treated as rigid-plastic boundary value problems, because elastic deformation is small and negligible in comparison with plastic deformation. Rigid Plastic Finite Element Method (RPFEM), which is based on limit analysis, is well known as a robust basis to solve such kinds of problems. The aim of this research is to develop the RPFEM by improving of accuracy and considering ground anchors or rock bolts.

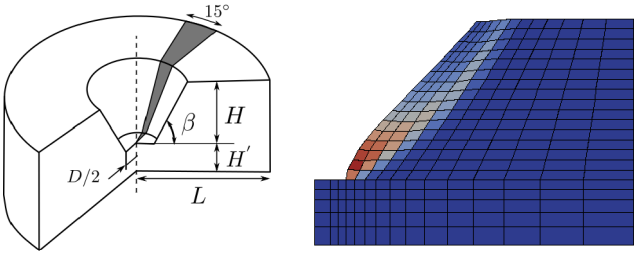


Fig. 2: Stability analysis of excavation

Fast/Stable flood simulation and integrated flood risk assessment

Future river and urban planning need to consider urbanization and future climate change. This research aims at establishing flood risk assessment under various urban and climate change scenarios through developing robust flood frequency models and computationally reasonable flood-inundation models.

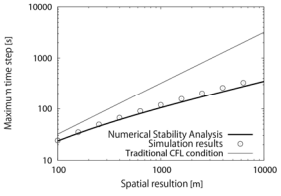


Fig. 3. Numerical stability analysis of the friction as a non-homogeneous term

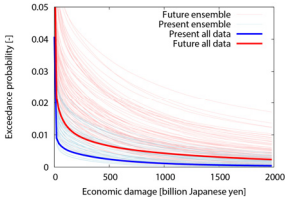


Fig. 4. Ensemble flood risk curves in the present (blue) and future (red) climates

Structural Materials Engineering

Professor
Takashi YAMAMOTO

Strong Beautiful and Durable -Concrete Structures-

In order to keep performance of concrete structures for long years, from molecule structures to civil structures such as deterioration mechanism, evaluation method of deterioration degree, performance of deteriorated concrete structures, mechanism and effectiveness of repair materials are studied in this laboratory.

Deterioration Mechanism

In order to develop more effective and economic maintenance method, it is necessary to make clear deterioration mechanism. And in some cases, chemical analysis or electro chemical measurement are used for making clear the mechanism of deterioration such as reinforcement corrosion and alkali-silica reaction (ASR).
For example, Fig.1 shows the result of Raman spectroscopy of aggregate before and after dissolution test carried out to investigate ASR reactivity of aggregate. As a result, it was observed that background (fluorescence) in low wave-number region decrease after dissolution test. It can be thought that this fluorescence is due to non-bridging SiO_2 (-Si-O・) because of its wave length.

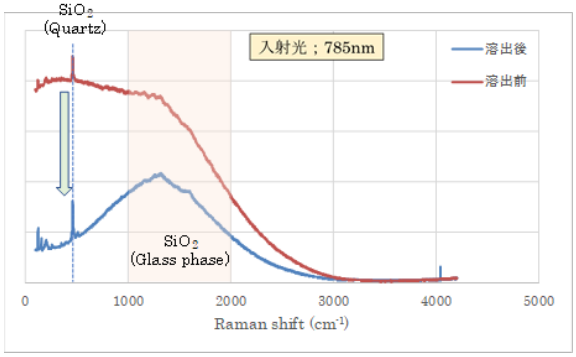


Fig.1 Comparison of Raman spectrum of aggregate before and after dissolution test

Quantitative Evaluation Method

In order to achieve sustainable society, maintenance is essential. However, it is difficult to judge appropriate time of repair or strengthening because quantitative evaluation method of deterioration degree has not been established. Therefore, quantitative evaluation methods based on deterioration mechanism are required.
For example, it has been already confirmed that fluorescence in Raman spectrum of organic coating materials increase as deterioration propagation. And it was also confirmed by IR spectroscopy and quantum chemical calculation that this increase of fluorescence was caused by cutting off of ester bond due to deterioration. The results shows the possibility of quantitative evaluation of deterioration of organic coating materials by fluorescence intensity. In order to make fluorescence intensity quantitative index, normalization with photo breaching curve is suggested in our study. Fig.2 shows change of photo breaching curve of an organic coating material due to deterioration propagation.

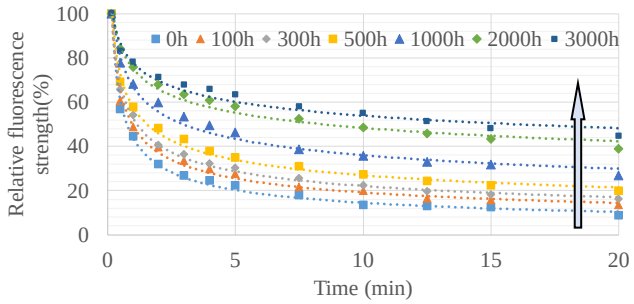


Fig.2 Change of photo breaching curve of an organic coating material due to deterioration propagation

Durability and Scenario Design

Performance-based design approach concerns with the failure probabilities of the structures and/or members in the limited states related to various required performances under the specified loading and/or environmental conditions. Under this topic, various investigations on the concrete structures in the ultimate limited state, serviceability limited state, fatigue limited state and durability limited state are being carried out in order to establish a more advanced and precious design methodology. Fig.3 shows the flexural loading test and FE analysis result of reinforced concrete (RC) beam with the corroded reinforcements.

Fig.3 Flexural loading test and FE analysis result of RC beam with the corroded reinforcements

STRUCTURAL MECHANICS

Professor	Associate Professor	Assistant Professor
Kunitomo SUGIURA	**Yasuo KITANE**	**Yoshinao GOI**

Explore “the MECHANICS” and Bridge “the WORLD”

The keywords for this laboratory are "Earth and Human" looking for developing "beautiful", "rich", "pleasant", "safe", "wholesome" and "energetic" societies. The laboratory pursues Structural Mechanics as related to structural design and analysis of Steel/Composite Structures on the short-, middle- and long-term viewpoints flexibly following the socio-cultural developments leading to the heritage of cultural, social and environmental assets under the general philosophy of sustainable development.

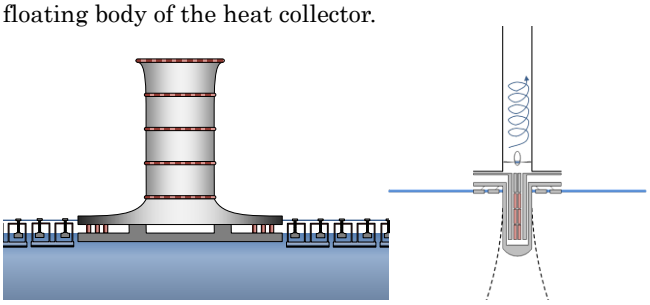
Application of Advanced High Performance Materials to Bridge Structures

Due to the developments of high performance structural materials, it becomes possible to design various forms in structures. In order to achieve such a creative design, specific functions such as a simple and easy-to-manufacture assembling, cost-effectiveness, large load-carrying capacity, high stiffness, high durability are considered in the design of structural elements. Furthermore, various advancements of Steel and Concrete including FRP (Fiber Reinforced Polymers) also have been contributed to the rationalization of structures resulted as Hybrid Structures which satisfy the various demands.

Research focuses on the load carrying and degrading mechanism, the performance evaluation, the rational and life-cycle design of steel, steel-concrete composite and FRP bridges. Fundamental characteristics of these structures are evaluated by advanced loading tests and versatile numerical simulations. In addition, their rational design method, repairing and retrofitting method for aging structures are also developed.

Structural Design of Floating Solar Updraft Tower Power Generator

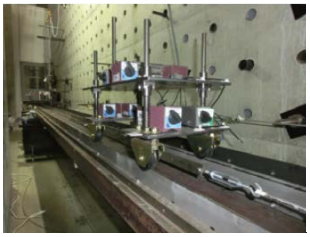
Solar and wind power generators are promising as renewable energy sources, but their power generation efficiencies are susceptible to weather conditions. Then, solar updraft tower generator is focused on as a hybrid type power generator making use of stable solar heat and wind supplies. It consists of vast solar heat collector and chimney tower and ascending air flow due to temperature difference between heated air at the collector and cold air at upper open air turns a turbine. Structural calculations and simulations reveals the structural concept of floating solar updraft tower on vast ocean space is feasible to generate 200 MW by adopting the tower of 1,000 m in height and the heat collector of 7,000 m in diameter. Advancing researches are proceeded for realizing self-weight reduction and long-term durability of the tower structure and of the floating body of the heat collector.



Nondestructive Evaluation of Structural Integrity and Lifetime Assessment

The maintenance technology of the infrastructures is recognized as an urgent issue as many infrastructures built for the rapid economic growth period have been aged, and various damages have been reported. Particularly, as for steel structures, the deterioration causes are corrosion, and fatigue. The development should be made to solve the important problem for sustainability of infrastructure and symbiosis of urban space.

Research focuses on the analytical technique that can cope with the structural change such as corrosion and fatigue crack formation; that is the effective thickness evaluation of the corroded steel members and the fatigue crack extension of steel structures under repeated traffic loading. In addition, nondestructive evaluation of structural integrity, or limited destructive test methodology also have been undergoing; such as solving environmental vibration problems due to traffic-induced vibration of bridge structures; short- & long-term bridge health monitoring (BHM); and developing a novel wireless sensing system, and so on.



Bridge Engineering

Professor
Tomomi Yagi

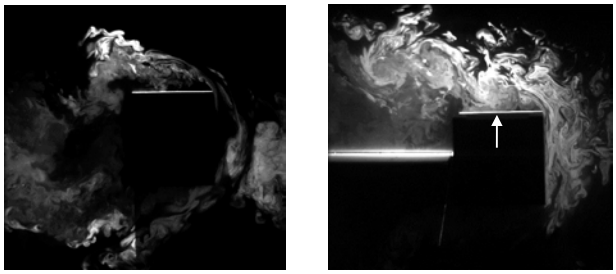
Assistant Professor
Kyohei Noguchi

Bridge Aerodynamics - Mechanics of Structure and Wind -

Under the theme of wind resistance of the structures, the mechanisms of wind-induced vibrations of structures such as bridge decks and cables, and their countermeasures are investigated using wind tunnel tests and/or Computational Fluid Dynamics (CFD). Also, the research areas which cover both the wind engineering and structural engineering, such as the strong wind disaster prevention and the maintenance of structures considering airborne sea salt, are conducted.

Bluff body aerodynamics

It is important to investigate the aerodynamics of fundamental cross sections such as circular and rectangular cylinders for the advance of researches in the aerodynamics of actual bridges. The interactions between the vortex shedding and the motion-induced forces are very complex problem due to their unsteady properties, but they may have vital roles to control the critical wind velocity of various kinds of instabilities.



Flow field around square cylinders

Wind-induced vibration of bridges

When a new bridge is desined and constructed, it is important to investigate aerodynamic stability of the cross section of the bridge in advance. For example, it is well known that the Tacoma Narrows Bridge (USA) collapsed in 1940 for a torsional vibration due to the action of wind. This research group conducts wind tunnel tests to investigate aerodynamic characteristics, vibration fenomena, and countermeasures to stabilize a bridge, by measuring wind force acting on the bridge and its response amplitude. Additionally, a bridge with a characteristic cross section, which has openings at the webs, is focused.

Cross section with openings at the webs

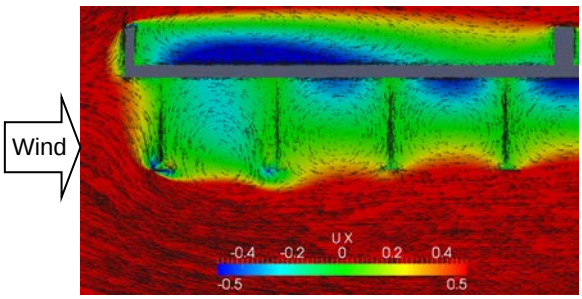
Wind-induced vibration of cables

It is well known that the bridge cables vibrate under wind and rain, which is called the rain-wind induced vibration. The generation mechanisms of this complicated phenomenon are considered as water rivulet on the cable surface, axial flow in the wake and so on. Recently, the vibration under the dry condition, which is called the dry-state galloping, has also been noted. In this research group, the generation mechanisms of these instabilities, development of aerodynamically stable cables, precise response prediction are investigated.

Rain-wind induced vibration

Evaluation of salt amount on bridge

Airborne salt particles, such as sea salt and anti-freezing salt, are transported by wind and adhere to each member of a bridge, which results in deterioration of steel and concrete members. Therefore, it is important to evaluate the amount of salt on each member of a bridge for effective maintenance. This research group seek to estimate the amount of salt adhering to bridge surfaces on the basis of a flow field around the cross section of a bridge. In addition, we also try to develop a method to decrease the salt amount by aerodynamic countermeasures.



Air flow around cross section of bridge

Structural Dynamics

Professor	Associate Professor	Assistant Professor
Yoshikazu Takahashi	**Lin An**	**Keita Uemura**

Earthquake Engineering and Construction Material

The research topics of Structural Dynamics group are centered around various engineering issues related to structural dynamics, earthquake engineering, and design of structural systems for large-scale infrastructures. The area of interest also covers the application of the state-of-the-art dynamic response modification devices, sophisticated high-performance structures. In addition, recently in bridge earthquake engineering, performance evaluation due to environmental action has been important. Therefore, researches on environment-friendly construction materials are conducted.

Earthquake Engineering and Structural Dynamics

The major field of this topic is seismic performance of structures. Especially, the developement of high seismic performance structure, the evaluation of structural control technologies are investigated. Also, the methodology of hybrid simulation of structural systems is another research topic.

Seismic Performance of Infrastructures

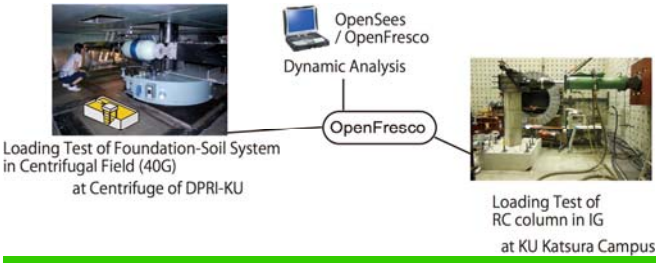
In the past, the seismic design was to design a structure that shall be safe against earthquakes. However, since the 1995 Kobe earthquake, Japan's modern seismic design is to design a structure that shall localize limited damage and to prevent collapse against severe earthquake. In other words, the structure shall be designed to be failed as expected against severe earthquakes. Therefore, we are developing a new seismic structure based on new concepts such as robust structure, unbonded bar reinforced concrete structure (UBRC structure), and metabolic structure.

Since bridge bearings are the boundary condition of the bridge girder, it is necessary that bearings exhibit the performance as designed. Since the 1995 Kobe Earthquake, laminated rubber bearings have been standard bearings for new constructions and seismic retrofit of continuous bridges. However, in the 2011 Tohoku Earthquake and the 2016 Kumamoto Earthquake, fractures of laminated rubber bearings have been reported. In the current bridge earthquake engineering, the bearings are often the key to seismic performance, and we are conducting researches on seismic isolation bearings and structural control devices.

Simultaneous Excitation of 16 RC Piers at E-Defense

Hybrid Simulation for Large Infrastructures

Hybrid simulation is an exprimental technique to evaluate the dynamic response of structural systems connecting physical experiments and numerical simulation. Middleware for hybrid simulation , OpenFresco, is proposed. OpenFresco supports to conduct geographically distributed hybrid simulation with any FE solvers.



Construction Materials of Infrastructures

The major fields of this topic are new construction materials and performance evaluation due to environmental action.

Environment-friendly and User-friendly Geopolymer Concrete

Aiming at to reduce the environmental impact of construction, and to use the enormous amount of industrial by-products and waste, Geopolymer which is made up of aluminosilicate materials with three-dimensional amorphous microstructure shows a promising trend on replacement of Portland cement. The synthesis of user-friendly Geopolymer concrete and its application is of our research interest in recent years.

Long-term Performance of Bridge Bearings

Steel bearings were widely used in railway and highway bridges, but due to severe environmental conditions, they are deteriorated and sometimes causes serious problem of superstructures. Experimental tests of 40-years old bearings of Shinkansen bridges are conducted to evaluate the movement following performance and the potential deterioration factors.

Int. Management of Civil Infrastructure

Associate Professor
Sunmin KIM

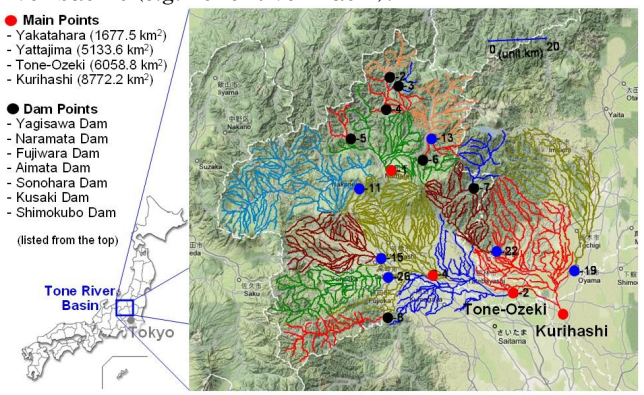
Jr. Associate Professor
Kai-Chun CHANG

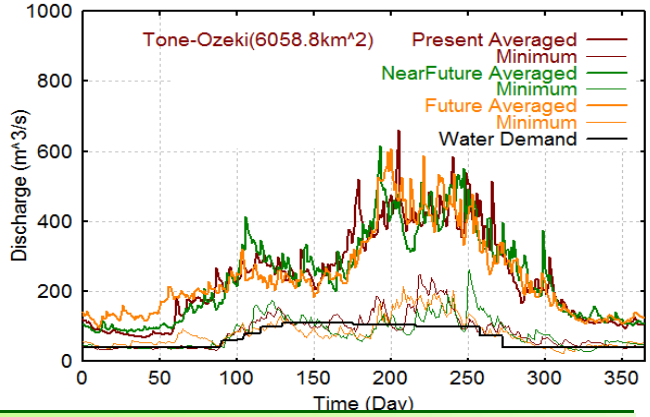
Climate Change Impact Analysis on Hydrologic System, And Health Monitoring of Bridge using Vehicle Vibrations

Researches in International Management of Civil Infrastructure Lab aim to answer questions related to designing and managing of civil infrastructure. The research topics in this interdisciplinary laboratory are composed of two subjects; climate change impact analysis on hydrologic system and health monitoring of bridge using traffic-induced vibrations.

Climate Change Impacts on Water Resources and Flood Risk

Based on Global Climate Model (GCM) output for the future climate projection, changes in heavy rainfall frequency and water resources conditions are analyzed to solve and prevent any water related problems in major river basins (e.g. Tone River Basin).



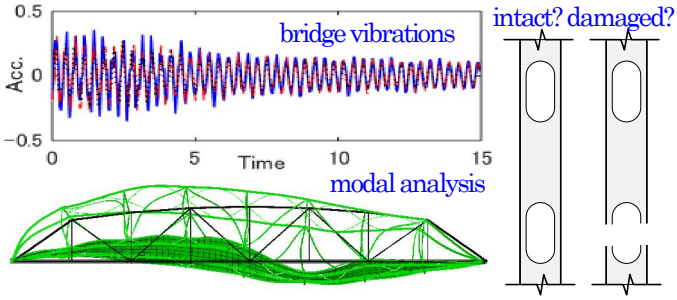


Realtime Flood Forecasting with Weather Radar Observation

Weather radar observation data is utilized into a distributed hydrologic model for a short-term rainfall forecasting as well as flood forecasting, and non-structural countermeasures are investigated to decrease the floods risk.

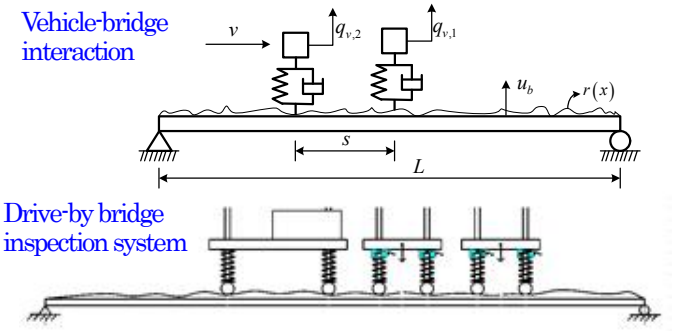
Bridge Modal Analysis & Damage Detection using Traffic-Induced Vibrations

Bridge damage detection has become an important research and engineering issue in facing the pressing problems of aging bridges. Our study focuses on detecting potential damage in short- and medium-span bridges using their daily traffic induced vibrations. Effective indicators are extensively investigated, including modal parameters, time-series coefficients, spectral functions and their derivatives.



Vehicle-bridge Interaction & Its Applications

Vehicle-bridge interaction is the interaction behavior between a bridge structure and vehicles moving on the bridge, which is broadly considered in bridge engineering, seismic design, health monitoring, etc. Our study focuses on its mechanical interpretation and innovative application to bridge dynamic analysis, drive-by inspection, and more.



STRUCTURES MANAGEMENT ENGINEERING

Professor (Concurrent) Yoshikazu TAKAHASHI

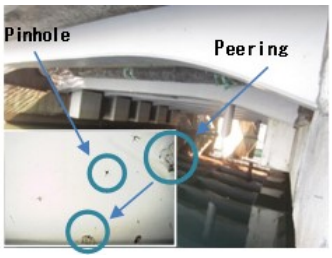
Assistant Professor Satoshi TAKAYA

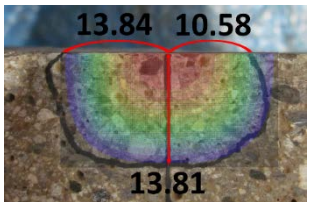
Development of New Structures Management

It is important to maintain performances and functions of our infrastructures to achieve their long service life and to reduce negative environmental impact in order to establish our social sustainability. In this laboratory, with focusing on high performance materials and/or recycled materials as well as concrete, steel and other traditional materials combined together effectively, we are developing rational design, durable service life, strategic maintenance and management under low negative environmental impact.

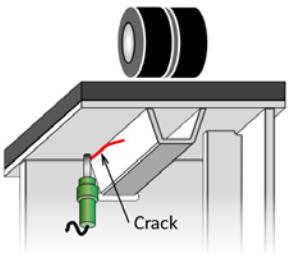
Mechanical behaviors, environmental impact and durability of structural materials

Mechanical behaviors, environmental impact and durability of high performance materials, recycled materials as well as traditional materials are investigated and evaluated.

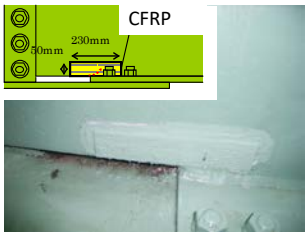




3D analysis of chloride invasion into concrete through defects of surface coating



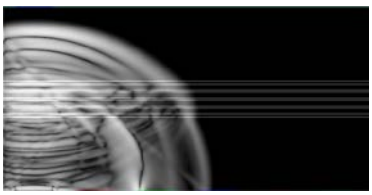
Proactive peening treatment to prevent fatigue failure



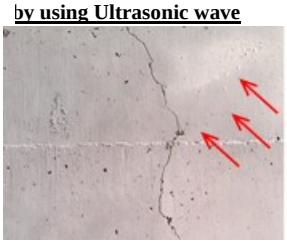
Cover plate bonding of steel or carbon fiber for repair of cracked steel member

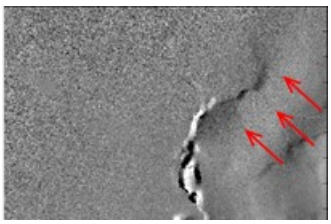
Inspection and deterioration prediction of existing infrastructures

Inspection methods for existing infrastructures to know their performances conditions and deterioration prediction system are developed.



NDT technique for checking health condition of infrastructures by using Ultrasonic wave

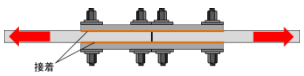




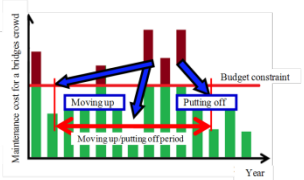
Optical imaging of surface acoustic wave to detect defects of concrete and steel

Maintenance management of infrastructures

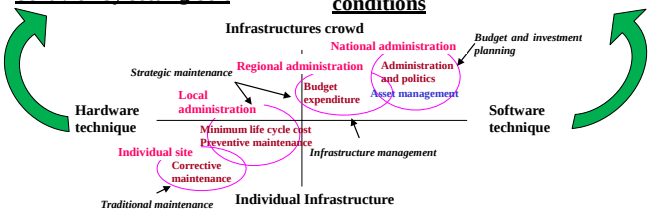
In order to maintain infrastructures efficiently, hardware related techniques and software oriented techniques such as strategic maintenance planning are connectedly developed.



Improvement of long-term behavior by setting bolt



Levelization of annual maintenance cost for infrastructures in local government with sustaining their service conditions



Systematic maintenance management techniques for infrastructures with hardware and software approaches combined

Earthquake and Lifeline Engineering

Professor **Junji KIYONO**

Associate Professor **Aiko FURUKAWA**

Toward Effective Earthquake Disaster Mitigation Measures

Earthquakes cause damage to our built environment and disrupt out social systems. Infrastructure, such as water, gas, electricity, communications and transportation systems are not independent but rather complexly interact with each other. Therefore, even if only a part of the infrastructure is damaged, the urban community can sustain serious damage and functional disruption. Our laboratory covers a broad field, from the estimation of strong ground motion in the near fault zone, to the investigations of the mechanisms of structural damage, human injury and organizational disruption. Our goal is effective earthquake risk reduction, accomplished via analysis of the earthquake loss chain of causation, and development of effective mitigation measures for each link in that chain.

Evaluation of Ground Vibration Characteristics by Microtremor Observation

Earthquake damage is influenced by the vibration characteristics of the surface ground, which is dependent on the sediment conditions such as sediment thickness and soil profiles. Understanding the surface ground characteristics is very important form the point of view of the earthquake disaster mitigation. The microtremor observation is a promising tool to understand the surface ground in the non-destructive manner. We are developing the evaluation method of surface ground characteristics though the microtremor observation, and investigating the effect of ground vibration characteristics on the earthquake damage by the on-site microtremor observation after the earthquakes.

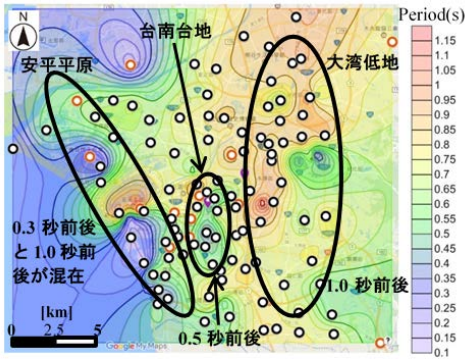


Fig. 1 : Predominant natural period distribution in Tainan city evaluated by microtremor observation

Analysis of Failure Phenomena of Masonry Buildings during Earthquakes

It has been reported that catastrophic earthquakes account for 60% of worldwide casualties associated with natural disasters. In most large-scale earthquake disasters, the principal cause of death is the collapse of buildings, and this has accounted for about 75% of earthquake fatalities over the last century. In addition, a large number of victims have died because of the collapse of masonry buildings. Therefore, it is necessary to improve the earthquake resistance of these primarily weak structures to reduce the number of casualties. With this background, a new numerical analysis method that enables the simulation of a series of seismic behaviors—from elastic to failure to collapse behaviors—is developed in order to clarify how the failure begins and proceeds, how the structures collapse, and how earthquake resistance can be improved effectively.

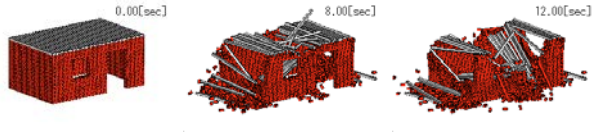


Fig. 2 : Failure process of masonry structures

Analysis of Behavior of Vehicles running on Highway during Earthquakes

Safety of vehicles running on highways during earthquakes is very important, especially in the urban areas in anticipating the great earthquake along the Nankai Trough in the near future. Considering the role of highways in the emergency response, preliminary measures to minimize accidents is essential. With this background, we are developing the running vehicle model considering the effect of earthquakes, and analyzing the behaviors of vehicles during earthquakes.

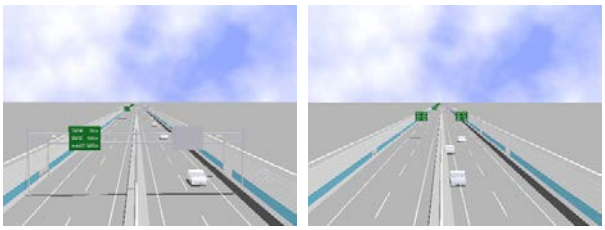


Fig.3: Behavior of vehicles running on highway during earthquake

Dynamics of Foundation Structures

Professor
Sumio SAWADA

Associate Professor
Hiroyuki GOTO

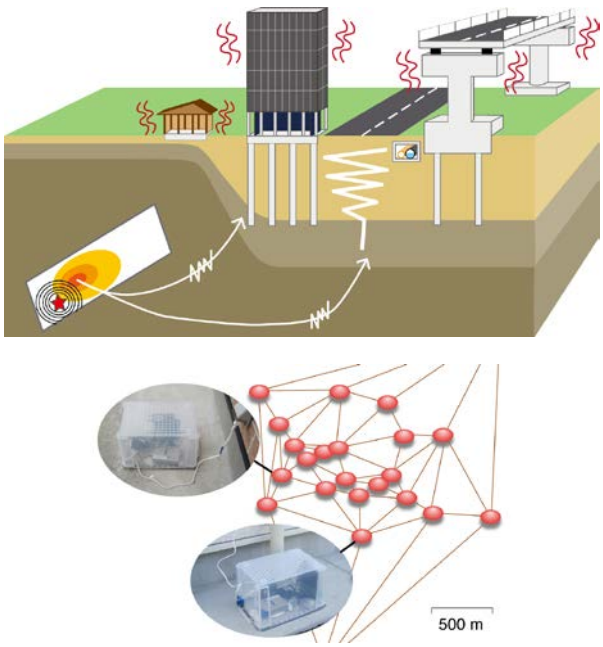
Innovation in Earthquake Engineering
– theoretical investigation & new generation devices –

Widespread knowledge on engineering and related fields is required for earthquake disaster mitigations. Our research activities aim to (1) investigate theories and methodologies related to the earthquake disaster mechanism: seismic wave generations, nonlinear soil structure response, and nonlinear dynamic response of structure systems, and to (2) develop new generation devices for rational seismic design.

Theoretical investigation of earthquake disaster mechanism

In order to understand the physical mechanism on earthquake disasters, we must consider a sequence from the generation of seismic waves to the dynamic response of civil engineering structures. We research the theory of earthquake ground motions, dynamic response of surface soil, structure foundations, and structures.

- High-performance computations of earthquake fault rupture and seismic wave propagations.
- Super-dense seismic array observations identifying the difference of ground motion amplifications.
- Innovative methods to explore underground structure based on advanced physics and mathematics.
- Dynamic response of soil embankment considering new significant failure patterns.



Super-dense seismic array observation in Furukawa area.

New generation devices and structures and

Levels of seismic load increases after experiences of earthquake disasters, especially after the 1995 Kobe earthquake disasters in Japan. In order to satisfy the structure performance under such a large ground motion, more capacity is required for the structures. Our concept to deal with the requirement is to develop new types of devices and structure systems, which do not require much additional cost in introducing.

- New device to prevent a liquid sloshing behavior on oil storages.
- High-capacity structure piers composite friction-based devices.

(a) New device preventing a liquid sloshing behavior.

(b) Dynamic experiments of high-capacity structure piers.

Urban Flood Control

Professor
Akira IGARASHI

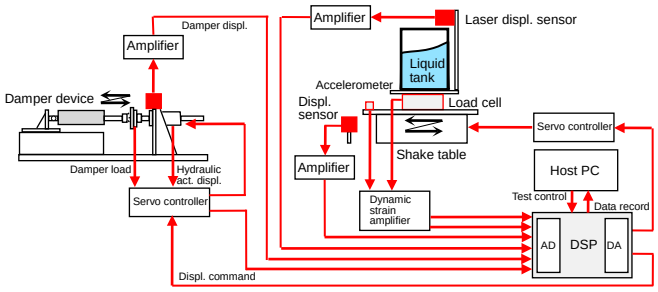
Associate Professor
Nozomu YONEYAMA

Mitigation of Compound / Secondary Urban Disasters Associated with Flood, Earthquake and Tsunami

Urban areas developed in basal zones along the coasts and on the river basin are incessantly exposed to natural hazards. Various compound and secondary disaster can take place in a scale which has not been experienced in the past, if earthquakes, tsunami and flood successively hit an urban area with such a feature. Toward the aim of establishing engineering solutions for mitigation of various disasters in urban areas, the research topics include the analysis, experimental evaluation of dynamic phenomena of coupled systems consisting of structures, fluids or the combination of those, as well as design/assessment/maintenance of infrastructures.

Experimental Validation of Coupled Systems using Real-Time Hybrid Simulation

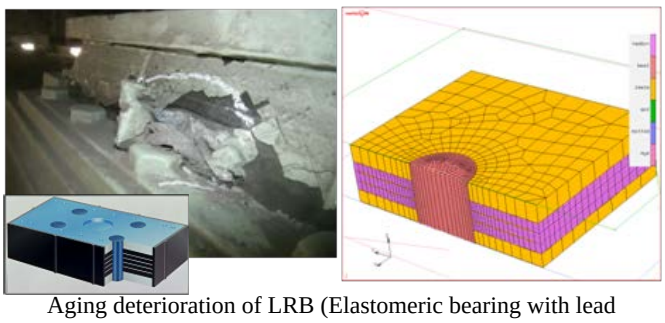
Implementation of advanced experimental systems based on the real-time hybrid simulation is investigated. In this unified testing-computing dynamic simulation, response calculation of the numerical substructure with computers and dynamic loading test of elements using shake tables or dynamic actuators, are synchronously executed on a real-time basis, allowing reliable validation of complicated coupled systems consisting of fluid, structures and mechanical devices.



Hybrid simulation of fluid-structure-device system

Aging Deterioration & Maintenance Measures for Elastomeric Bearings

In infrastructures served for long periods, deterioration of components and facilities due to aging, countermeasures and maintenance issues are of great concern. Aging effect on elastomeric bearings for bridges are investigated by experimental and numerical approach.



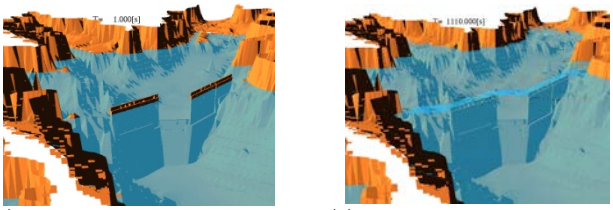
Aging deterioration of LRB (Elastomeric bearing with lead plugs) and numerical analysis

Research Related to the Damage Caused by Large Tsunami Events

Since the 2011 Tohoku Tsunami, forecasting and damage prediction of future tsunami events has become critical. Recently, tsunami inundation behavior, the effects of breakwaters on tsunami mitigation, and the forces of tsunami waves acting on bridges are all under investigation.

Effect of breakwaters on tsunami mitigation

A 3D numerical analysis was conducted to determine the mitigative effect for the 2011 Tohoku Tsunami event for locations along the coast of Kamaishi Bay due to the tsunami breakwater.

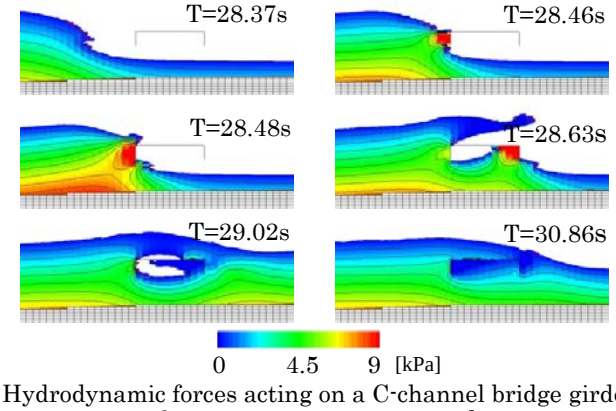


(a) Before tsunami attack (b) Time of tsunami attack

Simulation of tsunami attack in Kamaishi Bay

Assessment of tsunami wave forces acting on bridges

Bridges are important infrastructure, particularly following disasters so that transport operations can run smoothly to provide necessary assistance. Thus, we are investigating the strong tsunami wave forces acting on bridges to help provide guidelines for future construction.



Hydrodynamic forces acting on a C-channel bridge girder due to a tsunami wave attack

Environmental Hydrodynamics

Professor	Associate Professor	Assistant Professor
Keiichi Toda	**Michio Sanjou**	**Takaaki Okamoto**

Environmental Fluid Mechanics using Innovative Accurate Measurement Systems

It is quite necessary in Hydraulic Engineering to investigate hydrodynamic characteristics in open-channel flows with various boundary conditions for water-related natural disaster problems, river environment and aquatic eco-systems. In particular, it is very important to reveal turbulence dynamics in such free-surface flows, because turbulence motions have great influences on momentum and sediment transport in rivers as well as gas-transfer at the free-surface region.

Environmental Fluid Mechanics

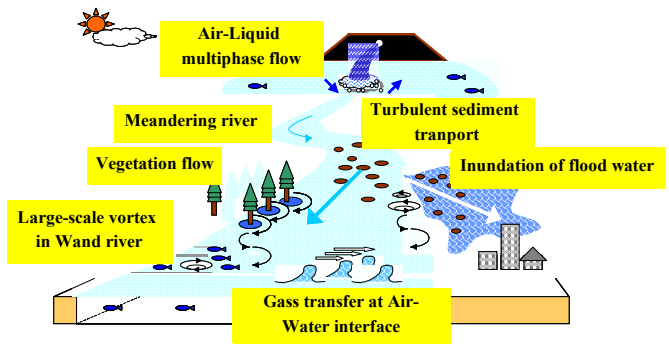


Fig. 1 : Hydrodynamics in actual river.

- **Flood disaster and water-related accident**
  We study the hydrodynamic force exerted on the human body in flood water experimentally, using small-scale human body model (Fig.2). We also study the underground inundation in urban area and the evacuation problems when it occurs.

- **Turbulence Interaction between Air and Water at Free Surface**
  We study the air-water interfacial turbulence and scalar transfer phenomena across the interface in wind-induced open-channel flows. The goal of the study is to clarify the air-water turbulent phenomena and to evaluate the turbulent scalar transport with good accuracy by means of experimental approaches and the proposed numerical procedure.

- **Interaction between flow resistance and aquatic plant motion**
  In actual rivers, many aquatic plants are often observed and they have significance effects on hydrodynamic properties. The study of its interaction with flow environment is important for the determination of the discharge capacity and ecological condition of the water. We examine the interaction between turbulence structure and coherent waving motion in submerged canopy flows with flexible plant models by a combination of PIV and PTV (Fig.3).

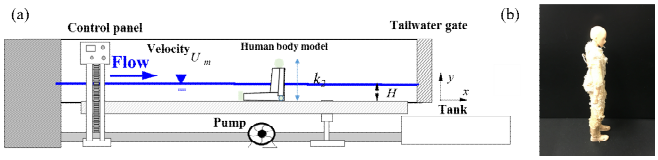


Fig. 2 : Drag force measurement of human body model in flowing water

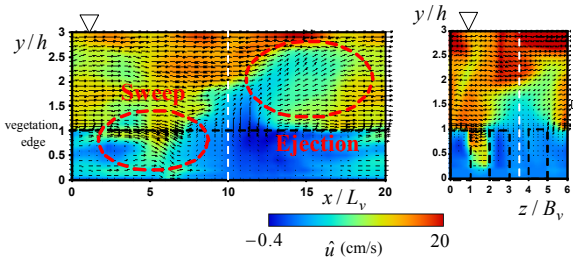


Fig. 3 : 3-D flow structure of vegetation flow

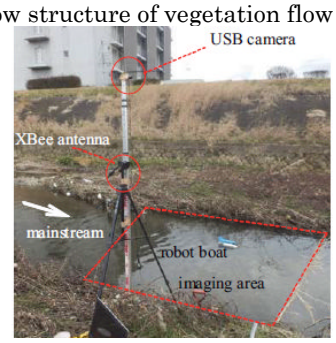


Fig. 4 : Field test of robot system

- **Development of autonomous robot for automated measurement in rivers**
  We developed autonomous boat-type robot to measure automatically mean velocity in natural rivers. Camera tracking system and PID control method make the robot remain the position against main stream, and then mean velocity was evaluated reasonably by a duty-ratio of screw propeller motor-properties(Fig.4).

Hydrology and Water Resources Research

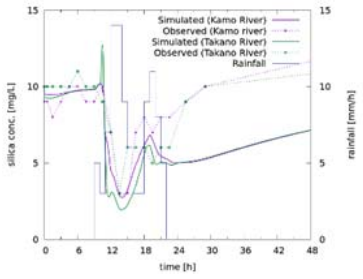
Professor	Associate Professor	Junior Associate Professor
Yasuto TACHIKAWA	**Yutaka ICHIKAWA**	**Kazuaki YOROZU**

Towards a better relationship between human society and water resources

We study physical mechanisms of the hydrologic cycle with energy and material transport. The research topics include analysis and numerical modeling of hydrological processes such as surface-subsurface flow, atmosphere-land surface interaction with human activities. Based on the understanding of the physical process in hydrology, we develop fundamental technologies for river planning, water resources management, real-time hydrologic forecasting and water-related disaster mitigation.

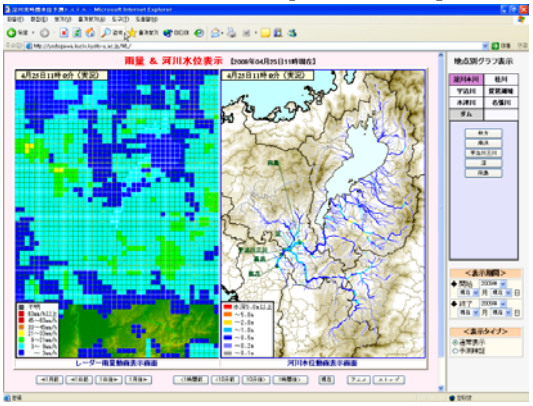
Analyzing and modeling hydrological processes

Understanding hydrological processes is essential for designing and implementing river basin management. We analyze hydrological processes and develop hydrological models. The below photo and figure show measurement and simulations of dissolved silica concentration in the Kamo River, respectively. We utilize water quality information to capture river basin water dynamics.



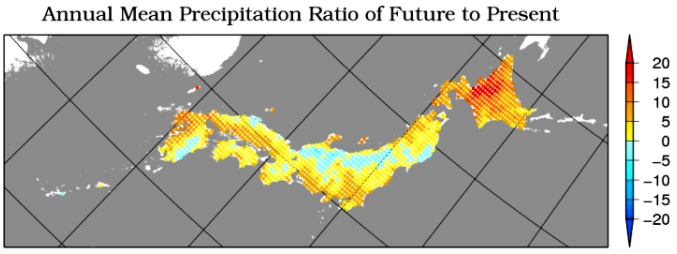
Fundamental technologies for river planning and real-time hydrologic forecasting

Based on the sound understanding of the hydrological cycle, we develop fundamental technologies for river planning and real-time hydrologic forecasting. Research topics include: Development of a hydrological modeling system: Development of a real-time flood forecasting system: A real-time hydrological prediction system which incorporates data assimilation techniques is developed.



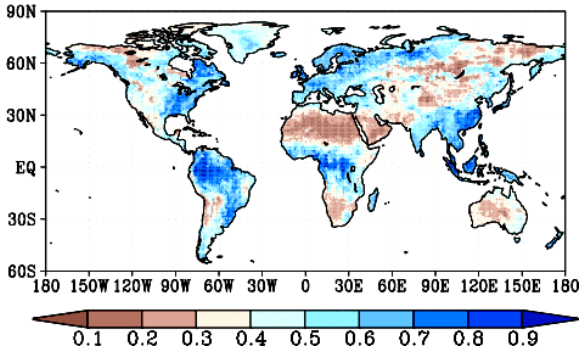
Climate change impacts on water resources

Climate change will give us a serious impact on our life. We develop a method to diagnose hotspots of river discharge change, a down-scaling method of GCM outputs for local scale water resources analysis, and a bias correction method of GCM output for proper river discharge projections. Then we analyze a change of future hydrological cycle to examine the impact on water resources and to detect the changes of frequencies and magnitudes of water-related disasters.



Land surface modeling for global water resources analysis

The hydrological cycle is the central focus of hydrology. Atmosphere-land surface interaction plays a dominant role on the hydrological cycle. We develop a land surface model including agricultural human activities. Using the developed land surface model, spatiotemporal changes of hydrologic variables are globally analyzed.



U r b a n C o a s t D e s i g n

Professor	Associate Professor	Assistant Professor	Assistant Professor
Hitoshi Gotoh	**Eiji Harada**	**Hiroyuki Ikari**	**Yuma Shimizu**

Simulation engineering by Lagrangian particle method

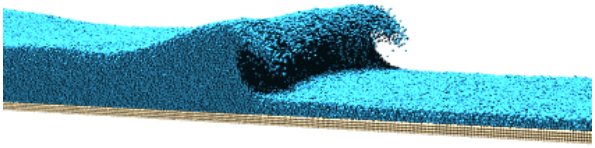
A leading technology in computational science of fluid flow (solid-gas-liquid multiphase flow) by using particle method is developed for dynamics of violent flow. We aim for establishment of the methodology of computational science and engineering, to describe various phenomena in civil engineering by fluid/granular-material analogy. For the details, access to: http://particle.kuciv.kyoto-u.ac.jp/

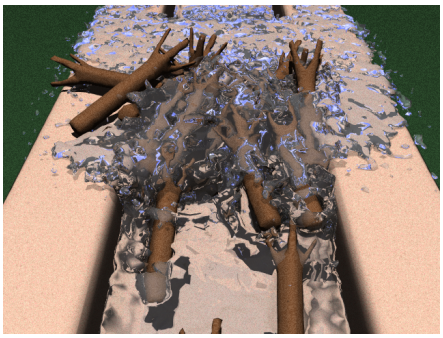
Particle Method for Computational Dynamics of Free-Surface Flows

In a particle method, or Lagrangian meshfree method, particles as calculating points are moved by interaction between neighboring particles. It enables to track a complicated surface change including fragmentation and coalescence of fluid, which is difficult to simulate in an Eulerian method using a computational grid. We conduct a research on both of a fundamental theory and a practical application of particle method for violent flows in coastal surf zone and mountain streams.

In our laboratory, a numerical wave flume based on a particle method has been developed to estimate a wave force or wave overtopping discharge for design of coastal structure. Development of 3D simulation tool using parallel computing (PC-Cluster and GPU) and fluid-elastoplastic hybrid analysis has also been conducted. Below figures show a plunging breaking wave and flooding in a girder bridge across a mountain stream due to drift woods.

Our laboratory proposed some accurate particle methods (CISPH-HS, CMPS-HS etc.) to improve drawbacks of particle method such as incompleteness of momentum conservation and pressure fluctuation. The accurate methods are known widely in CFD research field and some of our papers are ranked in highly cited papers lists of ISI journals.



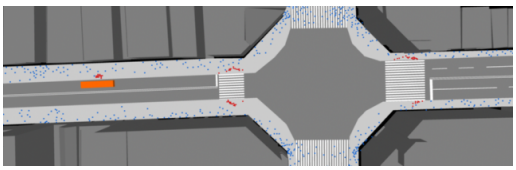


Computational Sediment Hydraulics by Multiphase Flow Model

Understanding of the dynamics of the movable bed is indispensable for both river and coastal engineering. In our laboratory, to address phenomena regarding the movable bed from computational point of view, numerical model of both solid-liquid two-phase flow and granular assembly has been developed. The numerical simulation for sediment transport under various flow conditions has been performed.

Crowd Behavior by Particle-Based Multi-Agent Simulation Model

Multi-agent simulation with directly handling personal behavior has been developed by using the Distinct Element Method. Evacuation simulation against Tsunami is promising tool in establishing evacuation planning. Moreover, the crowd behavior simulation in the urban pedestrian space is expected to contribute advanced urban design. Below is the computational example for the pedestrian behavior in case of the construction of a wide pavement in the Shijo St., Kyoto.



River System Engineering and Management

Professor
Takashi HOSODA

Associate Professor
Shinichiro ONDA

Toward Development of Diverse Capabilities of People and Nature in River Basins

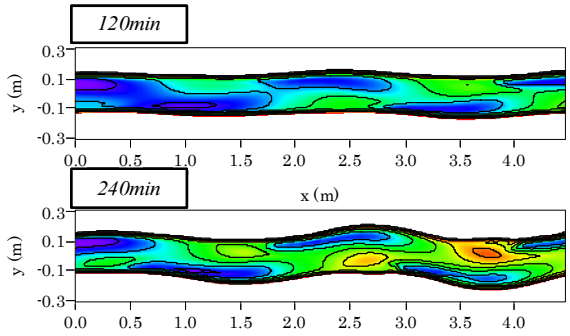
It is necessary to consider complicated interaction system between natural forces, natural environment and socio-economic activities caused by human-beings to resolve various problems on water in river basins and cities. Toward development of diverse capabilities of people and nature, we are studying the fundamental subjects on water flows and bed deformation in rivers and its applications, based on hydraulics, river engineering and geo-water system engineering and management.

Development of Numerical Model of River Flows and Bed Deformation

It is of great importance to develop a numerical model of river flows and sediment transport, to predict water stage during floods and river bed deformation and to design a stable channel as well as ecological issues. We have been developing various kinds of computational models for a prediction method.

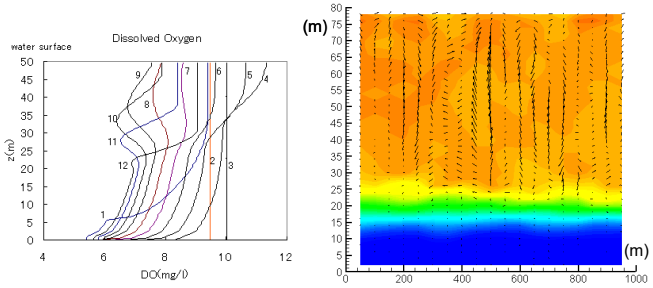
Various sand waves are formed at a river bed in response to hydraulic conditions, and flow resistance changes with development or attenuation of sand waves. The experiments are carried out, to examine a formation process of sand waves, and antidunes in which water surface is in phase with bed surface are observed in the following photo.

This figure shows the simulated results on the initiation of river channel meandering caused by the generation of alternative bars and flow meandering with bank erosion.



Numerical Simulation of Water Environmental Problems

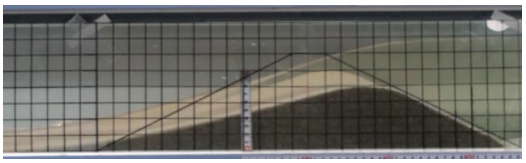
An eco-hydrodynamic model for a lake and an enclosed water basin has been developed to predict future change of situation and to assess the effect of the global warming. Left figure shows the seasonal variations of vertical distributions of dissolved oxygen in the north part of Lake Biwa. We are studying fundamental mechanism of seasonal variation of water quality by using an eco-hydrodynamic model.



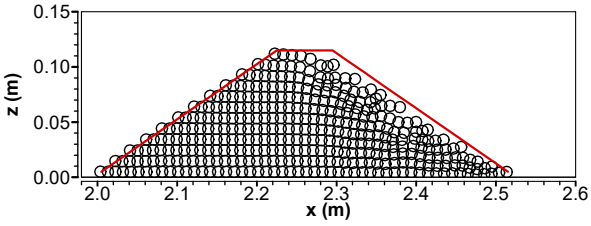
Numerical Model of Embankment Failures due to Overtopping and Seepage Flows

Embankment failures are recently occurred during floods, and the mechanism is explained by the surface erosion of embankment due to overtopping flows and soil deformation with reduction of effective stresses due to seepage flows. In our laboratory, we are developing a numerical model to predict an embankment failure process due to overtopping and seepage flows, by coupling a three-dimensional flow model and a bed deformation model.

To investigate a dike failure process, a hydraulic experiment is conducted and the dike erosion due to overtopping flows is observed in the following photo.



This figure shows the soil deformation due to seepage flows and the red solid line presents the initial shape of embankment. The soil deformation on the back side is simulated well by the proposed numerical model.



EROSION AND SEDIMENT RUNOFF CONTROL ENGINEERING

Professor	Associate Professor	Assistant Professor
Masaharu Fujita	**Hiroshi Takebayashi**	**Syusuke Miyata**

United research to create sound sediment environment in river basin

In a sediment transport system from mountainous area to coastal area, disasters occur due to the various kinds of sediment transport phenomena. These sediment transport phenomena triggered by natural causes as well as by human activities also impact on ecosystem within the sediment transport system. To mitigate the disasters and to understand the dynamics of sediment transport and water – sediment – ecosystem structure in the sediment transport system, various field observations, hydraulic experiments, and development of simulation models are carried out in our division.

Research on Sediment Disaster Prevention

Landslides, debris flow, channel deformation and so on cause sediment disasters. Sediment disaster prevention is one of the important social topics. This laboratory researches on the generation mechanism, prediction technics, up-grading of sediment hazard maps and so on. Recently, characteristics of ground water flow in mountainous slopes which information can be used to predict the sediment disasters. Figure 1 shows the results of numerical analysis of landslides geometry and vertical distribution of ground water.

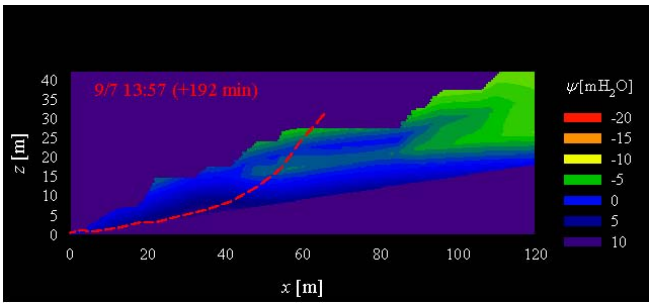


Fig. 1 : Land-slides geometry and vertical distribution of ground water.

Research on Sediment Resources Management

Sediment is produced in mountainous areas and is transported to coastal area through rivers. These processes are important factor to produce sound basin environment.

Sediment production mechanism and sediment transport process are researched by use of field observation, flume tests, and numerical analysis. Furthermore, new river regulation works to control sediment transport rate, bed deformation analysis model to reproduce habitats for plants and animals, and so on are developed. Figure 2 shows the field observation of both sediment production rate and meteorological conditions.

Fig. 2 : Field observation of both sediment production rate and meteorological conditions

Research on System Among Water, Sediment, And Natural Life Forms

Spatio-temporal change characteristics of bed and channel geometry is important facture to clarify the structure of habitats for plants and animals and have been researched focusing on sediment hydraulics. Figure 3 shows the sand bars formed in experimental flumes.

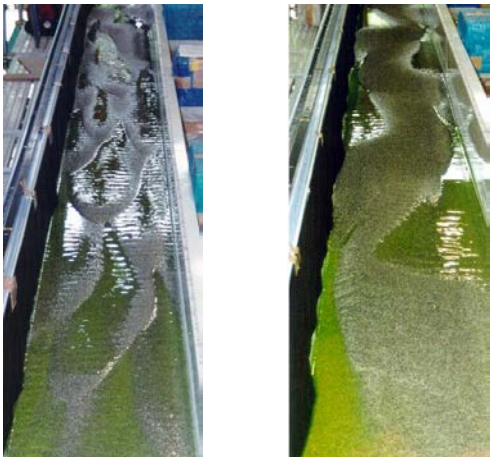


Fig. 3 : Sand bars

Hydroscience and Hydraulic Engineering

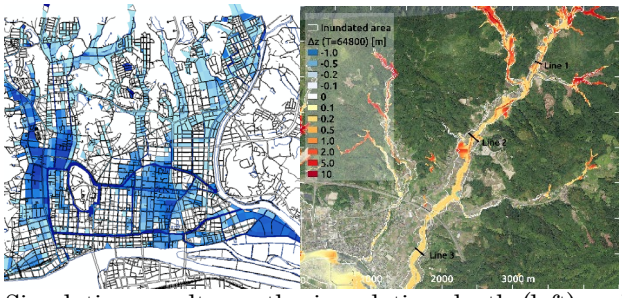
Professor	Associate Professor	Assistant Professor
Hajime NAKAGAWA	**Kenji KAWAIKE**	**Kazuki YAMANOI**

Approach to hydraulic aspects of water-related disasters and water environment through hydraulic experiments, field observations and numerical simulations

For prevention of water-related disasters and entrainment of water environment, it is important to understand its hydraulic aspects. In our laboratory we approach to its hydraulic aspects through hydraulic experiments, field observations and numerical simulations. Our specific research is experiments using flumes of large-scale facilities in the Ujigawa Open Laboratory.

Mechanism and Mitigation Strategies of Flood and Sediment Disasters

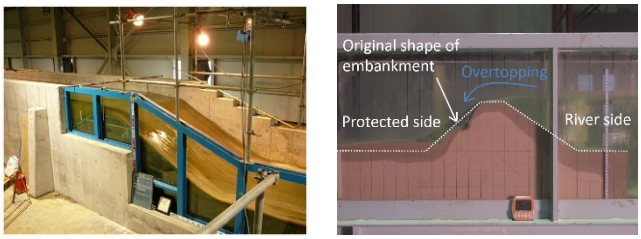
In our laboratory, to enhance hydraulic understandings of flood and sediment disasters, we have been trying to obtain data from observations and field survey. Also, we have been trying to develop more accurate numerical models to predict those phenomena of disasters using the data obtained. Those models would enable us to get significant information to evaluate the effect of flood prevention/ mitigation measures such as evacuation systems. Furthermore, sediment produced by landslides during huge rainfall event cause topographical variation and increase the flood risk. We are trying to develop the simulation method of such series of phenomena, and applying to the disaster prediction and risk evaluation.



Simulation results on the inundation depth (left) and topological deformation (right).

Strength Evaluation and Maintenance Method of River Embankment

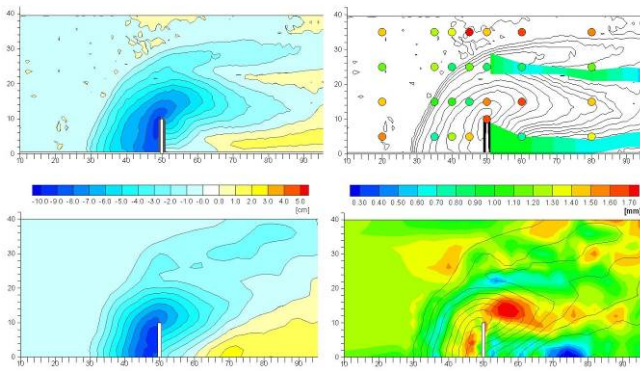
Recently, extreme floods frequently cause dyke breaches in rivers managed by central or local governments. As an urgent requirement, river dykes should be strengthened all over the country. We study the mechanisms of river dyke breach due to flood water overflow by carrying out model experiments. Based on obtained results, numerical simulations of dyke breach are tried to reproduce the experimental results. Furthermore, we also have been studying problem of landslide dam and its collapse, which may bring severe damage to downstream area, by the similar method as river dyke breach.



Experimental flumes for the river dyke breach (left) and landslide dam (right) in Ujigawa Open Laboratory

Nature-friendly River Design by Harmonizing with Ecology

River restoration projects have been tried in many places to create recreation spaces for local residents. As an example, 'groin' is installed perpendicular to the river dyke to form sand bar around it. But we should clarify its formation mechanism and sediment response to those groins. Therefore we have been carrying out flume experiments and numerical simulations, obtaining some knowledge of sand bar formation by means of groins.



Variations of bed topography (left) and particle size of bed material (right); experiment (above) simulation (below).

Hydrometeorological Disasters Engineering

Professor
Eiichi NAKAKITA

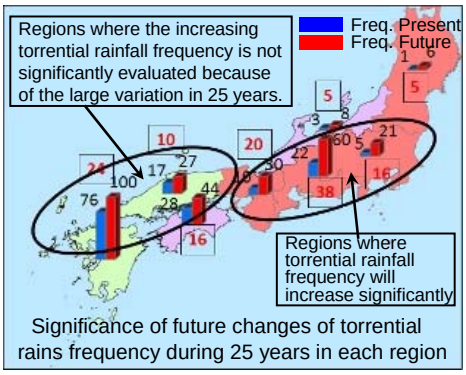
Associate Professor
Kosei YAMAGUCHI

Revealing the water behavior linking among atmosphere, geo-sphere and human-sphere toward heavy rainfall disaster prevention

Hydro-meteorological investigations and researches on various scales of rainfall events from the localized heavy rainfall and the global climate change are being carried out focusing on the rainfall forecasting by remote sensing information, the global warming impact assessment. And we are challenging researches on the human life style related with flood disasters and water utilizations.

Global climate change impact assessment

We analyze characteristics of the abnormal rainfall 30 and 100 years later by using of combination of global climate models (GCM) and regional climate mpodel (RCM) and we try to assess its impact on the human society. For example, we evaluate the frequency variation of the torrential rain occurrence in each region, and we propose the adaptable rule of dam operation to the seasonal variation of rainfall runoff predicted in the future.



Significance of future changes of torrential rains frequency during 25 years in each region

Field observation to understand initiation and development of convective storm

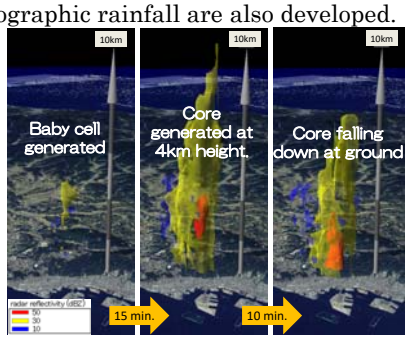
Multi-sensors observation toward the understanding of storm-genesis and its development is carried out at Keihanshin region and Okinawa. We have identified the structure of pairs of positive/negative vertical vortex tubes at the storm-genesis, and discovered a developing storm possesses a hierarchical structure of the vertical vortex tubes in a sense of spatial scale. In addition, the videosonde observation that measures precipitation particles is carried out to utilize particle information for heavy rainfall disaster prevention.

Multi-sensors observation at Keihanshin

Development of short period rainfall prediction method by RADAR information

The latest weather radar can detect raindrop size distribution and hydrometeor classification. New methods of quantitative precipitation estimation and forecast using the radar information based on in-situ campaign observation are being developed as fundamental researches. It is found that the baby cell of torrential localized downpour can be detected earlier in the upper atmosphere as applied researches. Data assimilation method of the radar and forecast method of orographic rainfall are also developed.

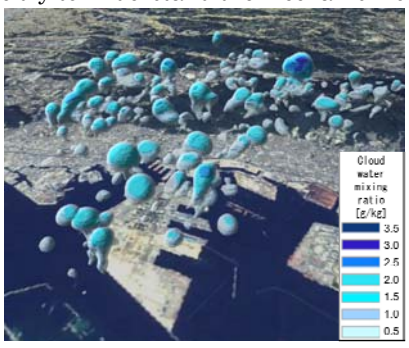
Flash flood at Toga river.



3D radar analysis generated at Rokko

Urban meteorological simulation based on LES for understanding convection genesis

Localized torrential rainfall disasters is caused by single or multi isolated cumulonimbus clouds that grow rapidly within one hour. A trigger of the generating baby-cell is concerned to be much affected by urban area, the heat-island effects. We try to understand the mechanism of the generation by developing our urban meteorological model based on Large Eddy Simulation (LES). We aim to improve the prediction accuracy and suggestion on what we should monitor in real time.



Simulated cumulous clouds over Kobe city

Coastal Disaster Prevention Engineering

Professor **Nobuhito MORI**
Associate Professor **Tomoya SHIMURA**
Assistant Professor **Takuya MIYASHITA**

Reduction of Coastal Disaster Risk

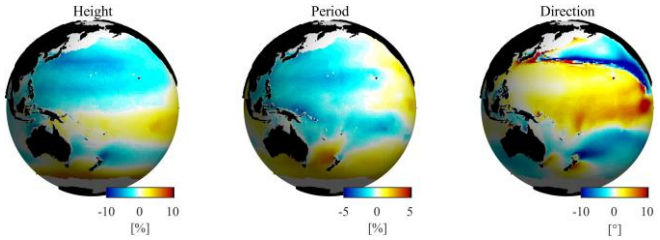
Modeling and Long-Term Assessment of Coastal Disaster Risk

Climate change will change extreme coastal hazard intensity and frequency, and integrated study of engineering and science is required for future projections, impact assessment and adaptation. On the other hand, the 2011 Tohoku Earthquake Tsunami gave catastrophic damages to the Northern part of Japan. We have developed the numerical models for simulating of tsunamis, storm surges and storm waves, and analyzed long-term impact of coastal disaster risk in a range of 100-1000 years extreme events.

Impacts of Climate Change on Coastal Disaster Risk

Impacts of climate change on coastal environment are not only changes of temperature and sea level rise but also changes in ocean wave climate and tropical cyclone activities as the results of changes in global atmospheric-ocean circulation. The changes of frequency and intensity of tropical cyclone give significant impacts on the Western North Pacific regions.

Our research of global climate change impacts on coastal environment is carried out for impact assessments, mitigation and adaptation strategies for future development of human society. Sea level rise and changes in ocean waves and storm surges due to global warming are projected for long-term assessment of coastal disaster risk reduction. We have contributed to the assessment reports of Intergovernmental Panel on Climate Change (IPCC) since the 5th report.

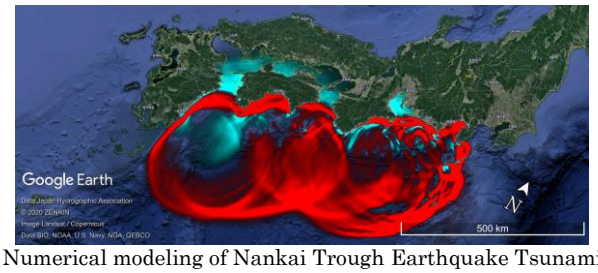


Future projected changes in ocean wave climate.

Assessment of Mega Earthquake Tsunami Hazard and Disaster Reduction

The 2011 Tohoku Earthquake tsunamis gave catastrophic damages to coastal areas in Japan. It is highly expected Nankai Trough Earthquake tsunamis would occur in the western part of Japan near future. However, it is difficult to predict intensity and location of next big one based on current scientific knowledge.

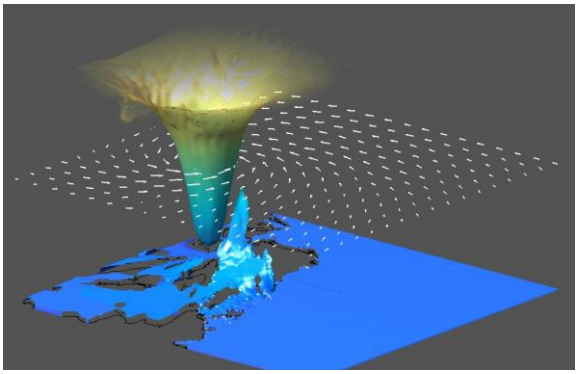
We have developed long-term assessment tools of megathrust earthquake tsunami, probabilistic tsunami hazard assessment model, and engineering technology for urban area inundation for tsunami disaster risk reduction based on the knowledge of the 2011 Tohoku Earthquake Tsunami.



Numerical modeling of Nankai Trough Earthquake Tsunami

Development of Numerical Models for Waves, Storm Surges, and Tsunamis

Numerical models for ocean waves, storm surges, and tsunamis have been developed especially targeting extreme severe conditions such as super typhoon and mega earthquake tsunami. Typhoon generates ocean currents and waves which give extreme wave forces on coastal defense structures. There are common governing equations and parametrization among three different phenomena. The detail processes of momentums and heat transfers from air to oceans has been incorporated into integrated model of typhoon-storm surge-wave for accurate estimation of coastal hazards.



Integrated model of typhoon-storm surge-wave for TC Haiyan.

Innovative Disaster Prevention Technology and Policy Research Laboratory

Associate Professor
Takahiro SAYAMA

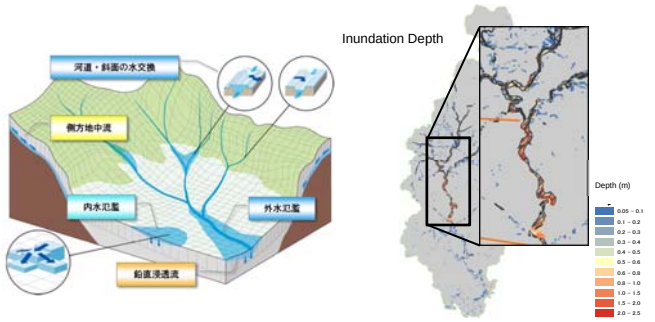
Junior Associate Professor
Florence LAHOURNAT

Policy research for the mitigation of disaster induced by socio-environmental change and extreme weather

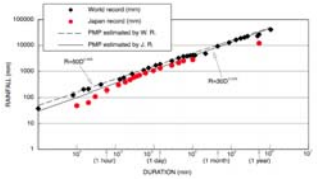
This laboratory conducts research on the evaluation of the climate change effects on disaster and the related adaptation methodologies, and on the quantification of city-, region-, and basin-wide disaster risk. Prediction methodologies are developed for water resources, flood, and landslide disasters using the advanced simulation and impact assessment models. Research topics include monitoring and prediction of the socio-environmental change using data collected through field observation, experiment, remote sensing as well as their applications to policy research for disaster mitigation.

Mitigations of water-related disasters induced by extreme weather

Policy-oriented research is conducted for the mitigation of water-related disasters such as cyclones, rainstorms, floods and landslides by investigating their mechanisms, and analyzing their frequency and magnitude. Water resources problems such as droughts are also research targets.



Development of Rainfall-Runoff-Inundation (RRI) Model and Real-time Flood Predictions with Data Assimilation

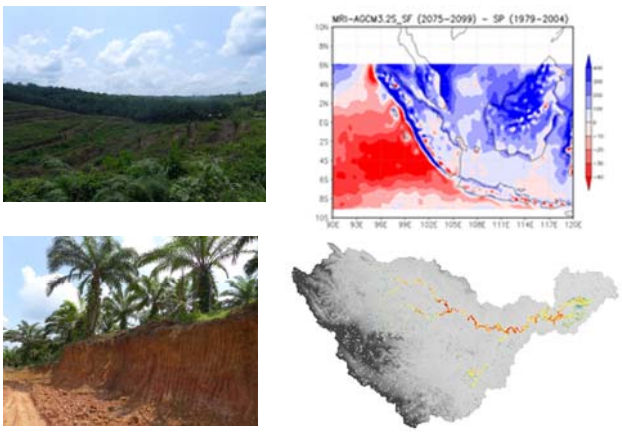


Probable Maximum Precipitation (PMP) estimation by extreme value statistics

Post Flood Surveys for the Northern Kyushu Storm in July 2017 with a backpack Mobile Mapping System (MMS)

Field studies for advanced water resource management and water disaster mitigation

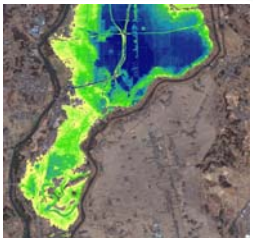
Through field investigations and experiments, we identify the socio-environmental characteristics of study sites. Based on this understanding, we propose new technology and policy for better management of water resources and water disaster mitigation relevant to each region. International collaborative research activities are implemented under the frameworks of UNESCO-IHP.



Impact Assessments of Climate Change and Deforestation in Humid Tropics in Sumatra Island: Field Monitoring and Basin-wide Hydrologic Modeling

Real-time predictions on flooding with ICT

We develop a distributed hydrologic models for real-time flood predictions, particularly focusing on flood runoff and inundation, notably by using Information and Communication Technology (ICT).



WATERFRONT AND MARINE GEOHAZARDS

Professor
Tetsuya HIRAISHI

Associate Professor
Yasuyuki BABA
(Shirahama Obs.)

Complicated Dynamics toward Waterfront Geohazards Solution

The research efforts have been directed toward establishing an integrated framework by which to predict the complex behavior of fluid-sediment systems under dynamic environmental loading, with consideration of their inherently multi-scale nature. Measurement activities in the field is one of the shorter ways to obtain the data in situ, and the measured data also have significant value for understanding of the natural phenomena and verification of prediction systems.

Reduction of Coastal Erosion and Soil Outflow Due to Tsunami and Storm Surge

When the water level rises rapidly due to the tsunami or storm surge, damage may be caused by flooding in the coastal areas where the population and properties are concentrated, such as houses will be destroyed by the pressure of the water flow. At the same time, there is a risk for beach erosion and scouring around coastal structures. Therefore, we investigate the movement of the coastal sediments in the event of tsunami and storm surge and aim to develop countermeasures and mitigate damages. For this purpose, we conduct a field survey and experimental studies on coastal scouring and erosion.

Fig. 1 : Erosion at backside du to tsunami (2011 Great Eastern Japan Earthquake Tsunami)

Identification of Flood-Related Sedimentary Features for Floodplain Management

Flood risk management is of increased importance, in view of enhancement of the extremum in meteorological events due to projected global warming and of ever diversifying use of flood-plains. This study addresses procedures by which to identify flood-related sedimentary features and incorporate them into community based hazard mapping. The topics discussed include the following: high-resolution determination technic of breaching-induced topographical changes by digital photo-theodolite surveying; applications of non-destructive geophysical explorations to identifying subsurface flood-related features; and GIS-based updating of geographical classification maps in flood-prone areas that may have relevance toward sustainable land-use planning.

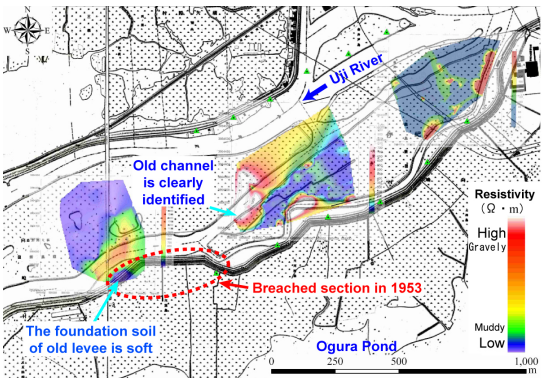


Fig. 2 : Contours of resistivity superimposed on to an old topographical map, published in 1921 by Kyoto City

Field Measurements on Oceanographical and Meteorological Phenomena

The offshore observation platform has great advantages for research activities of oceanographical and meteorological phenomena.

One of the great advantages is measurement operation under severe conditions such as high wave and strong wind because field observation under severe conditions is very difficult to carry out and therefore the amount of observed data under severe conditions is inadequate.

In 2018, strong typhoons approached around the observation site, and the maximum significant wave heights reached 11.09m by the typhoon Trami (TC24) and extremely strong wind up to 55m/s was also observed by the typhoon Jebi (TC21)

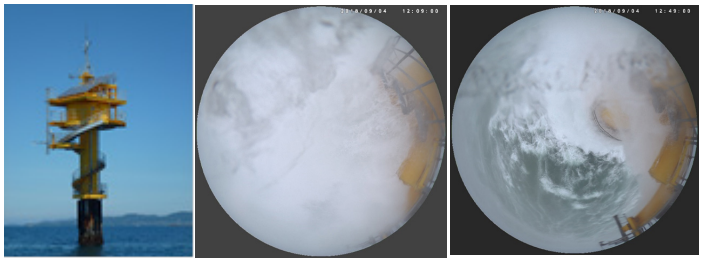


Fig. 3 : Observation tower and huge wave breaking at the observation tower (captured by omnidirectional camera at 10m high)

REGIONAL WATER ENVIRONMENT SYSTEMS

Professor **Shigenobu TANAKA**

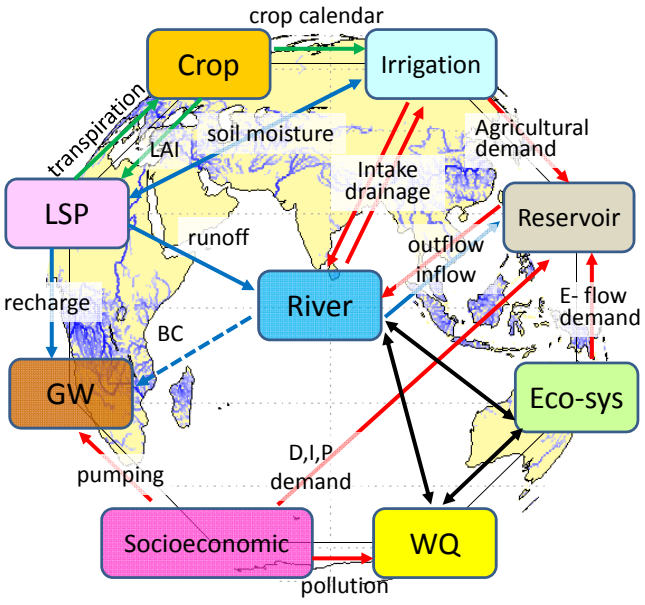
Associate Professor **Kenji TANAKA**

Sustainable Water Resources Development and Management

Water is one of the most precious and unevenly distributed natural resources in the world. Human beings have adapted with changing natural hydrological systems and increasing water demand. Learning past experiences, we develop the concept of integrated water resources management for promoting sustainable development under socioeconomic and climate change conditions.

Integrated Water Resources Management model

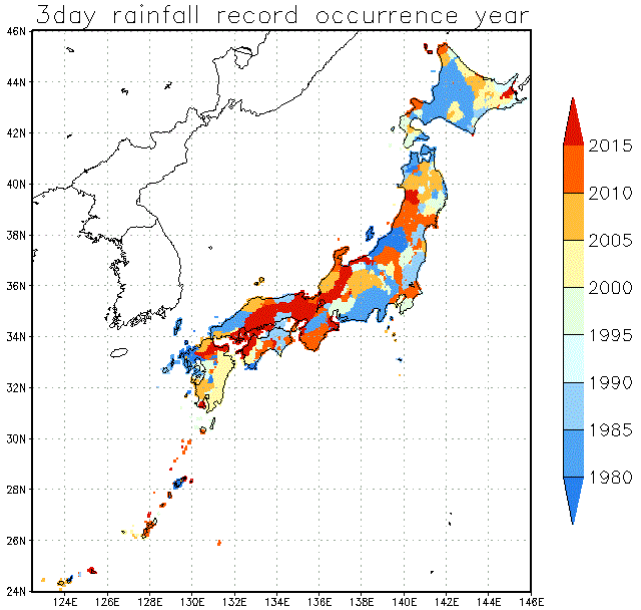
The "integrated water resources management model" consists of a distributed hydrological model, land surface process (LSP) model, groundwater (GW) model, water quality (WQ) model, sediment transport model, food chain model, crop growth model, reservoir operation model, socioeconomic model, etc. is being developed. This model is an integrated model which describes not only natural hydrological systems but also artificial systems such as those capable of regulating floods and releases from reservoirs in order to satisfy the demand from each sector. This model is expected to be applied to various kind of topics, such as diagnosis of the reliability of the current water resources system, decision support for water resources planning, evaluation of risks related to floods, droughts and ecosystems under future climate change, and proposal of risk reduction and adaptation measures to the anticipated impact from climate change.



Structure of integrated water resources management model

Current (On-going) Research Topics

- Hazard Monitoring and Risk Assessment
  Disasters have been triggers for countermeasures, however, proactive approaches in the non-stationary condition are necessary. With monitoring current disaster situation, future water-related risks are assessed for adaptation planning.
- Climate Change Impacts on Water Resources
  Global warming may change the amount and patterns of precipitation. Future changes in the available water resources of the major rivers in Japan and the world are assessed considering the water demand under expected socioeconomic scenarios.
- Groundwater Management
  Depletion of groundwater resources has become obvious in many parts of the world. Land surface model has been upgraded to monitor the groundwater storage change through recharge and groundwater withdrawal processes. The strategy for land and groundwater utilization toward sustainable water resources management is investigated.



3-day rainfall record occurrence year

WATER RESOURCES ENGINEERING

Professor

Tomoharu HORI

Interaction between Water Dynamics and Human Activities

The research is focused on analyses of interaction between global water dynamics and human activities seeking solutions for water resources issues. The current research topics include development of a global water dynamics model considering social economic activities and water resources management systems considering real-time hydro-meteorological information, and design of mitigation or response measures against water-related disasters.

Global Water Dynamics Model Considering Social and Economic Activities

Global point of view is indispensable to tackle water resources issues. This is because water circulation, which is governing phenomena inducing water issues, is a global scale natural process. It should also be noted that impacts of local water issues can be easily propagated worldwide by global networks of economy. Driving forces of global change in water dynamics such as greenhouse gas are widely spread all over the world, hence the change cannot be managed by a country or a region effort.

On the other hand, water resources issues are highly local issues. It is difficult to transport fresh water from one place to another, and freshwaters provided by rainfalls can naturally move within a catchment scale. Therefore, regional- or community-based point of view is also important for management of water resources systems.

From these viewpoints, we are tackling to develop an integrated model which can analyze interacted dynamics between natural phenomena of water circulation and socio-economic phenomena of human activities with various temporal and spatial scales.

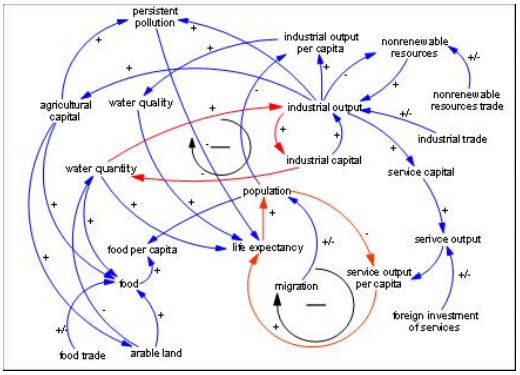


Fig. 1: Water dynamics model considering water resources, population, industrial and agricultural outputs.

Numerical Crop Growth Model and Advanced Reservoir Operation for Irrigation

Food production requires the huge amount of water. It is important to know the detailed withdraw process of agricultural sectors and the impact of climate change. A numerical crop growth model is developed to estimate water demand for irrigation as well as crop yield according to various climate conditions and water management options. Optimum reservoir operation scheme is designed based on the daily water demand and distribution management processes.

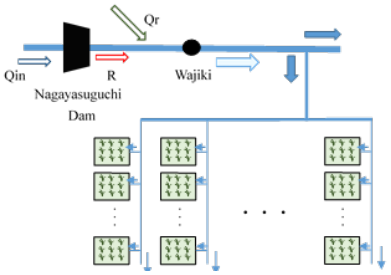


Fig. 2 Crop growth and optimum reservoir opera-

Flood Evacuation Simulation Model Considering Detailed Field Information

There is a growing concern about catastrophic flood disasters, the scale of which exceeds the design level of mitigation systems, as a consequence of climate change. Emergency response by residents and communities is getting more important to prevent and to mitigate damage caused by large floods. There are also many regions where construction of large scale flood control facilities is difficult for geographical, economical or environmental reasons.

Considering the situation mentioned above, a computer model to simulate resident's evacuation is being developed. The system comprises mainly three parts: a mental decision process model, a moving model and a communication process model. The mental model treats resident's decision about action based on their attitude to the flood risk and obtained information. The moving model simulates people's action of traveling to evacuation centers, which is affected by inundation water dynamics. The communication model simulates information transmission from municipalities to residents and information interchange in the community.

Taking advantage of these simulation models, it comes to be possible to analyze how the social systems for flood disaster mitigation work in various situations.

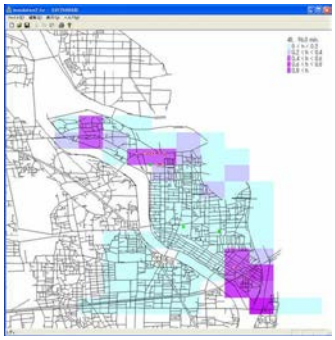


Fig. 3: Flood evacuation simulation model

Socio and Eco Environment Risk Management

Professor	Associate Professor	Associate Professor	Assistant Professor
Tetsuya SUMI	**Yasuhiro TAKEMON**	**Sameh Ahmed KANTOUSH**	**Daisuke NOHARA**

For planning of risk management of water resources systems and integrated river basin management

In order to realize environmental disaster mitigation and to solve environmental problems in the water resources issues, measures for integrated river basin management for flood control, water use and environmental conservation are investigated aiming at enjoyment of ecosystem services in a sustainable manner. We focus on subjects such as 1) asset management of dams and development of reservoir sediment management methods, 2) development of riverbed management methods for habitat creation and maintenance, 3) restoration of sustainable interactions between human use and ecosystem responses in water front environments and 4) water resources management in trans boundary river basins ex. the Nile and the Mekong River Basin.

Asset management of dams and development of reservoir sediment management methods

In order to achieve sustainable use of water resources and integrated sediment management in a basin scale, countermeasures for reservoir sedimentation will be a key subject. Aiming at technical support of cooperative sediment flushing of the Kurobe River dams, sediment bypass tunnel at the Miwa Dam, etc., we investigate on 1) applicability of methods for reservoir sedimentation management, 2) prediction of sediment transport during drawdown flushing operation, 3) fine-sediment and turbidity management in a reservoir at flood events and 4) sediment resources management for recycling, using both numerical simulation and field measurement methods. In addition, researches for reservoir sustainability through the asset management of sedimentation based on a life cycle management approach are conducted.

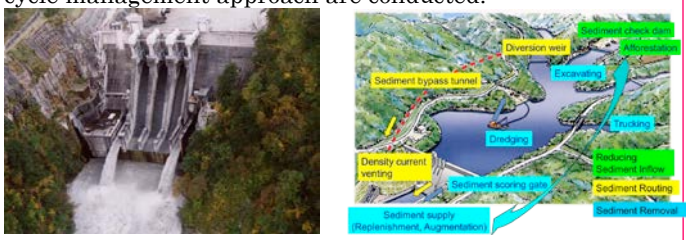
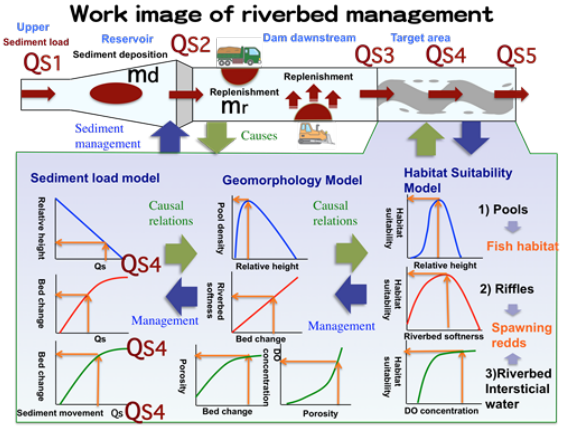


Fig. 1 : Reservoir sedimentation management in Japan.

Development riverbed management methods for habitat creation and maintenance

Riverbed management is essential for conservation and restoration of ecological functions in river ecosystems. We investigate on following subjects for developing the riverbed management methods: 1) elucidation of habitat conditions required for facilitating biodiversity and material cycling in rivers, 2) estimation and prediction of potential distribution of organisms based on the habitat structure, 3) estimation boundary conditions of sediment load and flow regimes for creating suitable habitat structure geomorphology, 4) assessment of human impacts on river ecosystems from the aspects of habitat dynamism and 5) proposal of countermeasures for riverbed management.



Restoration of sustainable interactions between human use and ecosystem responses

Ecosystem and social system are mutually interactive, and thus, for realizing a sustainable system of water resources, basin ecosystem structure, function and mechanisms for maintenance should be investigated in relation to human life styles and utilization patterns of natural resources. Our researches focus on the interactive nature of the system to propose a truly sustainable society.

COMPUTATIONAL ENGINEERING

Professor
Satoru USHIJIMA

Assistant Professor
Daisuke TORIU

High-performance computing for multi-physics problems

The actual problems in civil engineering are not necessarily categorized as a single research area, but sometimes involved in the multi-physics field in which multiple fields, including fluid and structural mechanics as well as thermodynamics, are mutually and intricately related. In our Lab., the governing equations in such multi-physics problems and our original models for them are derived and discretized in suitable methods (like FDM, FVM and FEM), so that multi-physics problems can be solved accurately and as fast as possible with the massively parallel computers.

Computational Fluid Dynamics around complicated structures

In our Lab., some advanced numerical prediction methods have been developed in the collocated grid system, in which both pressure and three velocity components are defined at the same cell-center points, on the basis of the finite volume method (FVM).

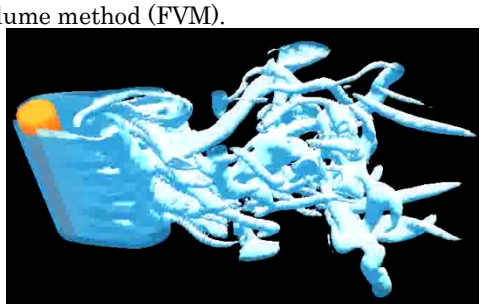


Fig. 1 : Wake flows behind a cylinder (iso-surface of vorticity)

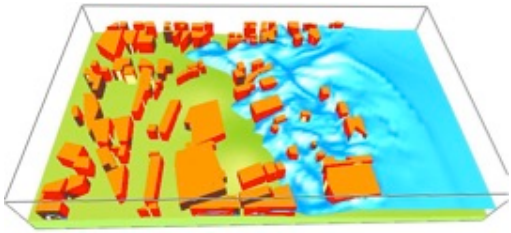


Fig. 2 : Three-dimensional tsunami flows through buildings

Fluid-Structure Interaction (FSI)

It is important to develop the computational methods to predict the interactions between free-surface flows and the motions of solid objects included in the flows. In order to develop the numerical method to deal with such problems, the target field is taken as a multiphase field, consisting of gas, liquid and solid phases, and we developed a computational method, called MICS (Multiphase Incompressible flow solver with Collocated grid System). The MICS allows us to estimate the fluid forces acting on the objects by the volume integral of the pressure and viscous terms of the momentum equations in a multiphase model. Thus, the numerical procedures to treat the objects in the flows become simple and numerically robust.

In our T-type solid model, an object is represented with multiple tetrahedron elements and the physical properties of the object, such as volume, mass and inertial tensors, are calculated with the elements. These elements are also utilized to estimate the fluid forces acting on the objects and other interactions with the fluid flows. In addition, the T-type solid model makes the numerical algorithms for collision detections much easier, since the collisions and contact forces are calculated with the contact detection spheres (CDS) which are placed near the object surfaces on the basis of the distinct element method (DEM).

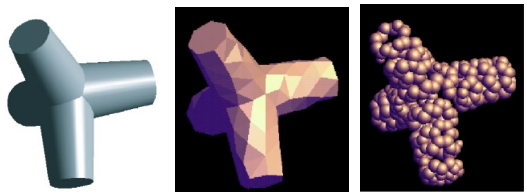


Fig. 3 : T-type solid model
(Left: CAD, Center: tetrahedron elements, Right: CDS)

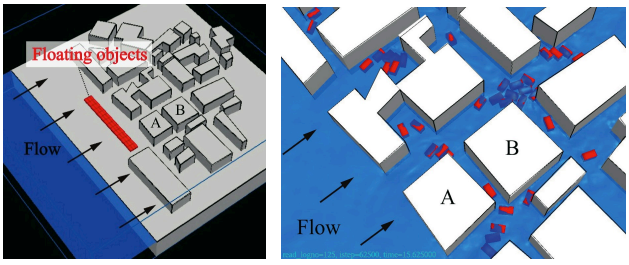


Fig. 4 : Transportation of 42 floating objects by tsunami flows in a coastal city model

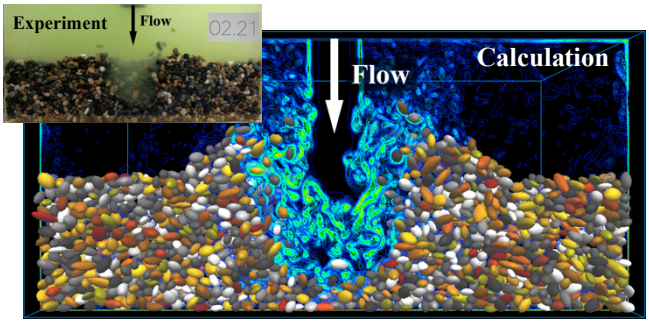


Fig. 5 : Transportation of 16,700 gravel particles due to downward water jet and intensity of vorticity vectors (particles are colored depending on 26 different shapes)

G E O M E C H A N I C S

Professor
Makoto KIMURA

Associate Professor
Sayuri KIMOTO

Assistant Professor
Ryunosuke KIDO

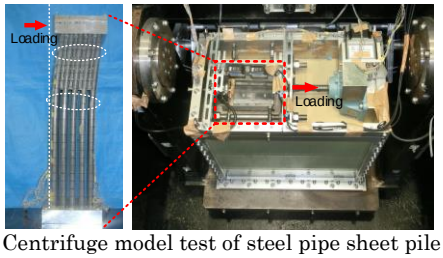
Clarification of Mechanical Behaviors of Ground Supporting Civil Structures

Geomaterials support the civil structures and environments as a ground. It is important to clarify mechanical properties of geomaterials under different conditions such as water contents and confining pressure, deformation and failure mechanisms of geomaterials subjected to earthquakes and rainfall, and soil-structure interactions in order to build the safe civil structures. This laboratory studies these topics by conducting experiments and numerical analyses to develop reasonable design methods and new techniques for maintaining the civil structures and environment safety.

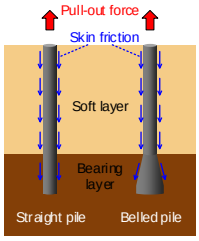
Clarification of Soil-Structure Interactions

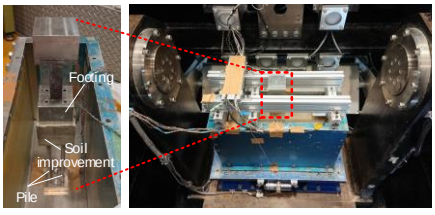
Civil structures are built on the ground or under the ground. Therefore, when designing and constructing civil structures, investigations of a soil-structure interaction such as a stiffness difference, a nonlinearity, a seismic characteristic due to earthquakes, are important.

This laboratory is carrying out researches for various civil structures, such as a pile foundation, a tunnel, and a reinforced earth by conducting centrifuge model tests, storing shaking tests and numerical analyses to establish reasonable design methods.

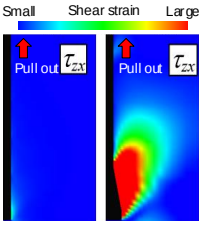


Centrifuge model test of steel pipe sheet pile





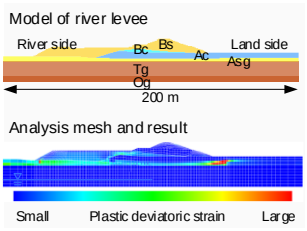
Centrifuge model test of group pile foundation with soil improvement



Simulation on pull-out behavior of pile

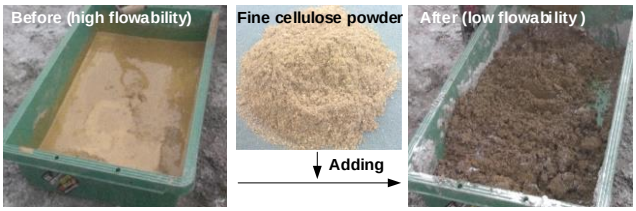
Mechanical Behaviors of Geomaterials and its Modelling

There are a wide variety of geomaterials, such as, sand, clay, and the improved soils. Laboratory tests are conducted to understand and model the mechanical behavior of soils. Numerical models on a seepage failure and a liquefaction failure of river levees are also developed. Furthermore, we are developing a new technique, for example, to prompt to carry sludges from construction sites by decreasing flowability of high water- content mud with fine powder from wasted paper.



Simulation on seepage failure at river levee

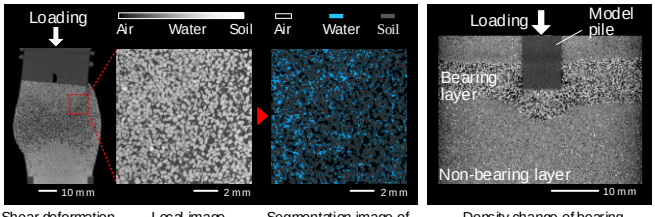
Hydrate-bearing sand (white part indicates hydrate)



Improvement of flowability of high water-content mud using fine powder from wasted paper

Clarification of Micro-Scale Behaviors of Geomaterials

Geomaterials comprise soil particle, water and air. Therefore, a clarification of the microscopic behaviors is key to understand the micro-scale behaviors of geomaterials. This laboratory is applying x-ray micro computed tomography (CT) and image analysis techniques to a triaxial test of sands and a loading test of a pile in order to investigate the failure mechanism and soil-structure interactions from microscopic viewpoint. We aim at clarifying the link of micro-scale behaviors to macroscopic responses.



Shear deformation of specimen | Local image scanning shear band | Segmentation image of three-phase mixture | Density change of bearing layer due to loading of pile

Applications of x-ray micro computed tomography for a triaxial test on multiphase mixed sand and a loading test of pile

Infrastructure Innovation Engineering

Professor

Chul-Woo KIM

Manage Civil Infrastructure System Smartly!

Researches in International Management of Civil Infrastructure Lab aim to answer questions in managing civil infrastructure systems whose answers are not yet clarified: developing effective methods to identify change in bridge health condition even including decision making on the health condition; developing a smart sensor system specialized for health monitoring of bridges.

Health monitoring of short and medium span bridges

More than 85 percent of bridges in Japan are classified as short and medium span bridges. A crucial issue in maintenance of those bridges, thus, is development of rapid and cost-effective tools for bridge health monitoring (BHM). The research covers developing novel damage-sensitive features, fault detection by means of statistical pattern recognition and Bayesian approach, drive-by inspection, smart wireless sensor system and a novel unmanned aerial vehicle (UAV) for bridge inspection.

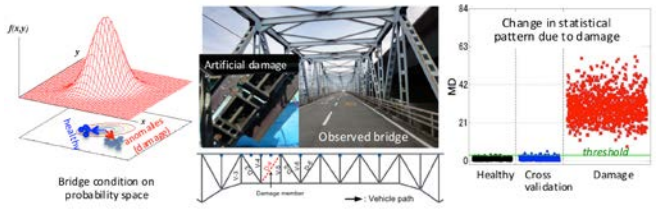


Fig. 1: Statistical fault detection(left)/ Damage experiment on a real truss bridge (middle)/ damage detection result (right).

Assessment of traffic-induced vibration of bridges

The low frequency sound radiated from bridges under traffic is one of the environmental problems especially in land scarce major cities of Japan, since the low frequency sound can shake houses near the sound source and also can cause psychological and physiological influences to residents. The research aims to develop a general platform simulating traffic-induced vibrations that can even apply to assess the low frequency sound radiated from a viaduct.

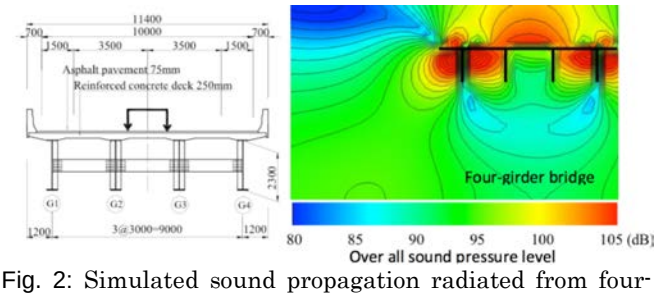


Fig. 2: Simulated sound propagation radiated from four-girder bridges.

Seismic behavior of viaducts under traffic and traveling safety

The research is intended to investigate the seismic response of a highway viaduct under moving traffic loadings as well as stationary traffic loadings by means of a three-dimensional dynamic response analysis considering a bridge-vehicle interaction when subjected to severe earthquakes. Developing a platform to simulate the nonlinear dynamic response analysis under seismic and traffic. It also is useful to investigate the safety of running vehicles on the bridge during earthquakes.

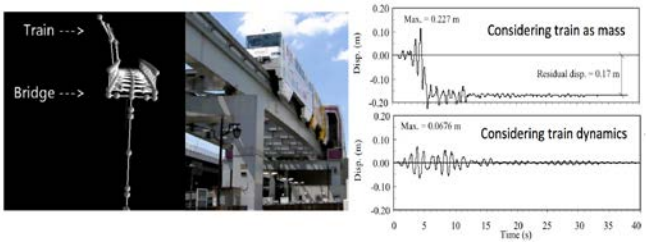


Fig. 3: S Seismic responses of monorail train and bridges by simulation.

Smart drive-by bridge inspection

This challenging research project aims to develop a smart way to monitoring bridges, esp. short and medium span bridges, utilizing vehicle vibrations when the vehicle passes on the bridge. The idea is that utilizing the inspection vehicle as an actuator, data acquisition and message carrier, and extract information about bridge behaviors.

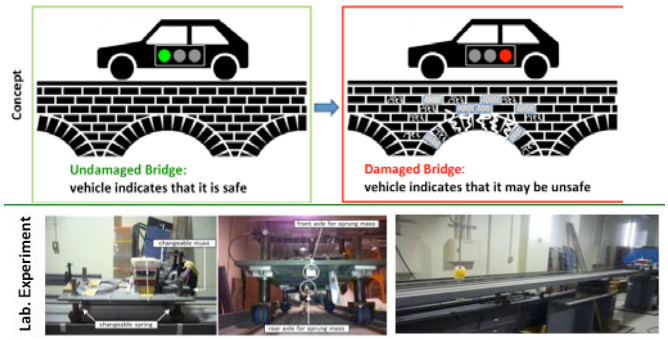


Fig. 4: Drive-by Bridge inspection systems.

Construction Engineering & Management LABORATORY

Associate Professor

Thirapong Pipatpongsa

For rational construction and maintenance for infra-structures

Civil engineering had been contributing to energy supply facilities and transportation network since the high economic growth period to construct insufficient infrastructures; however, currently paradigm shift of civil engineering as well as geotechnical engineering has been in high demand from conventional subject to that to rationally create and maintain the high-quality infrastructures. To correspond to the new construction market, our laboratory has been studying civil and geotechnical research based on the management technique in consideration with social economy. In addition, a numerical analysis and model test are also performed to consider a mechanism of embankment destruction by an earthquake.

Geo-Risk Engineering / Management

Recently risk management has been recognized as one of the important issues in public works. In this research, the evaluation of variable construction risk due to unforeseeable geological condition only by the investigation in advance of the construction has been studied. The evaluation has been carried out based on risk curves as well as value at risks in financial engineering. We have then proposed that the risk on the geological condition could be quantified with the cost dimension.

Also we have proposed risk management technique on slope failure due to torrential rain and seismic motions. The characteristic of our technique is to relate natural disaster to damage condition with using event tree analysis. In this technique as users are added to the road owners to take the risk, the profit and loss, which can be a parameter to assess the risk due to the disaster, can be evaluated based on the view point of social engineering.

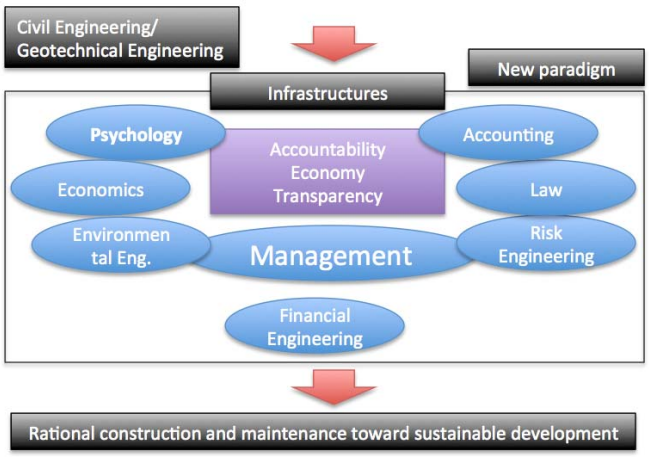


Fig. 1 : Conceptual configuration of our research.

Asset management of rock structures

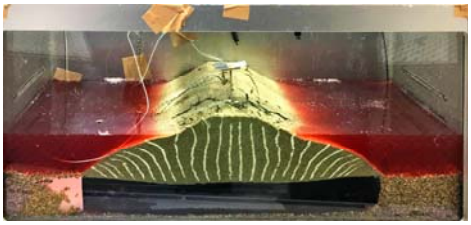
Asset management of infrastructures has been highlighted as our society has been matured. Specifically this tries to optimize the structural maintenance and repair program based on the long-term view. In this research, we have proposed to evaluate the life cycle cost which can be an index for the asset management in consideration with uncertainty on the degradation of the performance in rock structures.

Risk management in overseas construction projects

Construction projects involve a lot of uncertainties. In especial for those in developing courtiers, the risk management of the projects has become the complex issue as external uncertainties such as political or macro-economical risks are involved. In this research, the risk factor of construction projects in developing courtiers has been clarified and fundamental strategies to establish the evaluation- or management- methodologies have been proposed.

Arching effects in geo-materials and soil-structure interactions

Embankments stability against earthquakes are investigated by highlighting that initial stress states influenced by passive arch action across a basal deflection play a dominant role in the mechanisms of weakening resistance against liquefaction.



Embankment failure by dynamic centrifugal loading test

GEOFRONT SYSTEM ENGINEERING

Professor	Associate Professor	Assistant Professor
Mamoru Mimura	**Yosuke Higo**	**Mai Sawada**

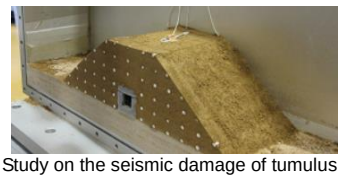
Disaster prevention and management from surface to deep underground

We study the soil-fluid coupled mechanical characteristics and their modelling, and develop numerical methods to predict the deformation of the ground. Based on these fundamental researches, we aim to contribute to the disaster prevention and management of the earth structures such as levees and man-made islands, and restorations of geoheritages like tumulus mounds.

Geotechnical contribution to the preservation and restoration of geoheritages

Historical monuments such as ancient tumulus mounds and masonry structures are vulnerable to damage due to earthquakes and rainfall. It is difficult to keep them intact for long time. Hence, in this research field, we investigate the preservation and restoration methodologies of historical monuments to maintain their authenticity based on geotechnical engineering aspects.

Triaxial tests on tumulus mound soils

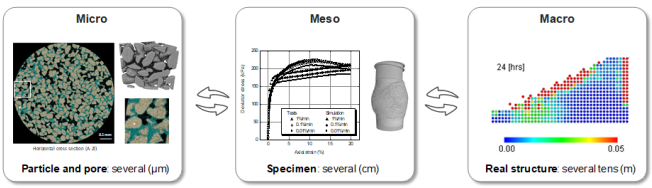


Study on the seismic damage of tumulus mounds

Investigation on the stone-paved ruins damaged due to rainfall

Modelling deformation characteristics of geomaterials from micro to macro

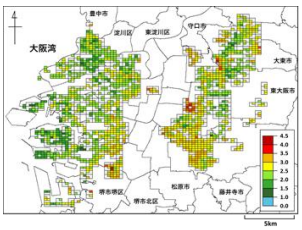
Geomaterial is a multi-phase mixture composed of soil, water and air. It is important to study microscopic changes in soil structures and phase interactions. We aim to clarify a link between the microscopic and macroscopic behaviors through experiments. Furthermore, we are developing analysis methods based on the physical origins to predict macroscopic geotechnical issues such as geoharzards induced by rainfalls and earthquakes.



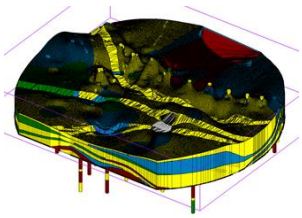
- Modelling behaviors of geomaterials -from micro to macro
- Evaluation of “Robustness” of river levee for performance-based design

Modeling underground structures and application to disaster assessment

It is usually difficult to observe ground except for the surface, although the deformation and failure of the ground are closely related to the underground structures. We study on geophysical explorations that enable visualization of wide-area underground structures and 3D-modeling of ground using boring database. The underground structures provided by these observations contribute to the numerical analysis and microzoning for disaster assessment such as evaluation of rainfall infiltration into the ground and liquefaction mapping.



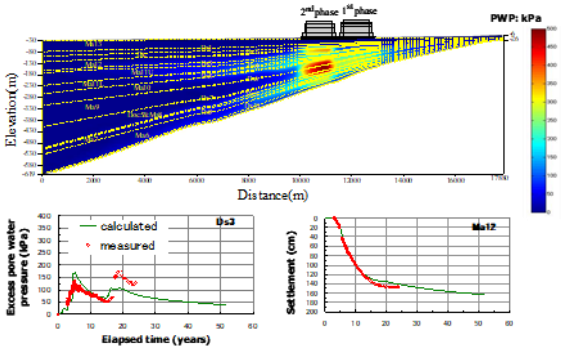
Disaster assessment for Nankai Trough Earthquake in Osaka



3D-modelling of the Kizu River valley

Numerical simulations of soft ground with elasto-viscoplastic constitutive model

Sand and soft clay layers are widely distributed in the coastal urban area and often suffered from ground settlement and liquefaction. In this research field, we have been developing numerical simulation methods with elasto-viscoplastic constitutive model to investigate the mechanical behavior of soft ground and applied to actual problems such as long-term settlement of the ground under the Kansai international airport.



Consolidation behaviors of the Kansai international airport

Urban Management Systems

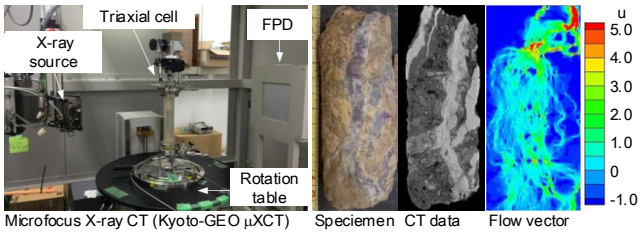
Professor	Associate Professor	Assistant Professor
Kiyoshi KISHIDA	**Yasuo SAWAMURA**	**Yuusuke MIYAZAKI**

Development of Infrastructures toward Sustainable Human Society with Harmony of Environments

In overcrowded urban areas, the developments of new infrastructures, such as railways, rapid transport systems, and energy facilities, is being adjusted in order to employ underground space. Underground space is useful as a solution for the geosequestration of by-products after energy generation. In order to develop new geofronts, the mechanical and hydro-mechanical properties of soils and rock are being studied and their application to tunnel and underground excavations, dam foundations, slope stability, and safe and trusted road network are being researched based on the geotechnical engineering, rock mechanics, and fluid mechanics.

Mechanical and hydro-mechanical behaviors of fractured rock masses

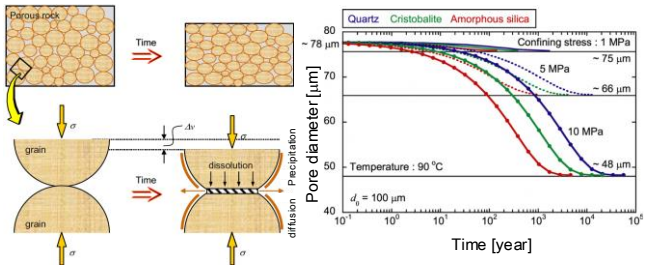
When discussing the construction and the maintenance of tunnels and underground caverns and the slope stability, the mechanical and hydro-mechanical behaviors of fractured rock masses should be clarified. The mechanical and hydro mechanical behaviors of fractured rock masses are strongly affected by those of the rock joints and/or fractures. Through experimental works on single joints and/or fractures, the mechanical and hydro-mechanical behaviors of single joints are studied.



Analysis on discontinuous rock by microfocus X-ray CT

Advanced approach for geological isolation of by-products after energy generation

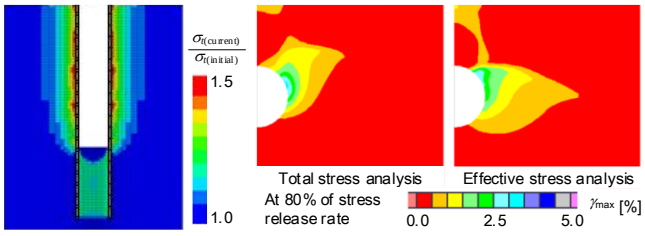
When considering the geological isolation of high-level radioactive waste and CO_2 geological storage, the integration of various types of information through geomechanics, rock mechanics, fluid mechanics, thermal dynamics, and geochemistry is required. The mechanical and hydro-mechanical properties of jointed rock masses are clarified through an advanced approach and fundamental experiments with iPSACC (interface for Pressure Solution Analysis under Coupled Conditions) coupling the thermal (T), hydro-mechanical (H), mechanical (M), and chemical (C) properties is developed.



Time history of pore diameter due to pressure solution

Design, construction, and maintenance of geo-infrastructures and rock infrastructures

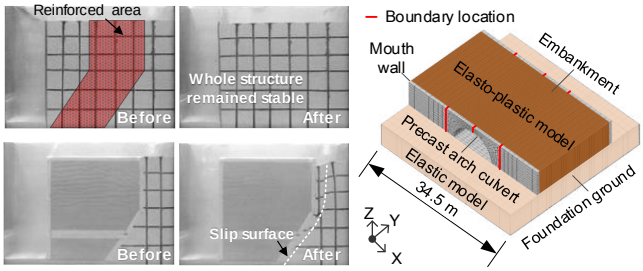
The effective design, safety construction, and smart maintenance of geo-infrastructures and rock infrastructures are studied here. For examples, when shallow overburden tunnel is to be excavated in an urban area, the auxiliary method that will be applied should be considered. When an area is to be excavated in deep underground, seepage and the huge earth pressure that will be encountered should be considered. For slope stability, the remote sensing system that actively uses InSAR and ICT is introduced.



Examples of excavation analysis on tunnels

Clarification of seismic performance of reinforced earth wall and precast arch culvert

In order to realize the labor saving of the earthworks, the reinforced earth wall and the precast arch culvert have been positively applied in the domestic road structures. Through the dynamic centrifuge tests and the numerical analyses, these unknown seismic behaviors due to dynamic soil structure interaction are being investigated. Based on these approaches, we aim to clarify the seismic performance.



Investigations by geotechnical centrifuge and 3D FEM

International Urban Development

Associate Professor

Ali Gul QURESHI

Studying International Urban Development Problems from a Multidisciplinary Perspective

Modern Cities are considered living organisms due to the complex interrelations between their various systems and sub-systems. Their management requires multidisciplinary knowledge and holistic methodologies to avoid the problems that encircle most reductionist solutions. This laboratory focuses on issues related to urban development from planning and geo-environmental viewpoints; working closely with the International Management of Civil Infrastructure Laboratory to incorporate concepts related to structural and water resource engineering.

Urban Logistics Systems and Humanitarian Logistics

Transportation and logistics networks make the backbone of the economy of any country. Within cities, they have enormous impact on sustainability and livability of a city. Planning for efficient urban logistics opens up a wide range of research opportunities, such as in policy making, management, operations research, environment, etc. One of the focus of this laboratory is on optimization of strategic and tactical logistics issues such as facility location problem and vehicle routing problem. Research is conducted in modeling various variations (such as considering land uses (Fig.1)) of these problems and in development of both exact and heuristics optimization methods. Integration of these methods in more comprehensive frameworks such as with multi-agent system or micro/macro traffic simulation, is also studied for evaluation of logistics policies. Humanitarian logistics is also an active and expanding area of research of this laboratory.

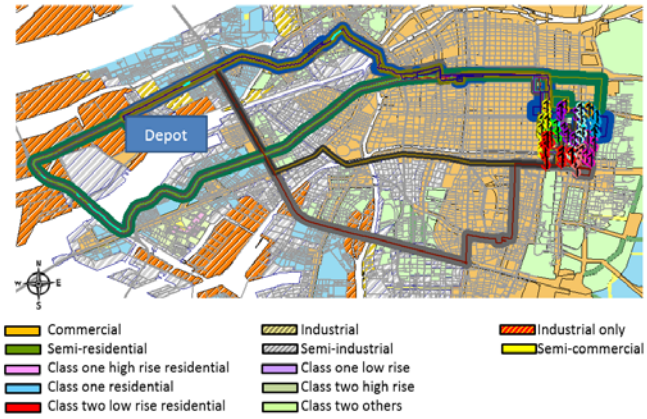


Fig. 1: Vehicle routing and land use

Geoenvironmental Engineering

Due to its accessibility, water for human consumption was originally obtained from surface water (rivers and lakes). Over time, however, groundwater has become the major source due to its stability as a water source (unlike surface water, groundwater is not easily affected by climatic conditions), its wide distribution, and fairly good quality. Unfortunately, groundwater often contains various contaminants, which are mainly due to human activities ranging from synthetic organic compounds and hydrocarbons to pathogens and radionuclides. Even worse, due to groundwater's slow velocity within the hydrologic cycle, contamination tends to be long-term and localized; Even after the pollution sources are removed, self-purification of the aquifer will require decades or centuries.

To remediate contaminated sites in an efficient and cost-effective manner, a complete understanding of the contaminant behavior is essential. Thus, accurate numerical models based on and compared to valid quantitative experiments (Fig. 2) are also part of the research scope of this laboratory.

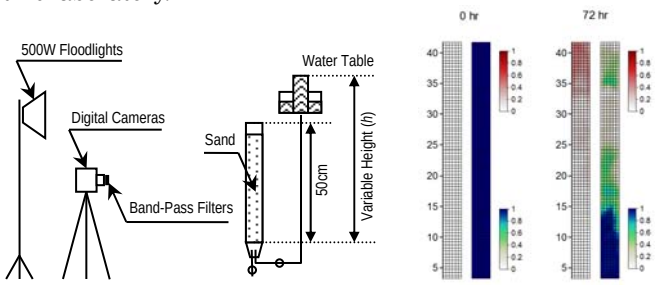


Fig. 2: Experimental setup for testing the migration of a contaminant in a one-dimensional column

A Multidisciplinary Perspective

In addition to working with topics directly related to Urban Logistics Systems and Humanitarian Logistics, and Geoenvironmental Engineering, the International Urban Development Laboratory works closely with the International Management of Civil Infrastructure Laboratory to incorporate concepts related to structural and water resource engineering, so as to include a complete multidisciplinary perspective in the study of international urban development problems.

Geotechnics for Hazard Mitigation

Professor
Ryosuke UZUOKA

Assistant Professor
Kyohei UEDA

Geo-hazard mitigation for disaster-resilient societies

Rapid development of urban areas originated from plains and lowlands towards hills in the suburbs poses increasing risks in geohazards. The potential geohazards include soil liquefaction during earthquakes, settlement of reclaimed lands, collapse of artificial cut-and-fill, and instability of natural slopes. A series of strategic measures are required for mitigating these geohazards and establishing higher performance of geotechnical works.

Simulation of dynamic soil-structure systems under large earthquakes

The 1995 Kobe, Japan, earthquake caused loss of more than 6,000 lives and catastrophic damages on civil infrastructures, such as lifelines, bridges, highways, and port/harbor structures. Among them, geotechnical structures along waterfront areas were also severely damaged due to liquefaction and lost their function after the earthquake. Tremendous costs for their reconstruction made a demand for reliable and practical methodologies for damage assessment and structure design with higher performance.

A broad extent of Tohoku and Kanto region was affected by strong shaking, and tsunami took nearly 20,000 lives after the 2011 Tohoku, Japan, earthquake. Liquefaction caused not only failures of geotechnical structures, but serious settlements and tilting on residential houses in Tokyo bay area. Also, a combined effect of long duration earthquake and tsunami created severe damage on civil structures located along the coastline. Again, development of methodologies for damage assessment against such a devastating earthquake and tsunami is urgent needs, especially, under the current situation that the Great Nankai Trough earthquake is expected with high rate.

To provide reliable and practical tool, we have been developing numerical simulation programs in which state-of-the-art constitutive models for saturated and partially saturated soils are implemented.

Centrifuge modeling on dynamic behavior of geotechnical structures

Due to concentration of population in urban areas, surrounding residential areas have been rapidly expanding by land reclamation. After recent large earthquakes, a number of reports on failure of such reclaimed land have been increasing (e.g., 2003 Niigata-ken Chuetsu and 2007 Notohanto earthquakes). Dynamic behavior of soil structure is highly nonlinear and its deformation is quite large compared to other materials, such as metals.

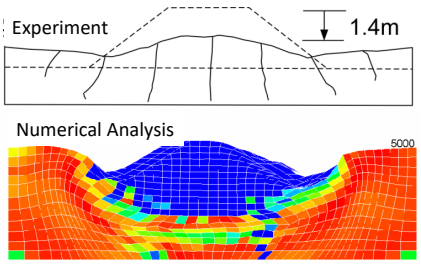


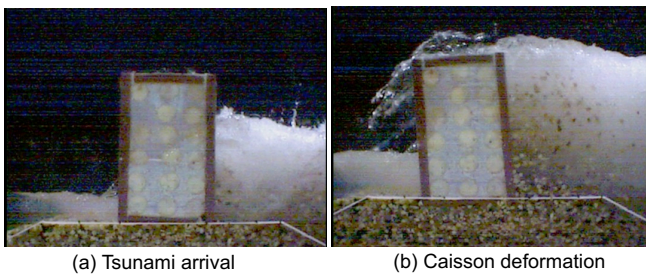
Fig. 1. Deformation of an embankment resting on liquefiable ground (Centrifuge experiment and numerical analysis)

Applicability of the numerical models developed by our laboratory is verified through comparison with a centrifuge test result (Fig. 1).

Damage mechanism of geotechnical structures during combined disaster

Many geotechnical structures were damaged by ground shaking and/or tsunamis during the 2011 Tohoku, Japan, earthquake. In the Tohoku region, the offshore tsunami breakwaters, coastal levees and river levees were found to be severely damaged by the tsunami after the earthquake. In the Kanto region, fill ground around the Tokyo bay severely liquefied during not only the main shock but aftershocks. The 2016 Kumamoto earthquake caused severe damage of geotechnical structures with multiple shocks. In addition, many slope failures were caused by heavy rainfall in June two months after the earthquakes. These recent earthquakes teach us that some natural disasters very often did not come alone, and the sequential multi external forces caused worse situations of geotechnical structures, which is known as combined disasters.

To clarify the damage process and the mechanism of geotechnical structures during combined disasters, we have assessed the residual performance of geotechnical structures after earthquake motions by using centrifuge model tests (Fig. 2) and numerical simulations.



(a) Tsunami arrival (b) Caisson deformation

Fig. 2. Centrifuge experiment for stability of the tsunami breakwater

ENVIRONMENTAL INFRASTRUCTURE ENGINEERING

Professor
Takeshi KATSUMI

Associate Professor
Atsushi TAKAI

Sustainable Geoenvironmental Engineering

Environmental sustainability of the subsurface should be maintained for a long period of time since it is crucial for life and society. This laboratory mainly focuses on the study of recycling technologies of various wastes as geo-materials, remediation technologies for contaminated lands, and lowering environmental impact of infrastructure development. The main research topics are detailed below.

Geotechnics for Waste Landfills

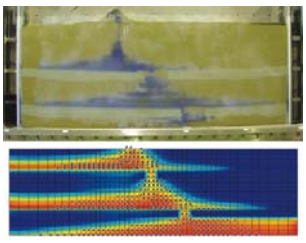
In order to build a recycling-based society, the 3R principle should be a strong driver of our life. Unfortunately, certain amount of wastes that are technically and economically difficult to recycle is going to be generated. Hence, to properly dispose such wastes to landfill sites so that we can use the land after post-closure is a reasonable solution. In this laboratory, a series of studies related to the construction, management, and utilization of waste landfill sites are performed including the geotechnical evaluation of construction materials, the mobility assessment of toxic elements in the sites, and the risk assessment of the utilization of closed landfill sites.

Environmental Geotechnics for Disaster Recovery

Treatment of disaster wastes is one of key issues to be addressed immediately after a huge disaster occurs. This laboratory contributes to geotechnical characterizations and utilization of recovered materials, including tsunami deposits, based on lessons learned through the 2011 Great East Japan Earthquake.

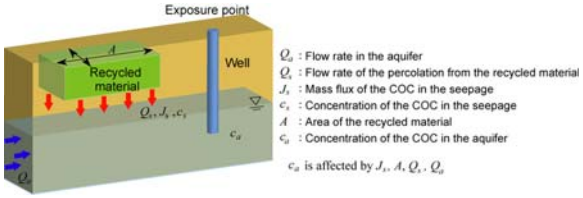
Geoenvironmental Remediation

When selecting adequate techniques to solve soil and/or groundwater contamination problems, the mobility of the contaminants, their mechanisms, and the reliability of the countermeasures should be scientifically clarified. In this laboratory, the mobility of heavy metals and VOCs and their effective countermeasures, such as remediation and containment techniques, are experimentally and analytically studied. In addition, the quantification of the environmental impacts and that of the effectiveness of the countermeasures are calculated using the environmental risk assessment method to contribute to the adequate communication of risks.



Construction and Demolition Waste (CDW) Management and Utilization

The social and economic system is now shifting to promote further resource recycling and the maintenance of existing infrastructures, in order to attain a sustainable development. Furthermore, environmental problems are being exacerbated by climate change, which can also trigger various ground disasters. In this laboratory, new concepts for infrastructure improvement are studied considering such global environmental problems as the application of recycled wastes as geo-materials, the development of the more environmentally-friendly construction, and methods for foundation maintenance.



Geoinformatics

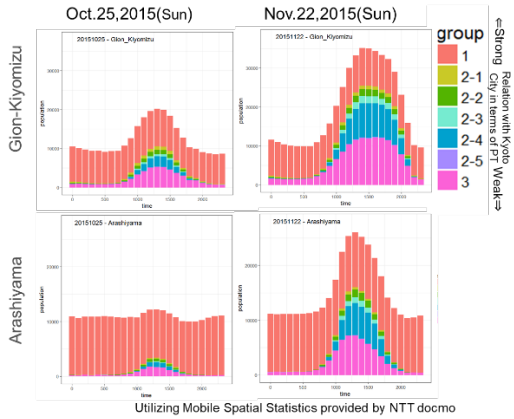
Professor	Associate Professor	Assistant Professor
Nobuhiro UNO	**Junichi SUSAKI**	**Yusuke KIMURA**

Analysis and Utilization of Spatial Information

We analyze and utilize spatial information for disaster prevention, environmental protection, urban planning and transportation management. In particular, we focus on satellite remote sensing, 3-D digital photogrammetry, laser surveying, geographic information systems, and location identification using mobile phone for monitoring, modeling, and management of urban and natural environment.

Observation of moving objects in urban area and its utilization

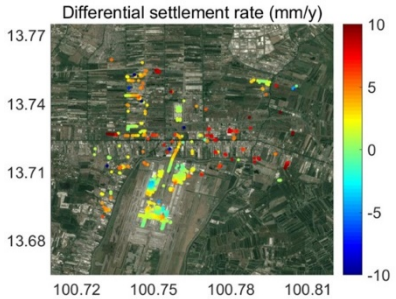
For vitalization of urban area, it is important to enhance smoothness and safety in mobility of people. Accordingly, we apply GNSS, mobile phone and video image related technologies for observation of moving objects such as travelers and cars, and attempt to propose proper utilizations of the observations to mitigate congestion, prevent serious impact from disaster, enhance tourism and so on.



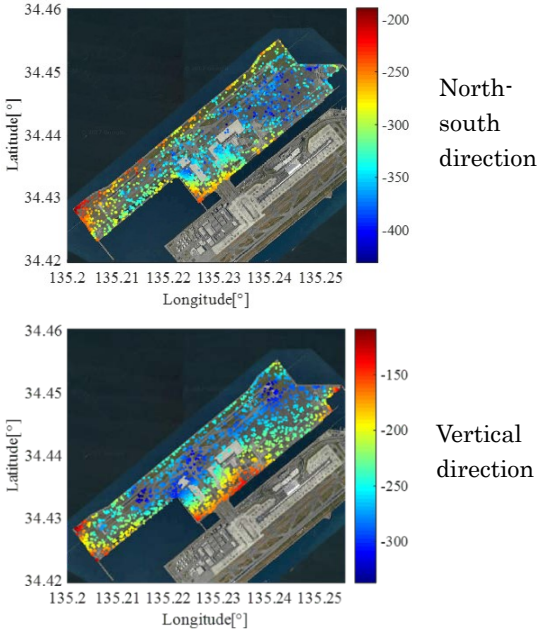
Temporal distribution of visitors by using mobile spatial data

Assessment of disaster damage and environmental changes by remote sensing

Satellite or airborne sensors can regularly observe temporal changes of land and environment on a large scale. We are developing methodologies for observing the current state and changes of Earth's surface using optical and radar sensors, especially synthetic aperture radar (SAR), for disaster prevention and environmental protection.



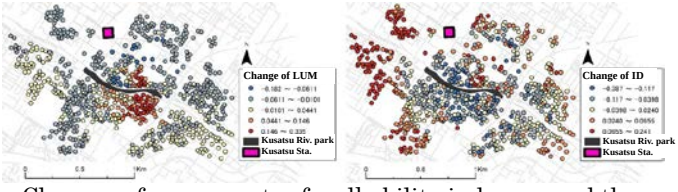
Differential settlement, i.e. gap between building base and surrounding ground, of Bangkok Airport estimated from temporal SAR images



Three-dimensional displacement of Island II of Kansai International Airport estimated from temporal SAR images and GPS data

Assessment of urban pedestrian space based of the concept of walkability

For realizing livable city or healthy lifestyle, expanding pedestrian space is becoming more important. We focus on the Walkability Index, which enable to grasp objectively and widely how walkable the neighborhood is in urban area. Using Geographic Information System (GIS), we analyze environmental factors corresponding to physical activities. We aim to develop methodology for expanding pedestrian space effectively.



Changes of components of walkability index around the Kusatsu River site park (Land use mix at left and intersection density at right)

Urban and Landscape Design

Professor
Masashi KAWASAKI

Associate Professor
Keita YAMAGUCHI

To integrate creatively the beautiful landscape and cultural environment based on rich water, green and land

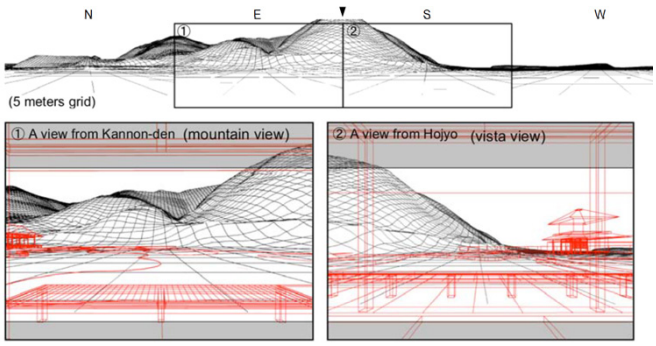
Landscape involves habitat, cultural climate and geographical field. It means integration of natural and cultural environment of mankind. This lab aims to study on the structure of the landscape based on landscape engineering, cultural climate analysis, and regional planning. It also aims to develop the methods and theory of urban and landscape planning and design to sustain and create the proper landscape and the natural & cultural environment.

Landscape Planning and Design for Public Spaces and Urban Infrastructure

By way of actual planning and design practices on Infrastructure such as roads, parks, waterfront and terminal facilities, We study on the construction of the concept for design and methods for spatial structuring, and consider making drawings and the visual simulation for the project. On the other hand, we research on the Design Methodology on making colors and texture of Infrastructure. And we aim to harmonize artificial environment with natural environment and human activities, to create spaces and facilities of inducing cultural activities.

Research on Landscape Structure and Development in Historic Districts

We aim to find the concept and methods of practical landscape design using the natural or nature-origin water ways or environment characterized by the surrounding landform, by focusing on the historical area of hillside and riverfront. And we aim to clarify the cultural trials to make connections between nature and human in the name of "sustainable development". Lastly we try to make sure the method and theory of regional landscape design for the proper, natural, and cultural environment.



Landscape Analysis of a historic site of scenic beauty

Research on Cultural and Climatological Environment

It is necessary to understand the mechanism of physical structure to evaluate the quality of the space since there is deep relationships between the structure and the space. We cannot design appropriate structures unless we consider the physical structure and the quality of space simultaneously. On such a theme of integration of engineering and architecture, we aim to develop the method of integrated design of infrastructures and design management, with studying fundamental principles underlying the structures, systematizing the design methodology, and developing the knowledge management in design.

Research on Methodology for Making Livable Cities

In order to deal with the increasing number of urban problems such as disasters, medical care, communities and environment etc., the study aims to establish the theory and methodology to make cities liveable. Our research focuses on the perception of space and environment, especially the perception of landscape, its cognitive process and a sense of place (physical realm). The results of our studies will provide the theories and methods to manage the sense of a place and redesign our environment and increase civic engagement.

Comprehensive Strategy Plan of Omihachiman City

PLANNING AND MANAGEMENT SYSTEMS

Associate Professor **Kakuya MATSUSHIMA**

Assistant Professor **Shunsuke SEGI**

Urban Management Policy in a Knowledge Society

While a knowledge society yields a variety of creative activities, policy makers are required the flexibility in decision making in order to accommodate complex urban problems. We commit to developing methodologies and policies aiming at realizing better social systems in a knowledge society. The research interests include (but not limited to) communication and human behavior, investment strategies for infrastructure, infrastructure asset management, and construction project management.

Communication Behavior in a Knowledge Society

Infrastructure shall play a greater role in developing a national wealth in a so called knowledge society, where knowledge is a driver of the economic development. We are interested in developing policies concerning infrastructure development and management derived from the new aspect of infrastructure's role in the knowledge society. The relevant questions are, for example, 'what infrastructure facilities are needed in the knowledge society?', what are the desirable urban and regional policies for the creative development? Methodologies employed to analyze those questions include the economic growth model, urban economic model, game theory and so on.

Communication is a critically important activity in knowledge society. New transportation technology and ICT (information and communication technology) has been contributed to the growing opportunity of communication among human beings. The increase of communication opportunities have a substantial impact on human behaviors which eventually results in the structural change of the social system. We are aiming at developing a model technique to investigate the strategic mechanism of mutual interaction among agents who communicate, in order to discuss relevant policies for transportation infrastructure which supports communication activities.

Fig 1. Agora as a place of meeting

Infrastructure Asset Management

While our lives heavily depend on the existing infrastructure, appropriate maintenance and repair activities are necessary to enjoy its benefit in the future as well. As the necessary cost to keep the service level of existing infrastructure is not negligible, a strategy to implement the efficient maintenance and repair works which maximize the value of national infrastructure is necessary. It requires considering the issues such as the durable period of infrastructure asset, the uncertainty of deterioration process, the value of infrastructure asset, and the life cycle costing.

The study interests related to the infrastructure asset management covers broad academic fields including modeling of the deterioration process based on the statistical approach, developing the efficient management system of infrastructure asset management utilizing the advanced monitoring and information technologies, and investigating the contracting methodologies for maintenance and repair works.

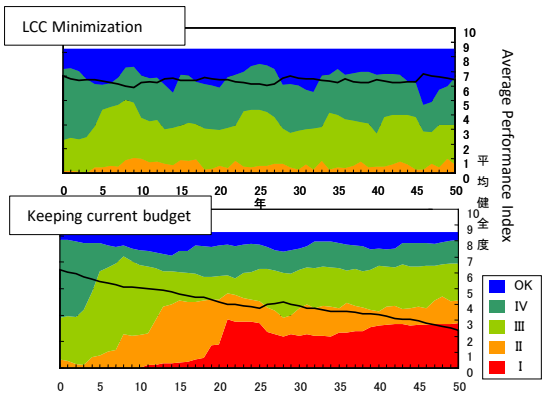


Fig 2. Life Cycle Cost Minimization using Bridge Management System

Project Management and Financing

Apart from the traditional procurement system, different schemes of construction project have emerged such as design-build contract, performance-based contract for example. Among them, Public Private Partnership (PPP) has been growingly utilized around the world, which is an emerging public procurement scheme where a single private company contracts from the design stage to operation and maintenance stage. We are interested in relevant issues of project management from the institutional point of view, such as contracting design, risk management and financing in infrastructure projects.

Urban and Regional Planning

Associate Professor **Ryoji MATSUNAKA**

Associate Professor **Tetsuharu OBA**

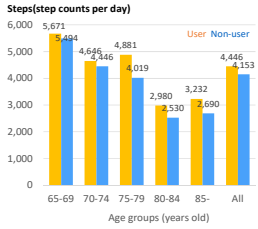
Empirical research to realize the appeal and vitality of cities

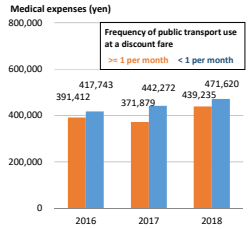
While cities play a role in people's daily activities in work, leisure, and peace of mind, they also introduce many issues such as in environment, energy, transportation, landscape, and land use. In our laboratory, in order to bring about the appeal and vitality of cities, the basic theoretical structure for solving these issues is applied to real cities and real problems in our research applications. Our goal is to observe and analyze cities, and to make use of the results of our research in greater society.

Evaluating the impact of public transport promotion on health improvement

In recent years, there is growing interest in the view that public transport plays a role in improving people's health as well as providing them with mobility. To measure the effectiveness of health promotion, we examined the impact of a fare reduction program on the step counts and medical expenses of older citizens. Step counts and travel behavior were obtained using mobile phone GPS data and medical expenses data were also analyzed. The figure below (left) compares step counts per day between older citizens who participated in the fare reduction program to those who did not. Fare reduction program users walked more than non-users in each age group. In addition, program users walked 293 steps more than non-users in all age groups.

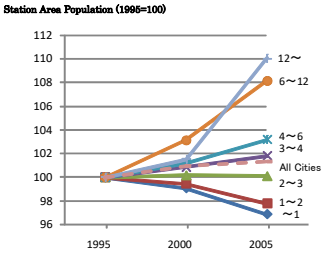
The opposite figure (right) shows the relationship between frequency of public transport use at the discounted fare and medical expenses. The data shows that medical expenses were lower in each study year for older citizens whose frequency of public transport use at the discounted fare was greater than once a month.





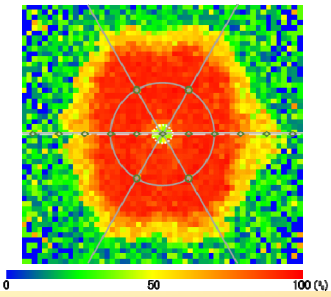
An international comparison of rail service level and urban structure

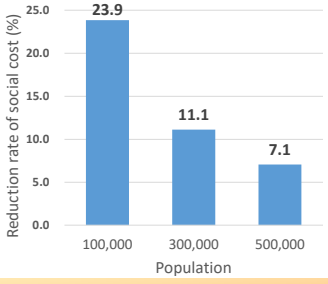
It is said that to move toward compact cities, the realization of highly-convenient public transportation is important. However, in many local cities with rail service, service levels are dropping. It is not unusual to say that service is not being put to proper use. Considering this background, real-world data is used to analyze how differences in rail convenience can bring about differences in service area population changes. The figure below (left) shows changes in station area population according to rail service levels in Japanese local cities. At stations whose service level is 3 or more trains per hour, station area population increases, but where the service level is less than 3 per hour, population decreases. It can be said that the convenience of rail service has a large accumulating effect on population. On the other hand, if service level is low, this effect is not visible. The same method of analysis is used for local cities in England, France, and Germany. The figure below (right) shows the population distribution around stations in German cities. It is clear that population concentrates in areas around rail stations.



Estimating social benefits obtained from the spread of Shared Autonomous Vehicle

With the recent development of autonomous driving, conventional transportation system will be changed radically. Shared Autonomous Vehicles (SAVs)- a combination of short term on-demand rentals and autonomous driving, will be key to driving this change. Using urban traffic simulation, we analyzed social benefits obtained from shifting from private cars to SAVs. Under several assumptions, including the complete penetration of SAVs, results show that benefits amount to 24.6 million yen per day, fleet requirements to meet trip demand is decreased by 84% and parking requirements are decrease by 71% of that of conventional cars. The figure below (left) shows reduced parking requirements in the city by percent. The opposite figure (right) shows the reduction rate of social costs simulated on different population settings. According to this figure, the smaller the population of a city, the greater its reduction rate of social costs will be. This supports our hypothesis that cities with small populations are the most suitable for implementing SAVs.





INTELLIGENT TRANSPORT SYSTEMS

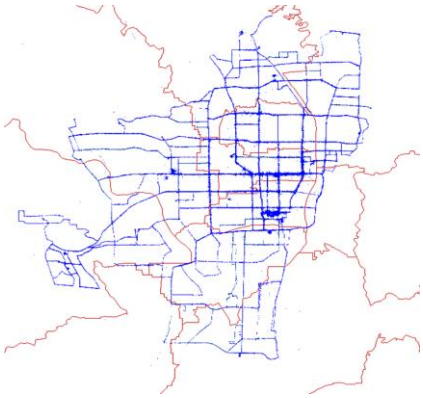
Professor	Associate Professor	Assistant Professor
Tadashi YAMADA	**Jan-Dirk SCHMÖCKER**	**Satoshi NAKAO**

Creating smart transport and logistics systems
— Intelligence and Optimization —

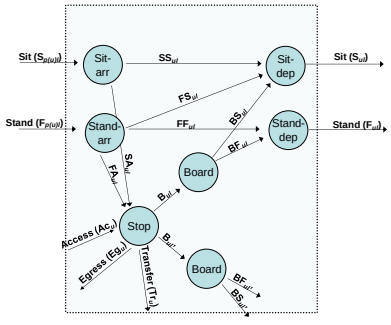
Utilizing information technologies like ITS (Intelligent Transport Systems), we have been developing efficient procedures to settle transport and logistics problems in urban areas. We are dealing with various research topics; including traffic flow modeling, transport and supply chain network design, effective operation, management and control of transport systems, and behavior analysis on private car users, public transport users and tourism.

Utilizing Big Data to understand travel patterns

Nowadays a large amount of data have become available to the transport analyst. IC card data tell us the boarding and alighting points of passengers. ETC data provide us with information for car drivers. Mobile phone data can be used to understand how many people are where during different time periods. GPS bus data give us information about bus locations and service regularity (the figure on the left shows Kyoto's bus lines obtained from GPS data). Truck data obtained via GPS or digital tachograph can indicate truck routing and scheduling. Other sensors installed within the city can help us understanding the walking pattern of people. We aim to utilise such data in an efficient way with novel analysis methodologies.



Modelling network flows for public and shared transport systems



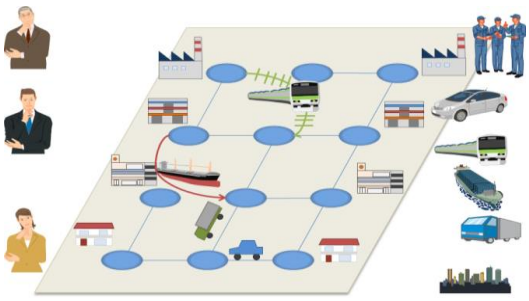
Data often build the basis for subsequent network flow models. In other cases we start from theoretical models to gain general insights into efficiencies of networks. The figure on the left shows a model of a bus stop to reflect that only some of the newly boarding passengers will be able to find a seat. Extending this model to a network helps us understanding the effect of, for example, service frequency changes. We create multimodal network flow models especially considering the growing importance of car sharing, cycle sharing, cooperative freight transport systems, and other technological developments that influence network flows such as autonomous vehicles.

Network design for transport and supply chain

Passengers and freight move on a transport network (TN). Designing optimal TNs is therefore efficient for alleviating or settling urban and regional transport problems.

In the case of designing an optimal TN in terms of logistics, we need to take into account the decisions on logistics typically made looking over an entire supply chain network (SCN). Therefore, accurate comprehension of what happens on the SCN, namely, precisely describing the behavior of economic entities in the SCN and the resulting flow of products (and of raw materials as well) is necessary to understand the mechanism of the generation of freight movement.

We are developing mathematical models to represent the behavior of manufacturers, wholesalers, retailers, consumers and freight carriers. The behavior of passengers is also incorporated within the models as well as the behavioral interaction between passenger and freight traffic. This approach is a sort of supernetwork modeling. We are also tackling the development of AI-based optimization techniques capable of solving large-sized problems.



Travel Behavior Analysis

Professor
Satoshi FUJII

Assistant Professor
Yuichiro Kawabata

Pragmatic social science regarding transportation, urban management, nation-state and environmental issues

Social science is today divided into particular disciplines such as economics, sociology, political science and social psychology, but it has originally been a pragmatic intellectual activity derived from a process in which human beings try to solve problems in the modern society. During the last 200 years, social science has lost its comprehensiveness and practical connections to the real social problems. As a result, there are unfortunately a large number of urban problems which we have no actual methodology to cope with. Our laboratory studies “pragmatic social science” dealing with real issues related to transportation systems, urban management, development of rural areas, national economy and environment. Our research is based on the axiomatic truth that these issues are all critically based on the existence of “society” and “humanity”.

Social dilemma studies and social psychology

Social issues such as environmental problems, destruction of the scenery and disorder in urban areas are mostly caused by egoistic tendencies of individuals. For instance, as a consequence of each having a desire to drive car, there are a large amount of CO2 emissions and heavy traffic congestion. This is generally called “social dilemma with conflict between public and private interests”. This research group takes psychological approaches to reveal the socio psychological mechanisms of these issues. In addition, we make an extensive effort to study countermeasures against these real issues relevant to transportation, landscape, disaster prevention and environment, and to make suggestions to adopt in the real society. In more detail, we conduct in-house experiments, field tests, administration supports and so on.



Experiment on responses to a social dilemma (Left)
“Prescription for Social Dilemmas” (Center)
“Prescription for Mass Society” (Right)

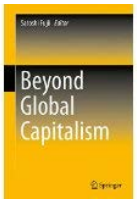
Pragmatic social science supporting the vitality of cities and nations

Civil engineering including urban and national planning aims to improve the facilities of urban and rural areas. For that purpose, “vitality” is a key: For example, community development (Machizukuri in Japanese) can be carried out by vital, active and energetic residents. Without such active residents, many cities would be devastated. We study what actions are required to increase the “vitality”, which is the core source of all the improvement, taking transportation, disaster prevention and landscape of individual cities. Then, we make suggestions for those issues. We search for social policies to increase vitality applying psychology, sociology, folklore, politics and social philosophy with keywords such as: local attachment, regional charisma, altruistic behavior, dialectics and narratives.


Field study on the background of historical landscapes (Left) / “Managing the mobilities” (Right)

National policy theory based on social science tools

In every region or city, any economic, social or cultural activity are determined by an overall national policy for national land, economy, industry, finance and trade. From that macro perspective, this research group aims to make our country wealthier and more resilient. This process will enable all the people to obtain peace and wellbeing in their daily lives. It involves national theory; economic, industrial, financial and trade policy theories, as well as comprehensive social science (macroeconomics, sociology, political economy, social psychology, etc.). In particular, the study of journalism is also part of our research since it proves to have a large impact on our economy and politics.



“Beyond Global Capitalism”
（Satoshi Fujii, 2015）

DISASTER RISK MANAGEMENT

Professor **Ana Maria CRUZ**

Associate Professor **Muneta YOKOMATSU**

Natural and Technological Disasters: Building Resilience

Growing urban populations and industrialization have resulted in more people and property at risk from natural disasters and so called Natechs (conjoint natural and technological disasters). We evaluate physical and socio-economic impacts of these complex disasters and their mitigation in an effort to promote sustainable development, reduce overall disaster losses and increase societal resilience. Our lab is multidisciplinary integrating skills and knowledge from a variety of disciplines such as engineering, sociology, economics, and disaster risk management (DRM). The lab benefits from synergistic association with local, national and international researchers and faculty. A sample of some of the ongoing research projects follows. For more details please visit our website at: www.natech.dpri.kyoto-u.ac.jp

Improving Resilience to Natech Risks

Despite efforts to consider natural hazard loads in the design and construction of industrial facilities and to ensure industrial safety, natural hazards are not part of process hazard and risk assessments resulting in inadequate assumptions concerning safety barriers as well as gaps in emergency planning. Given the potential severity of Natech accidents, a way to systematically rate improvements towards risk reduction goals, while strengthening business continuity and territory resilience is needed. We propose an area-wide comprehensive Natech risk management framework to assess and manage risks, protect residents, and ensure business continuity leading to an increase in territorial resilience. See Figure 1.

Figure 1. Area-wide Natech risk management framework.

Dynamic risk assessment of Natech hazards: The case of domino effects

Domino effects are secondary chemical accidents caused by a primary chemical accident. See Figure 2. Domino effects make Natechs dangerous and complex. Japan has many potential earthquakes like the one expected along the Nankai Trough. Thus, Natech risk assessment is needed to prevent Natech accidents and domino effects in the future.

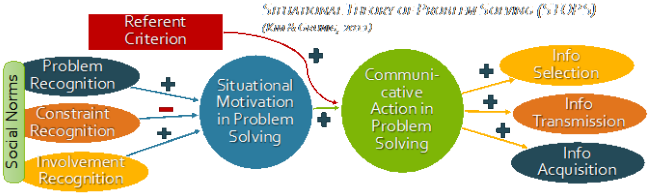
Figure 2. Domino effects at the Cosmo Oil Refinery, Japan.

In this study, we use Bayesian Network based Natech specific domino effect analysis to determine the likelihood of propagation using a probit function.

Furthermore, we propose and test a Natech specific domino effect analysis methodology using the Cosmo Oil Refinery fires during the Great East Japan Earthquake in 2011 as a case study.

Appetite for Natech Risk Information and Citizen's Communicative Behaviour

In Japan and elsewhere, there still limited to no information provided to local governments and citizens regarding the potential for chemical accidents. In areas where there is the threat of Natech accidents, the risk to nearby residential areas is even greater. In this study, we use the Situational Theory of Problem Solving (STOPS)(Kim & Grunig, 2011) to identify factors of community appetite for Natech risk information disclosure and formulate policy guidelines for effective risk communication. Figure 3 presents the STOPS model and hypothesis being tested through a household survey to residents living near industrial parks in Osaka Bay, Japan.



Economic Growth Theory under Disaster Risks

Catastrophic disasters bring long-term socio-economic impacts. The severity of impacts depends on the development level of society, and may vary among income classes. People in developing countries can suffer from a disaster-triggered poverty trap after being thrown into an economic environment where individuals have to curtail their education time for working hard to secure livelihood, which decreases human capital and increases disaster vulnerability. Disaster intrinsically brings more severe damage to lower income people, and therefore, it turns out that disaster prevention infrastructure is more beneficial for the poorer people. We formulate stochastic economic growth models to investigate the long-term macroeconomic impacts of disaster and examine how inequality changes in the development process of disaster recovery and reduction through policy implementation.

Integrated Disaster Risk Management Systems

Professor
Hirokazu TATANO

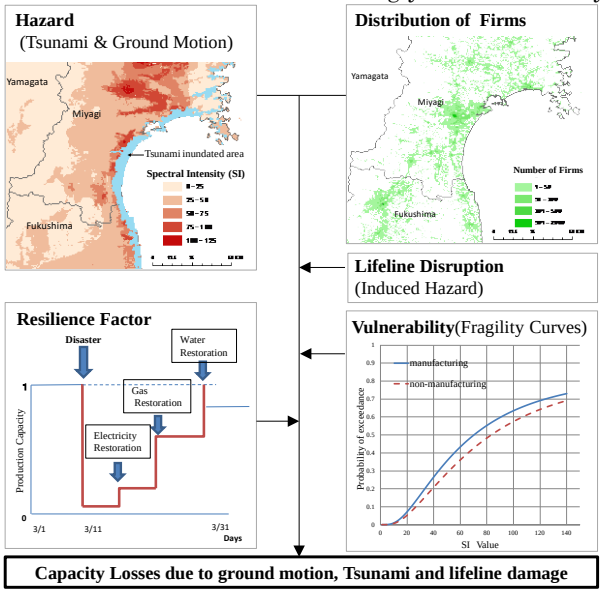
Associate Professor
Subhajyoti SAMADDAR

Social Systems for Disaster Risk Governance

To realize a safe and secure society, integrated disaster risk governance is a key infrastructure which supports design and implementation of management policies consisting of risk control and financing. Considering disaster risk governance and/or management, public involvement and participatory approach to planning are essential frameworks. Our laboratory focuses on human behavior before/during/after disasters and aims at constructing original methodologies for efficient integrated management of disaster risk. It also aims at establishing a comprehensive mechanism for successful implementation of disaster risk reduction strategies through better risk communication.

Economic Impact Assessment of Natural Disaster

In order to enhance social resiliency against natural disaster, it is necessary to introduce integrated disaster risk management measures effectively. Establishment of methodology for design and estimation of effective alternatives against disaster is requested. In our laboratory, consistent measurement of economic losses of a natural disaster considering the problem of double counting is promoted. For evaluation of the overall economic impact of a natural disaster considering the recovery process, attention needs to be paid to the problem of double counting of economic losses. For this purpose, it is necessary to answer the following research questions: (1) how does a natural disaster impact the economy at each phase of the disaster and recovery, and (2) how do you consistently evaluate overall economic losses of all stakeholders during the recovery process. Methods for avoiding double counting of losses are referred to as "consistent measurement" of economic losses and have been increasingly studied recently.

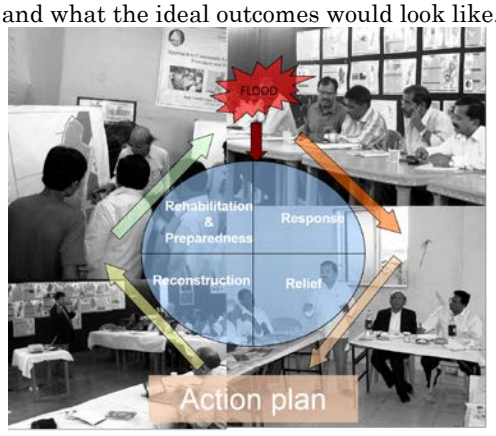


Risk Communication and Community Based Disaster Risk Management

Community preparedness and community participation in disaster management are considered cornerstones to realize the vision for disaster resilient community. In practice, however, local community are left unsolicited and their preparedness remains unrealized. This calls for better risk communication and risk governance. Our research endeavors, therefore, encompass in following areas

(i) Household Preparedness and Risk Communication: We examine the cognitive perceptual process of an individual during his/her preparedness decisions, which include an individual's risk perception, response orientation and preparedness intention and so on. Further, we investigate, how these beliefs are shaped and constructed through social learning and social influence in order to develop a comprehensive risk communication mechanism.

(ii) Evaluating Community Participation in Disaster Risk Governance: Our objective is to develop an implementable mechanism for community participation. Therefore, we redefine "community" from a disaster management perspective - how communities are formed as a response to, in the aftermath of and in adapting to long term disaster. We investigate in what ways (when, how, to what extent and effective tools) such communities can be effectively involved, and what the ideal outcomes would look like.



Facilitating the Preparation of a Community Led Action Plan for Flood Risk Management

Integrated Disaster Reduction Systems

Professor
Katsuya YAMORI

Associate Professor
Masamitsu ONISHI

Assistant Professor
Genta NAKANO

Interdisciplinary approach to disaster reduction

We commit to contributing to disaster risk reduction by implementing various policy approaches from the both of social and natural scientific point of view. Particularly, we emphasize the aspect of social psychology to establish information system, education methodology and culture for disaster risk reduction. In addition, we also employ the systems analysis approach to develop reasonable strategies and plans of hard policies as well as soft policies for disaster risk reduction.

Building Implementation Science of Disaster Reduction

Implementation science should be developed and implemented in a scientific manner. Because implementation deals with how well scientific knowledge is implemented in an arena in which more diverse stakeholders rather than only limited number of scientists join, knowledge of implementation science by itself should be developed in a more dialogical and more discursive way. In other words, implementation science is a process to (re-)co-construct knowledge networks in which multiple locally and/or temporarily "viable solutions" co-exist and are mutually interlinked, rather than a process to identify universally "correct solutions" exclusively by scientists.

Thus, we need to create a new-type of communication medium by which people can see a society, not as a world where a single "correct solution" is specified by privileged persons, such as a professional scientist, an influential politician, or an talented administrative government officer, for example, but as a debatable, conflicting, and dilemmatic world, and thus, a world where multiple "viable solutions" can coexist.

Concrete Research Targets

The followings are seven major research targets:

1) Promoting citizens' participatory disaster management system in a local community.
2) Developing disaster education tools and methods to be used at a school and in a local community.
3) Developing countermeasures to reduce damages caused by big and complicated disasters like the Tokai, To-Nankai, and Nankai earthquake, the earthquake in Tokyo Metropolitan Area and large-scale eruption of Mt. Sakurajima.
4) Building a crisis management system for catastrophic natural and man-made disasters.
5) Analyzing disaster information from the viewpoint of social sciences such as mass media studies, risk communication studies, and narrative theory.
6) Creating theoretical foundation of implementation science in disaster reduction studies.
7) Developing computer simulations to estimate damages caused by the Nankai Trough Earthquake and Tsunami

Fig.1 Examples of disaster education materials, "Cross road," and "Nige-tore," developed in the laboratory

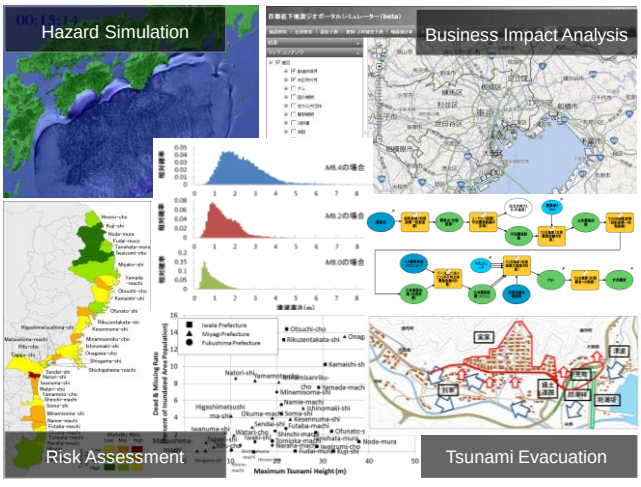


Fig. 2 Examples of computer simulator to estimate hazards and damages caused by the expected Nankai Trough Earthquake and Tsunami.

Crisis Information Management Systems

Professor
Michinori HATAYAMA

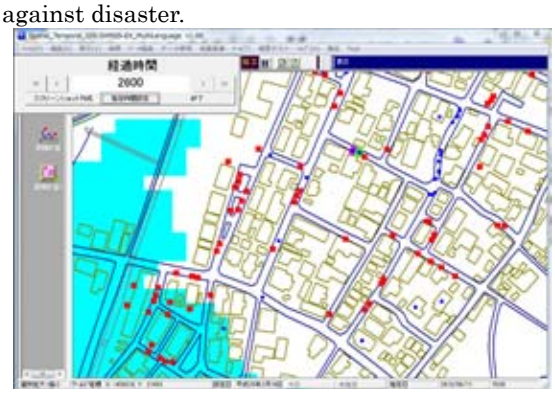
Associate Professor
Kei HIROI

Disaster Information Systems with Information Technology

After Great Hanshin-Awaji Earthquake in 1995, Rapid and remarkable advances have been made in Information Technology (IT). A number of advanced information systems were proposed, but most of them didn't work sufficiently as we expected under disasters. Our goal is to establish design methodologies for development of effective disaster management systems against various types of disaster for National/Local Government, local communities in affected areas and disaster relief organizations. One of the most important key technology is spatial temporal database to record, visualize and analyze current/near future status in affected areas. In addition, our laboratory focuses on human behavior before/during/after disasters as targets to supply valuable services

Disaster Management / Response Support System based on Advanced IT

Our goal is to submit efficient information system considering human behavior for disaster prevention and mitigation. In our laboratory, we have been developed several disaster management systems such as evaluation of regional disaster response plan and Tsunami evacuation plan and IoT based Early Warning System for sediment disaster and tried to implement them to local governments and regional communities to improve their coping capacities against disaster.



Tsunami Evacuation Evaluation System
as a disaster risk communication tool

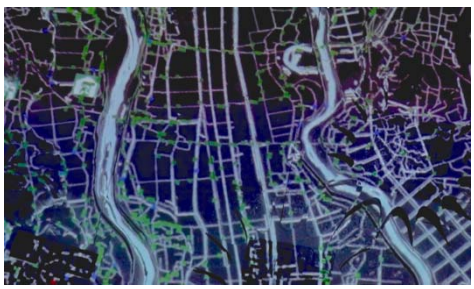
Development of Spatial Temporal and Parallel world Shared Information Platform to realize RARMIS Concept

Through the experience with disaster and recovery support activities obtained as a result of Great Hanshin Earthquake, our research group have been developing an information system that can use after immediately a disaster in local governments and their surroundings, such as regional communities, and studying implementation processes to them. RARMIS (Risk-Adaptive Regional Management Information System) concept is an output of these activities. In the concept for disaster risk management we proposed an information system which has these three features; (1) continuity between emergency and routine use, (2) independence and decentralization, and (3) integrated space and time information.

We have already implemented database management system for routine and emergency work in local government. However, fundamental technology is evolving day by day. We try to submit a next generation system which replace system which we have developed.

Cutting-edge Data Analysis Methods / Data Federation Platforms that are Compatible with the Real World

AI, big data, and IoT have come to be common in every situation. However, it is difficult to use such convenient technology in an emergency. The data that can be collected in a disaster is limited. This research proposes a system that enables stable data collection even in a disaster, and an analysis method for precisely predicting damage from limited data using the cutting-edge IT. Another goal is to research and develop superior IT that is compatible with real world and IT development. Another goal is to research and develop superior IT that is compatible with real world and IT development. It is important that the system or technology can actually be used. We are carrying out technical and social development of system architecture that enables high-speed/performance calculation processing even in an environment with many restrictions, network protocols and cyber-physical systems that realize data federation of various systems and simulations.



Data Federation Result of Simulator in Flood Situation