CIVIL ENGINEERING

Kyoto University

Structural Engineering Laboratories

Katsura Campus

Applied Mechanics (応用力学講座) **(page 13)**

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 Structure (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)

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 (防災技術政策研究分野)

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

Regional Water Environment System Research (地域水環境システム計画分野)

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)

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Computational Engineering (計算工学講座)

Geotechnical Engineering Laboratories

Katsura Campus

Geomechanics (地盤力学分野)

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

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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)

Logistics Management Systems (ロジスティクスシステム工学講座)

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)

Disaster Information and Intelligence (危機管理情報システム分野)

Structural Material Engineering

Associate Professor Takashi YAMAMOTO

Assistant Professor Satoshi TAKAYA

Strong Beautiful and Durable -Concrete Structures-

In this laboratory, we study properties of various structural materials used for construction or repair of infra-structures. Because especially concrete is one of the most popular materials, we mainly study 'micro structure to macro structure' of concrete in order to develop more effective and economic maintenance method of concrete structures.

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 have to be carried out. Fig.1 is SEM pictures of typical corrosion products Goethite (α-FeOOH) and Lepidocrocite (γ-FeOOH). The purpose of this analysis is to make clear influence of surrounding environment on formation of corrosion product.

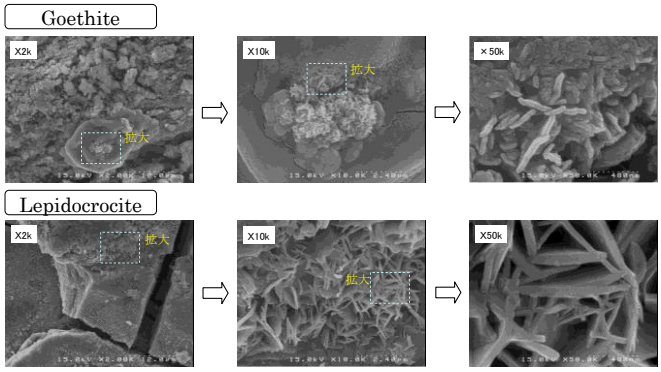


Fig.1 SEM pictures of Goethite and Lepidocrocite

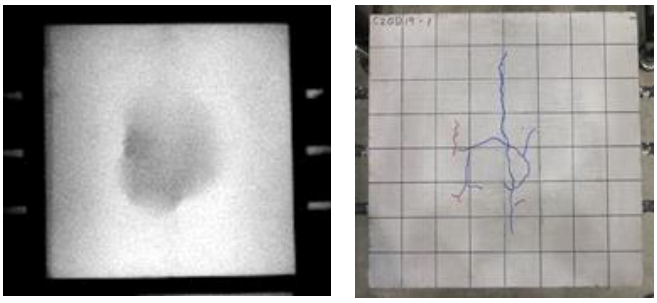
Durability and Scenario Deasign

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.2 shows the flexural loading test and the FE analysis of reinforced concrete (RC) beam with the corroded reinforcements.

Fig.2 Flexural loading test and FE analysis of RC beam with the corroded reinforcements

Inspection Method for Maintenance

In order to achieve sustainable society, maintenance is essential. Then we also study on development of evaluation method of soundness of concrete structures. Furthermore, we study on development of repair and strengthen method. Fig.3 shows the results of observation of inner crack induced by reinforcement corrosion with infrared thermography. The purpose of this study is to establish quantitative prediction method of crack propagation with infrared thermography.



(a)Thermography Picture (b)Visible Inspection

Fig.3 Crack inspection by infrared thermography

STRUCTURAL MECHANICS

Professor	Associate Professor	Assistant Professor
Kunitomo SUGIURA	**Masahide MATSUMURA**	**Yasuo SUZUKI**

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.

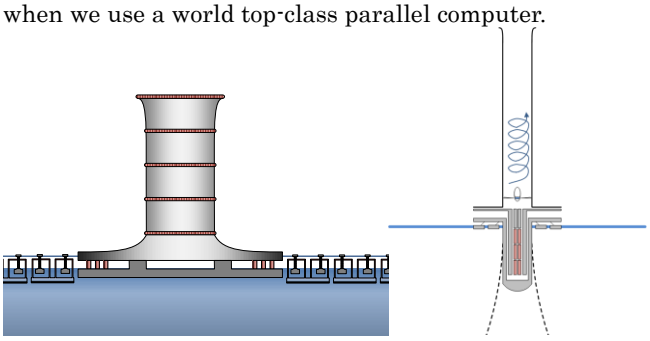
Application of Advanced High Performance Materials to Bridge Structures

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.

Development of Very Large Floating Structures

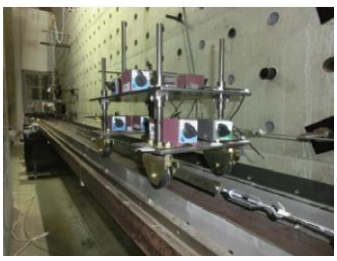
In order to guarantee safety and serviceability of Very Large Floating Structures (VLFS) such as "Floating Bridge", "Floating Power Plant" and "Floating Airport", it is essential to estimate accurately dynamic responses of deflections, accelerations and stresses as well as rigid-body motions due to excitations by waves. In the analysis, dynamic fluid-structure interaction effect must be considered. Until now, many studies have been done on this topic, where only idealized models can be treated. However, in real projects, "response analysis for complicated models (complicated shape consisting of many structural components) with ultra-large degree of freedom" is required; which is still a very difficult problem to be solved even when we use a world top-class parallel computer.

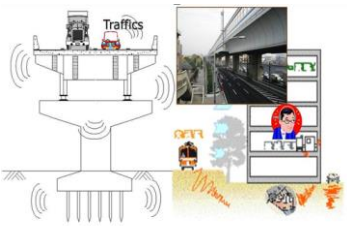


Nondestructive Evaluation of Structural Integrity and Lifetime Assessment

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

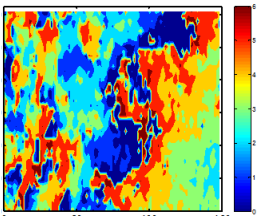
Professor
Hiromichi SHIRATO

Associate Professor
Lin AN

Pursuit of a safe living environment - through mechanics of structure and wind -

In order to create safe living environment with infrastructures with long durability and enough reliability, it is important to predict the precise response of structures due to external forces and to reflect the results to the design of structures. In this research group, various problems related to structures and wind are investigated through observations, experiments and numerical analyses. The quantitative prediction of salinity adhesion to steel structural members and intrusion to concrete members, and the development of power generation using solar radiation aiming higher efficiency are also ongoing challenging subjects.

Effect of turbulence on aerodynamic phenomena

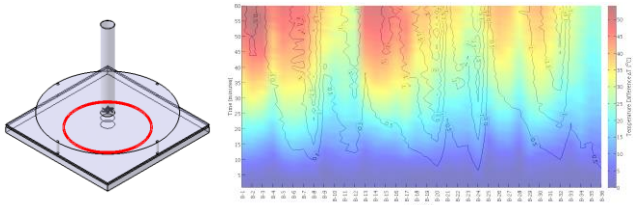


The influence of turbulence enables more precise evaluation of wind loads and aerodynamic response of structures. We explore the mechanism of the turbulence effects through wind tunnel experiments.

DMD analysis of velocity fields in bottom layer of a separation bubble.

Power generation using solar radiation aiming higher efficiency

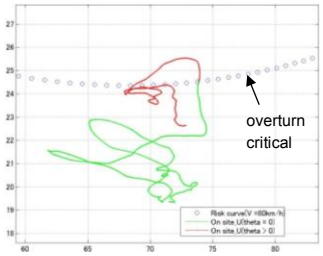
The Solar Updraft Power Generator (SUPG) must have higher efficiency in order to broaden its suitable area on the earth and its feasibility by furnishing more compact structure. We began with developing fluid-thermal mathematical model in SUPG which was validated by fundamental experiments. New series of experiment in out-door is expected to start as a next step.



Experimental model of SUPG and comparison of efficiency in power generation.

Safety of vehicles to crosswind

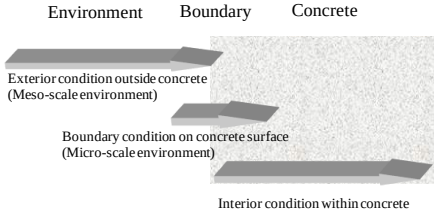
When a vehicle running in high speed encounters strong crosswind, meandering may occu or overturning in worst case. In order to avoid such occasion and assure safety, the aerodynamic force on a vehicle and the short-term wind prediction are now investigated. An application to railway system, development of engineering logic in remove of regulation are next target of our research.



Simulation of tilting angle of a moving vehicle due to un-site wind (red: a vehicle tilts and follows to overturn.)

Environmental action on concrete surface boundary due to air-born salt

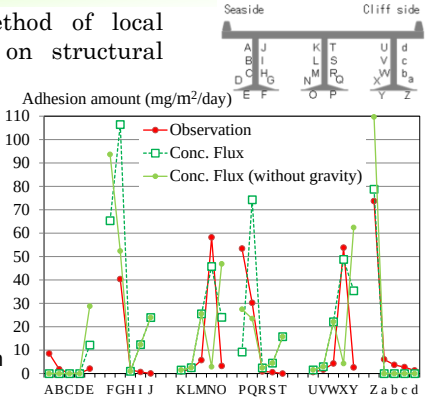
To evaluate the deterioration of concrete structure due to air-born sea salt, three conditions have to be considered as shown in the figure. The purpose of this research is to clarify the fundamentals on penetration of air-born salt into concrete surface layer and construct corresponding simulation models.



Three kinds of environmental conditions acted upon concrete structures

Evaluation of local sea-salt deposition

The evaluation method of local sea-salt deposition on structural members is to be developed. Numerical weather forecasting model and statistical evaluation will be combined to predict long-term deposition.



Local salinity deposition around a bridge girder.

Structural Dynamics

Professor
Tomomi Yagi

Associate Professor
Yoshikazu Takahashi

Dynamics of Infrastructures due to Earthquake and Wind

The research topics of Structural Dynamics group are centered around various engineering issues related to structural dynamics, wind engineering, 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.

Dynamics induced by Earthquake

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.

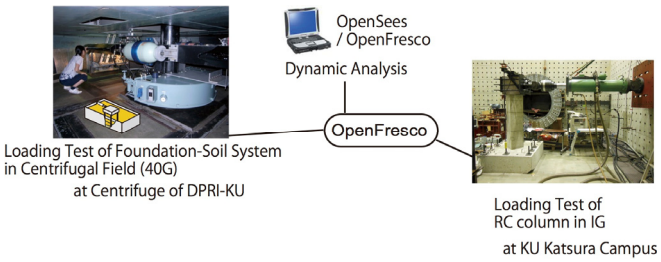
Seismic performance of infrastructural systems

To evaluate the dynamic nonlinear response quantitatively, Middle-scale models were excited at the world's largest shake table, E-Defense. 16 RC column models were placed on the 20 x 15 m table and excited simultaneously.

Simultaneous Excitation of 16 RC Piers at E-Defense

Hybrid simulation for large infrastructural systems

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.

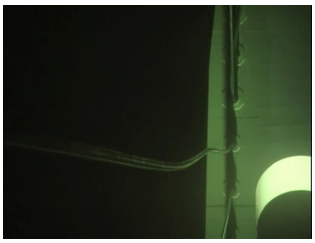


Dynamics induced by Wind

Under the theme of wind resistance of the structures, the mechanisms wind-induced vibrations of structures such as bridge decks and cables, and their countermeasures are investigated using wind tunnel tests. Also, the research area which covers 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.

Wind-induced vibration of cables

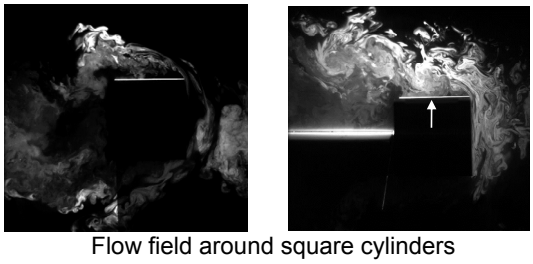
It is well known that the cables vibrate under wind and rain, which is called the rain-wind induced vibration. The generation mechanisms of this complicated phenomenon are considered as water rivulet on the cable surface, axial flow in the wake and so on. Recently, the vibration under dry condition, 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 cable, precise response prediction are investigated.



Rain-wind induced vib.

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. For example, 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

Int. Management of Civil Infrastructure

Professor
Chul-Woo KIM

Associate Professor
Sunmin 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. Researches also focus on reanalyzing proper design values for hydro-structures considering climate change.

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.

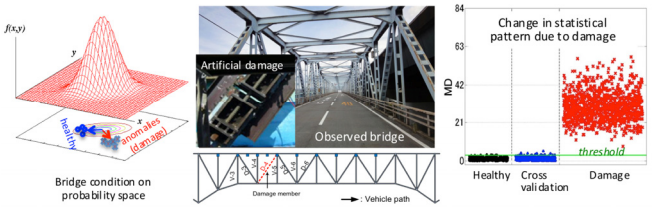


Fig. 1: Statistical fault detection (left)/ Damage experiment on a real truss bridge (middle)/ damage detection result (right).

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.

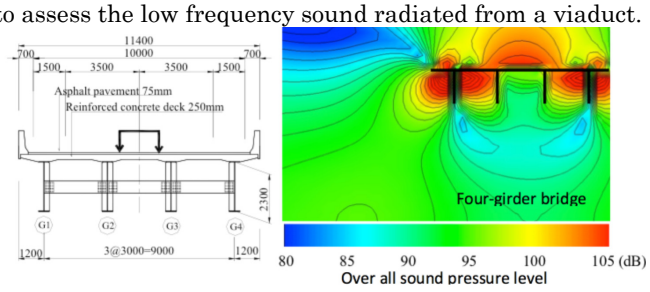


Fig. 2: Simulated sound propagation radiated from four-girder bridges.

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.

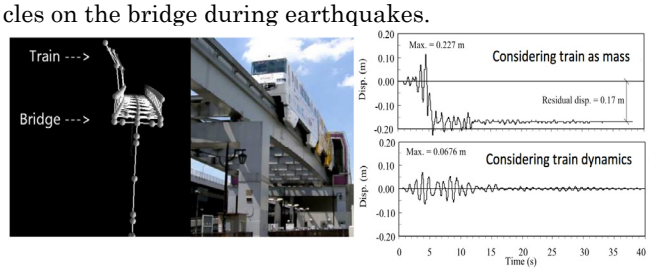


Fig. 3: S Seismic responses of monorail train and bridges by simulation.

Design of hydrologic structures considering climate change

We are reanalyzing proper design values for hydrologic structures, such as dam reservoir size and floodplain area, considering non-stationary pattern of extreme events under climate change condition. We are also developing statistical downscaling methods and bias correction methods on the output of General Circulation Model (GCM), which has a global scale resolution, to carry out local scale analysis with higher resolution and decreased uncertainty.

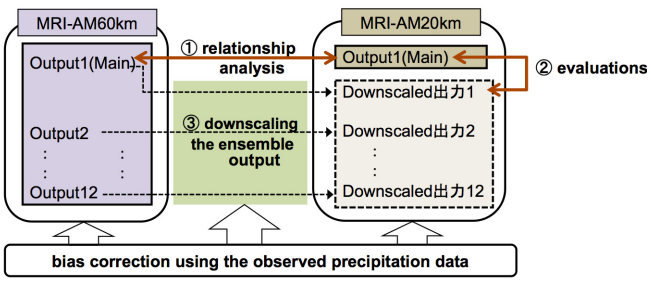


Fig. 4: Concept of statistical D.S. and bias correction.

STRUCTURES MANAGEMENT ENGINEERING

Professor
Hirotaka KAWANO

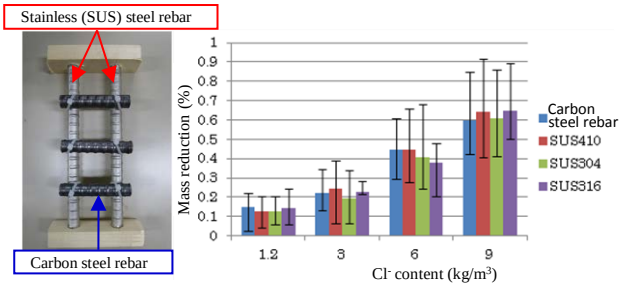
Associate Professor
Atsushi HATTORI

Development of New Structures Management

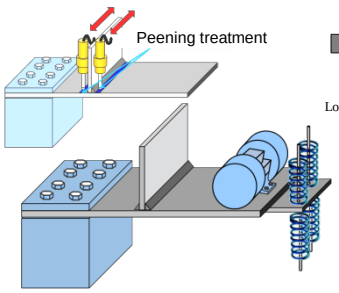
It is important to maintain performances and functions of our infrastructures to achieve their long service life and to reduce negative environmental impact in order to establish our social sustainability. In this laboratory, with focusing on high performance materials and/or recycled materials as well 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

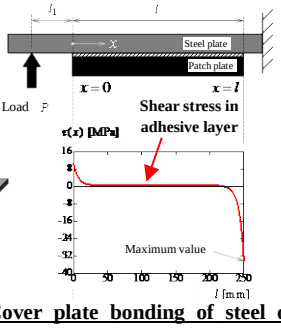
Mechanical behaviors, environmental impact and durability of high performance materials, recycled materials as well as traditional materials are investigated and evaluated.



Galvanic coupling between carbon steel and stainless steel in concrete containing high amount of chloride ion



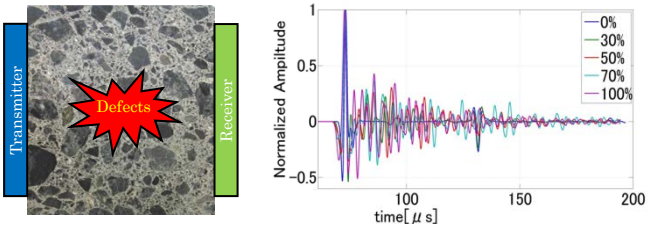
Proactive peening treatment to prevent fatigue failure



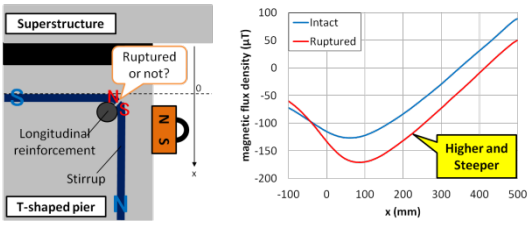
Cover plate bonding of steel or carbon fiber for repair of thinned steel member due to corrosion

Inspection and deterioration prediction of existing infrastructures

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



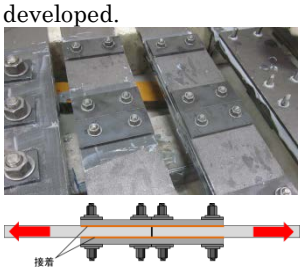
NDT technique for checking health condition of infrastructures



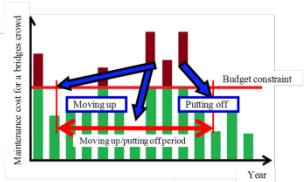
Nondestructive investigation of steel rupture in concrete

Maintenance management of infrastructures

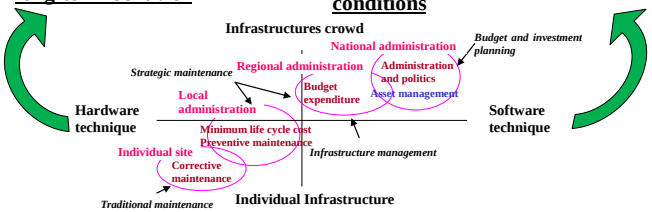
In order to maintain infrastructures efficiently, hardware related techniques and software oriented techniques such as strategic maintenance planning are connectedly developed.



New technique to improve long-term behavior



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

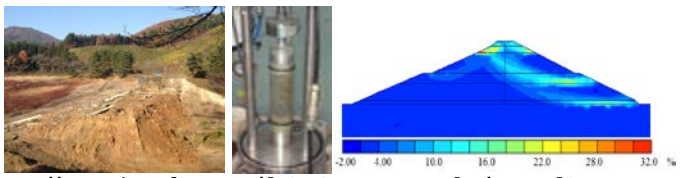
Professor	Associate Professor	Assistant Professor	Assistant Professor
Junji KIYONO	**Aiko FURUKAWA**	**Yoshihiro OKUMURA**	**Charatpangoon BHUDDARAK**

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.

Investigation of Failure Mechanism of Earth Dam during Earthquakes

During the 2011 Tohoku earthquake, Fujinuma dam, an irrigation earth dam in Fukushima Prefecture, had collapsed with homes washed away and 8 people had lost their lives or are still missing. It is important to understand the failure mechanism of earth dams during earthquakes, and take effective measures. Our laboratory had conducted field investigations, soil tests, and microtremor observations of Fujinuma dam, and understood the underground structure. Moreover, the finite element analysis had conducted to understand the failure process during the earthquake. Since the finite element analysis based on the infinitesimal strain has limitation in predicting large deformation during earthquakes, we are developing soil-water coupled dynamic finite element method based on the finite strain theory.



Fujinuma dam after Tohoku earthquake | soil test | Analysis result (Shear strain distribution)

Fig. 1 : Investigation of failure mechanism of Fujinuma dam

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.

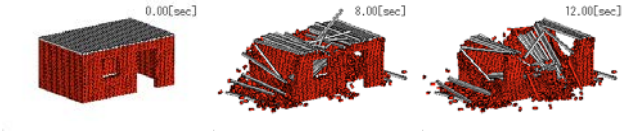


Fig. 2 : Failure process of masonry structures

Integrated Tsunami Disaster Reduction for the Flexible and Resilient Society

The great earthquake and tsunami along the Nankai Trough will occur in the near future. In anticipation of the wide-area catastrophic disaster, the disaster flexible and resilient society should be built. Therefore, integrated tsunami disaster reduction research is conducted through developing the tsunami inundation and evacuation simulation.

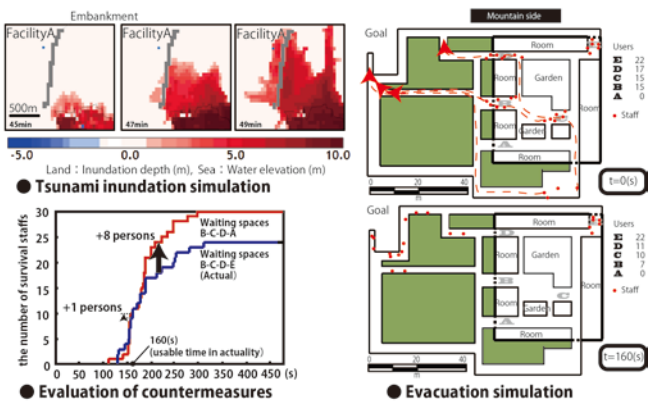


Fig.3: Countermeasures for the flexible society against disaster magnitude

Dynamics of Foundation Structures

Professor
Sumio SAWADA

Associate Professor
Hiroyuki GOTO

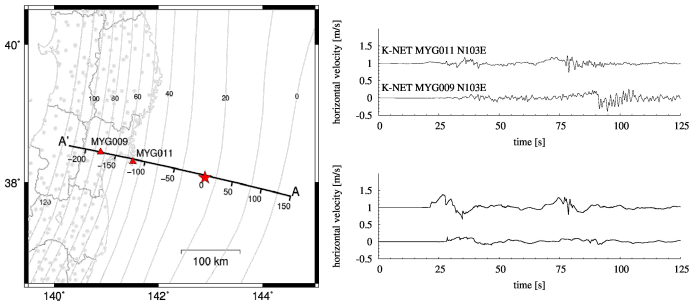
Innovation in Earthquake Engineering
– theoretical investigation & new generation devices –

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.

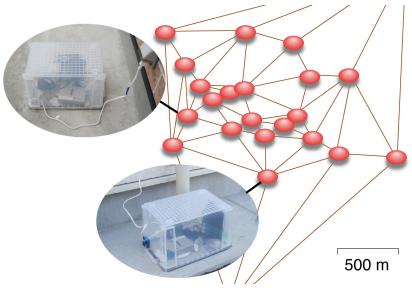
Theoretical investigation of earthquake disaster mechanism

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.



(a) Rupture simulation for the 2011 great Tohoku earthquake.



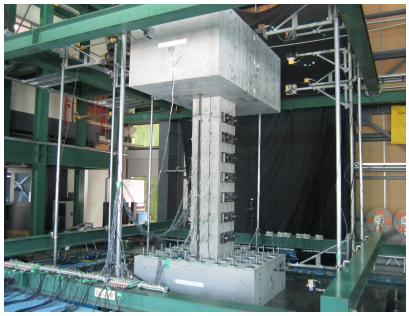
(b) Super-dense seismic array observation in Furukawa area.

New generation devices and structures

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.

(c) New device preventing a liquid sloshing behavior.



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

Urban Flood Control

Professor
Akira IGARASHI

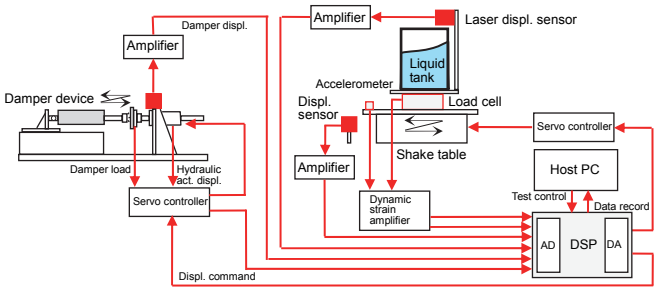
Associate Professor
Nozomu YONEYAMA

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

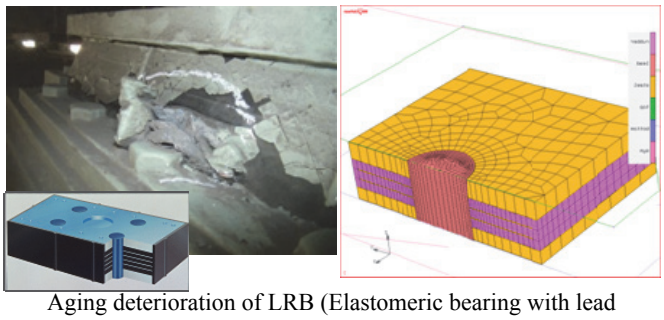
Implementation of advanced experimental systems based on the real-time hybrid simulation is investigated. In this unified testing-computing dynamic simulation, response calculation of the numerical substructure with computers and dynamic loading test of elements using shake tables or dynamic actuators, 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.



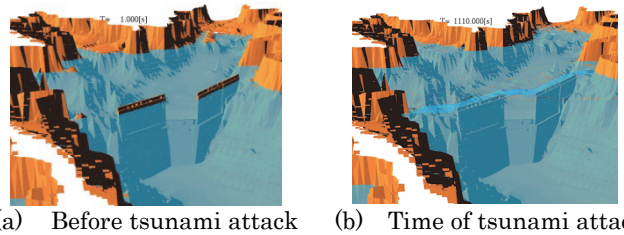
Aging deterioration of LRB (Elastomeric bearing with lead plugs) and numerical analysis

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.

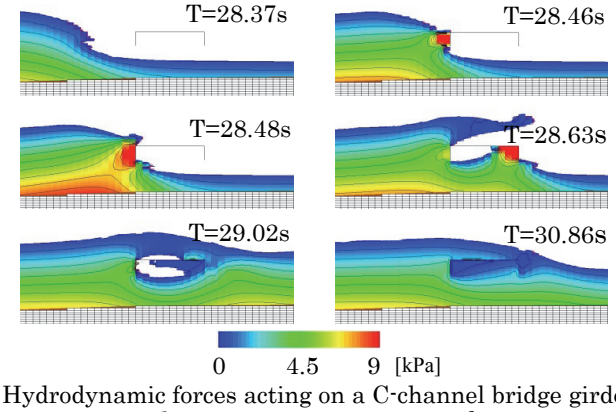


(a) Before tsunami attack (b) Time of tsunami attack

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

APPLIED MECHANICS

Associate Professor
Abbas Khayyer

Associate Professor
Jun Saito

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 multi-physics particle-based models for practical simulation of engineering problems. The main areas of interest include violent fluid flows, multiphase flows, 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 highly-deformed convection-dominated 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 overcome by development of accurate schemes for discretization of the constitutive governing equations (e.g. Navier-Stokes). The main future/ongoing researches 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 meticulous modeling of the governing physics
3. extension of developed particle methods to model fluid-structure interactions by considering the Cauchy momentum equation governing the dynamics of elastic structures.

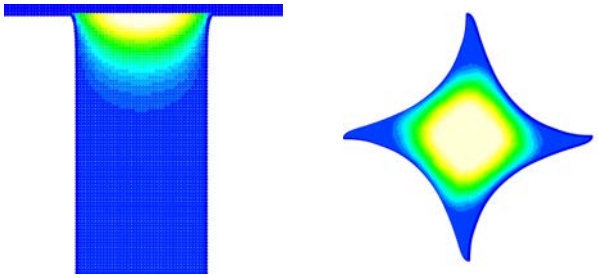


Fig.: Particle-based simulation of fluid flows

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.

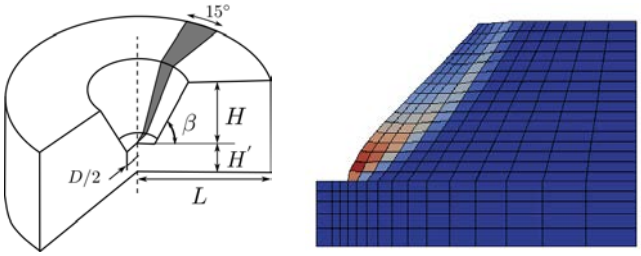


Fig.: Stability analysis of excavation

Numerical analysis of non-Newtonian fluid for civil engineering

Numerical analysis of non-Newtonian fluid is of importance in civil engineering. For instance, fluid behavior of fresh concrete, avalanche or mudslide is modeled as non-Newtonian fluid. The aim of the study is to develop numerical schemes for the fluid analysis and apply them to various problems.

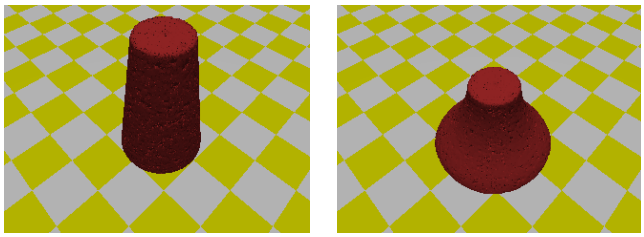


Fig.: Simulation of concrete slump test

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

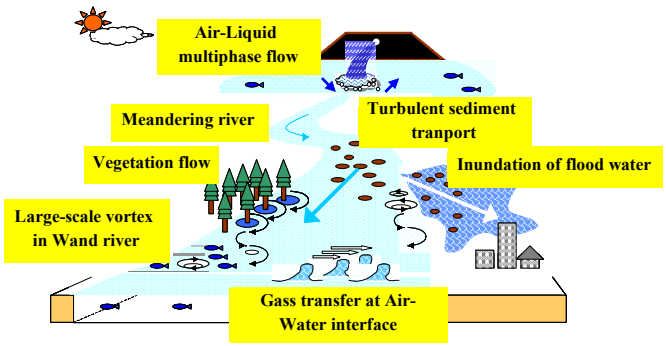


Fig. 1 : Hydrodynamics in actual river.

- **Urban Flooding**
  It is very important to clarify car behaviors in flooding. We study the critical incipient condition and the subsequent floating motion experimentally, using small-scale model cars (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 (Fig.3).

- **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.4).

Fig. 2 : Floating motion of vehicles

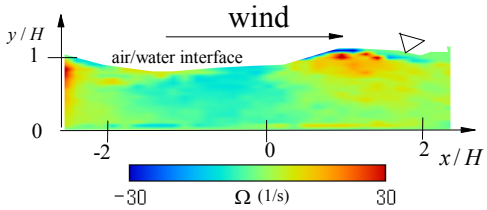


Fig. 3 : Coherent vortices in wind-induced open-channel flows

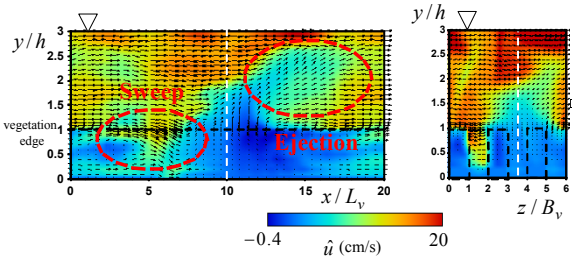


Fig. 4 : 3-D flow structure of vegetation flow

- **Hydrodynamic Characteristics in Open-Channel Flows with Side Cavities**
  "Wando" has been noticed as one of environmental hydraulic structures in actual rivers. Wando means a side-cavity in rivers, which is made by set groins in rivers bank. In and around Wando, variable aquatic eco-systems are formed. We have been carrying out the turbulent measurements and analyzing flow properties in such Wando regions.

Hydrology and Water Resources Research

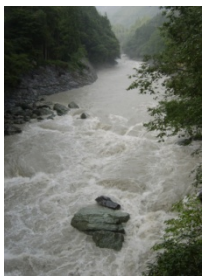
Professor	Associate Professor	Assistant Professor
Yasuto TACHIKAWA	**Yutaka ICHIKAWA**	**Kazuaki YOROZU**

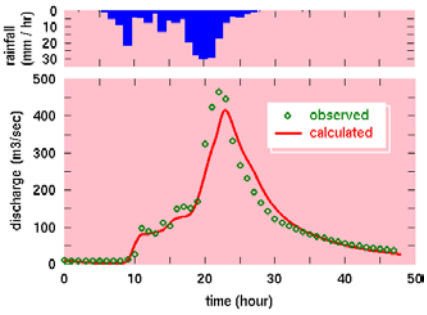
Towards a better relationship between human society and water resources

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.

Analysis and numerical modeling of hydrologic processes

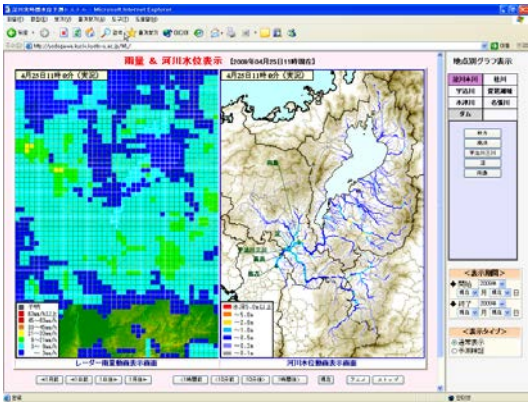
Understanding the hydrologic cycle is the basis for river planning and mitigation measures against water-related disasters. We analyze hydrologic phenomena in various aspects and improve our understanding of the hydrologic cycle.





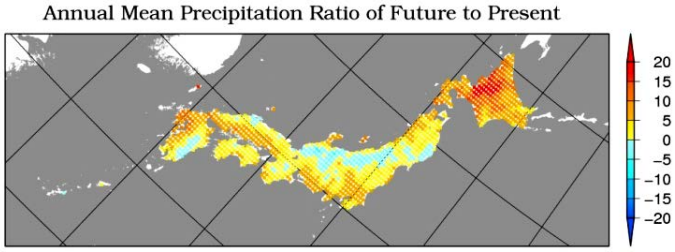
Fundamental technologies for river planning and real-time hydrologic forecasting

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



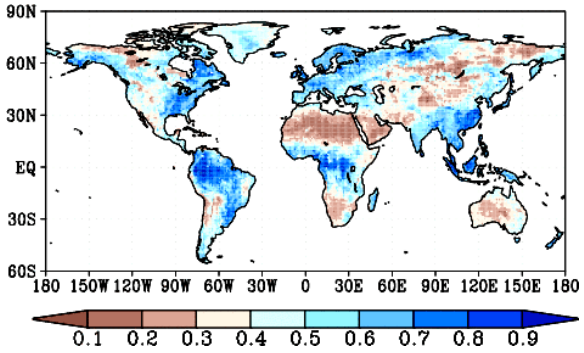
Climate change impacts on water resources

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 hydrologic 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 hydrologic cycle is the central focus of hydrology. Atmosphere-land surface interaction plays a dominant role on the hydrologic 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
Hitoshi Gotoh	**Eiji Harada**	**Hiroyuki Ikari**

Simulation engineering by Lagrangian particle method

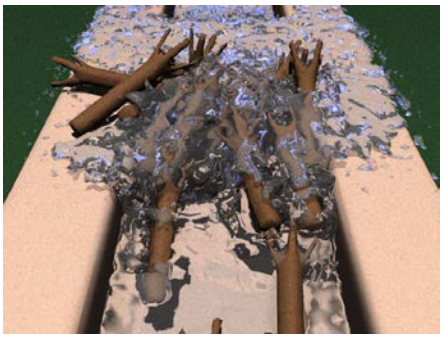
A leading technology in computational science of fluid flow (solid-gas-liquid multiphase flow) by using particle method is developed for dynamics of violent flow. We aim for establishment of the methodology of computational science and engineering, to describe various phenomena in civil engineering by 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.

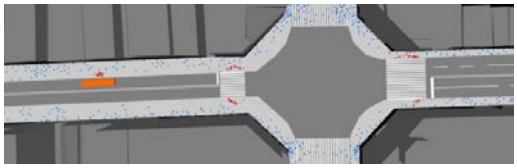


Computational Sediment Hydraulics by Multiphase Flow Model

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

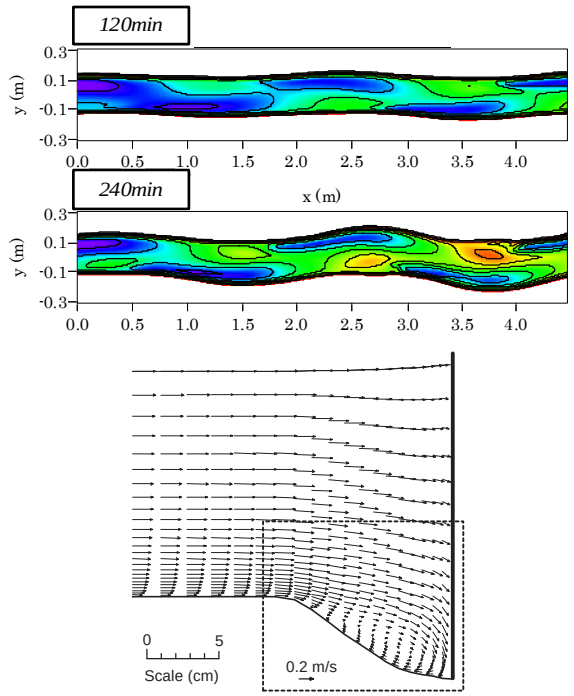
Professor	Associate Professor	Assistant Professor
Takashi HOSODA	**Kiyoshi KISHIDA**	**Shinichiro ONDA**

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

It is necessary to consider complex 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 and its applications based on hydrodynamics, river engineering and geo-water system engineering and management.

Development of Numerical Model of River Flows and Bed Deformation

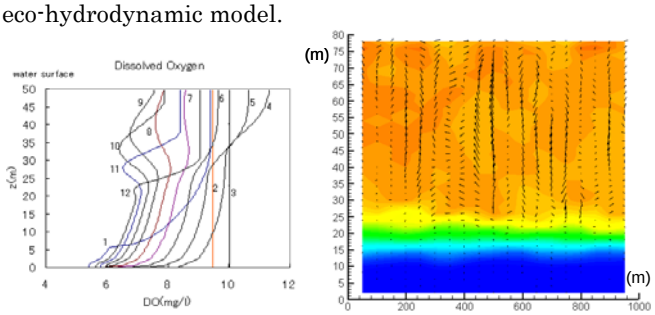
It is of great importance to develop a numerical model of river flows and sediment transport, to predict water stage during floods and river bed deformation and to design a stable channel as well as ecological issues. We have been developing various kinds of computational models for a prediction method. Some examples of the simulated results on the initiation of river channel meandering caused by the generation of alternative bars, flow meandering and bank erosion, and local scouring around a bridge pier are shown as bellow.



Numerical Simulation of Water Environmental Problems

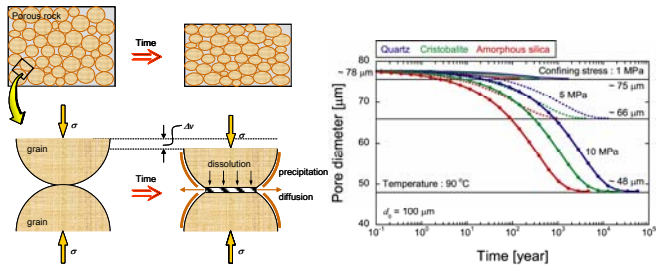
An eco-hydrodynamic model for a lake and an enclosed water basin has been developed to predict future change of situation and to assess the effect of the global warming.

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.



Estimation of Mechanical and Hydro-mechanical Behavior on subsurface

As one of the measurements for disposal problem of high-level radioactive wastes, stratum disposal using the underground cavern is considered. To deal with such a problem, visualization of underground geo-structure, excavation of underground space, and monitoring of the stored waste or the global warming gas (advection and dispersion) should be carried out. We are studying mechanical (M) and hydromechanical (H) characteristics of jointed rock and chemical (C) and thermal (T) effects, and are developing a numerical model which couples with mechanical, hydrodynamic, chemical and thermal properties of the jointed rock.



EROSION AND SEDIMENT RUNOFF CONTROL ENGINEERING

Professor	Associate Professor	Associate Professor	Assistant Professor
Masaharu Fujita	**Hiroshi Takebayashi**	**Daizo Tsutsumi**	**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.

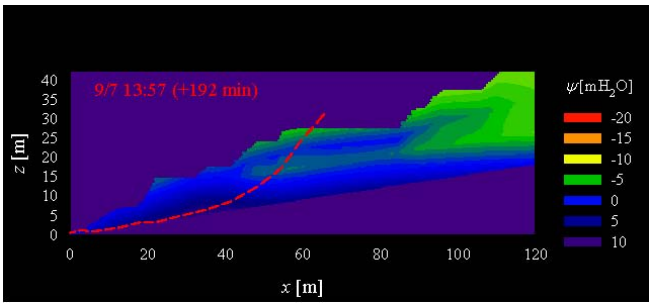


Fig. 1 : Land-slides geometry and vertical distribution of ground water.

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.

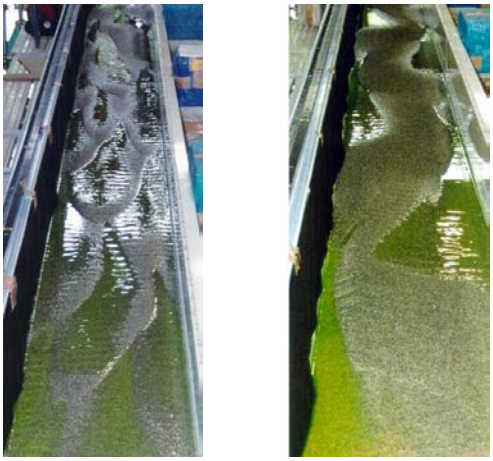


Fig. 3 : Sand bars

Hydroscience and Hydraulic Engineering

Professor **Hajime NAKAGAWA**

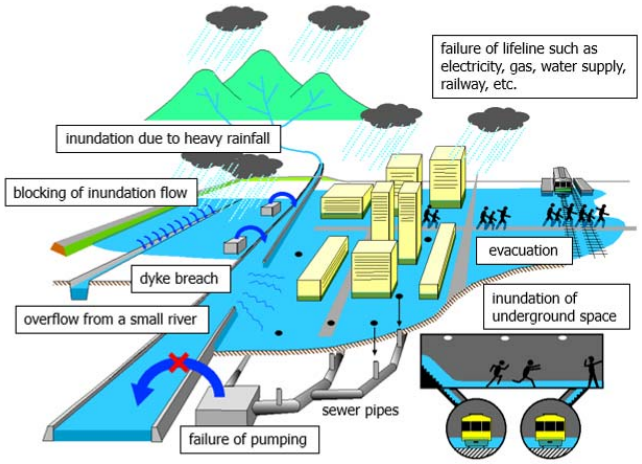
Associate Professor **Kenji KAWAIKE**

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.

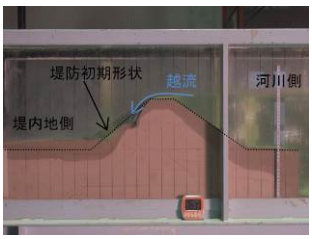
Mechanism and Mitigation Strategies of Flood and Sediment Disasters

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.



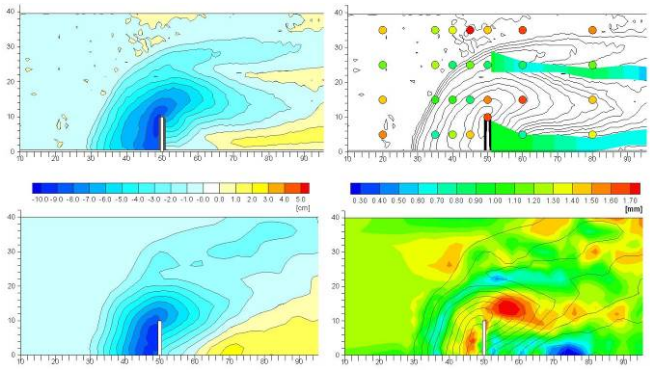
Strength Evaluation and Maintenance Method of River Embankment

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.



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

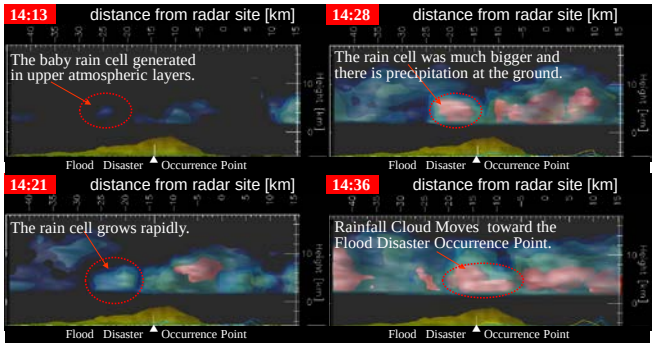
Eiichi NAKAKITA

Revealing the water behavior linking among atmosphere, geosphere and human-sphere

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 the non-point pollutant reduction estimation. And we are challenging researches on the human life style related with flood disasters and water utilizations.

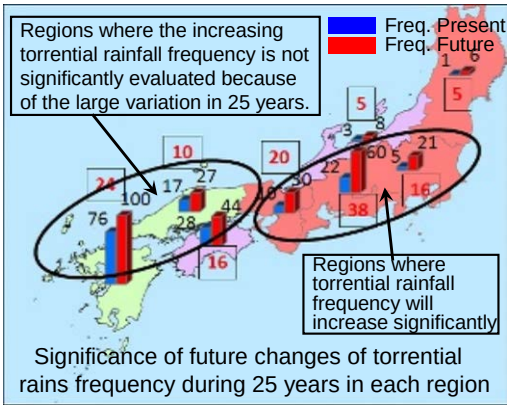
Development of short period rainfall prediction method by RADAR information

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.



Global climate change impact assessment

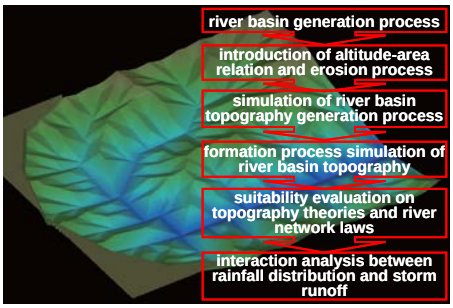
We analyze characteristics of the abnormal rainfall 30 and 100 years later by using of combination of global climate models (GCM) and regional climate model (RCM) and we try to assess its impact on the human society. For example, we evaluate the frequency variation of the torrential rain occurrence in 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

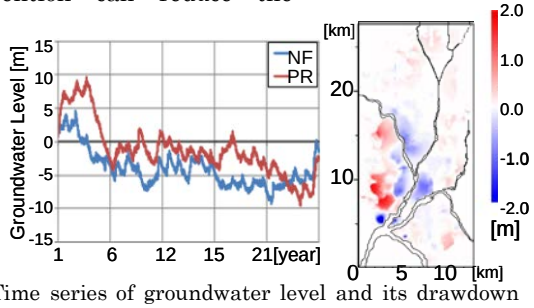
General principle of relationship among precipitation, topography, river network and stormwater runoff

It is one of fundamentally interested researches in the river-hydrology that the rainfall-runoff process is clarified by the interaction between rainfall distribution and basin structure. We are trying to simulate the generation process of river basin topography based on physical based theories during more than some million years in order to clarify effects on flood runoff by rainfall spatial distribution scales with some parameters such as the basin scale, topographical theories and river channel network laws. Such information can be applied to evaluate river basin conditions where radar information with a high spatial resolution becomes available to the river flood runoff analysis.



Water budget and pollutant balance evaluation in Kyoto basin

Water resource availability in near future is quantitatively and qualitatively evaluated by using of water budget and pollutant material balance analysis and modelling based on the hydrological and environmental observation in Kyoto basin. And it is evaluated that the real time control of urban stormwater storage system mainly used for the flood prevention can reduce the non-point pollution load with the latest rainfall forecasting information by RADAR.



Time series of groundwater level and its drawdown spatial distribution between present and near-future

Coastal Disaster Prevention Engineering

Professor	Associate Professor	Assistant Professor
Hajime MASE	**Nobuhito MORI**	**Tomohiro YASUDA**

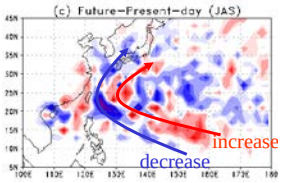
Reduction of Coastal Disasters

Modeling of Coastal Disasters and Their Countermeasures

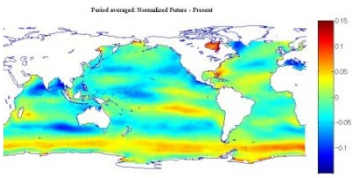
Japan surrounded by ocean has been suffered loss of human lives and precious estate caused by disasters due to storm surges, high waves, and tsunamis. We have developed the numerical models for prediction of tsunamis and storm surges, and applied the models to design of coastal disaster reduction structures and to assess impact of climate change on coastal environments.

Impacts of Climate Change on Coastal Areas of Western North Pacific

Research of global climate change effects on coastal environments is carried out for impact assessments, mitigation and adaptation strategies for future development of human society. Changes of sea level rise, ocean waves, and storm surges due to global warming are projected for coastal disaster prevention and reduction by utilizing the latest data of General Circulation Models. Impacts of typhoon on extreme waves and storm surges are analyzed and contributing for the IPCC reports.



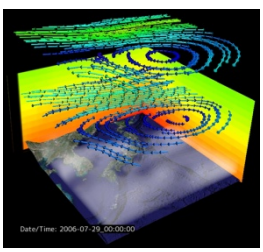
Projection of future change of typhoon tracks



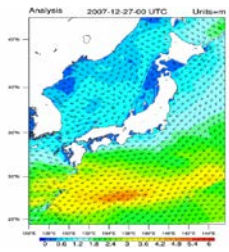
Projection of future change in average wave height

Short-Term Prediction of Sea State and Extreme Weather

Accurate and comprehensive prediction of ocean condition is necessary to someone who engages in activities near coasts or in the ocean. More importantly, disaster prevention management depends on accurate information to timely activate disaster evacuation plans and deploys inundation counter measures. We have developed the wind and wave prediction system for short to medium range forecasts.



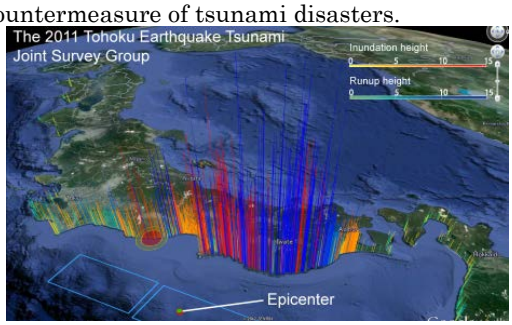
Numerical modeling of typhoon around Japan



Short-term wave prediction around Japan

Countermeasures for Mega Earthquake Tsunami

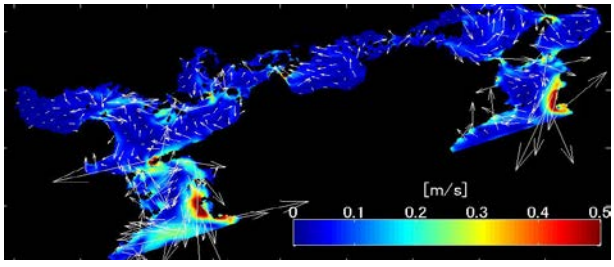
The 2011 Tohoku Earthquake tsunamis gave catastrophic damages to Japanese coastal areas. We conducted field survey around Japan coasts. Based on the detail survey data, numerical simulation models have been developed to estimate effectiveness of countermeasures for expected Nankai Trough Earthquake tsunamis. For example, the movable tsunami barrier (Flap-gate) has been developed as a countermeasure of tsunami disasters.



Survey data of tsunami run-up around Japan coast by the 2011 Tohoku Earthquake tsunamis

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. Typhoon generates currents and waves which give extreme wave forces on coastal defense system. The detail of momentums and heat transfers from air to oceans has been modeled to estimate coastal disasters.



Coupled ocean-wave model for Seto Inland Sea

Innovative Disaster Prevention Technology and Policy Research Laboratory

Professor
Kaoru TAKARA

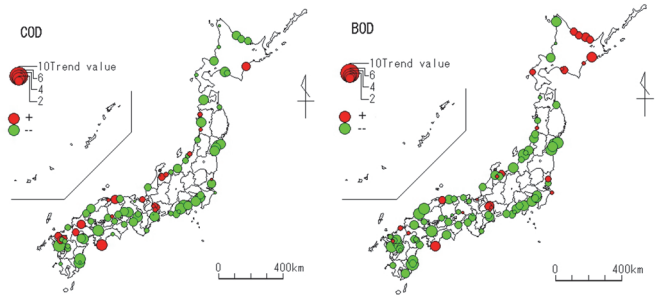
Associate Professor
Takahiro SAYAMA

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

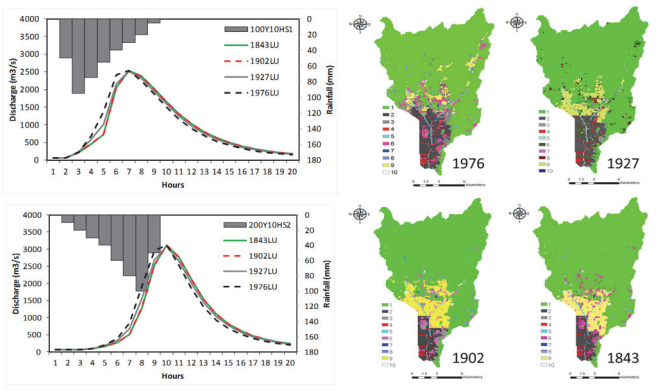
This laboratory conducts research on the evaluation of the climate change effects on disaster and the adaptation methodology to them, and on the quantification of city-, region-, and basin-wide disaster risk. Prediction methodologies are developed for water resources, flood, and landslide disasters using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

Water-related disasters induced by the climate change

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 and water quality are also research targets. International collaborative research activities are implemented under the frameworks of UNESCO-IHP.



Water quality index for major rivers of Japan



Land use change and its impact on flood runoff in Kyoto

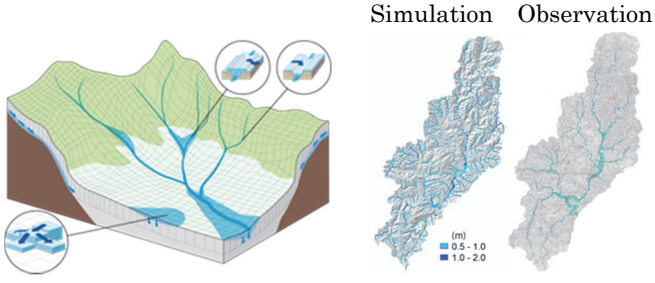
Field studies for advanced management of water resource and flood disasters

Through field investigations and experiments, we identify the socio-environmental characteristics of study sites. Based on the understanding, we propose a new technology and policy for better management of water resource and flood disaster mitigations relevant to the regions.

Floods in Kelantan River Basin, Malaysia (left, mid)
Study on water use in Bali, Indonesia (right)

Real-time predictions on flooding with ICT

We develop distributed hydrologic models for real-time flood predictions, particularly focusing on flood runoff and inundation by utilization also Information and Communication Technology (ICT) to collect local disaster information.



Rainfall-Runoff-Inundation Model (left)
and its application (right)

WATERFRONT AND MARINE GEOHAZARDS

Professor
Tetsuya HIRAISHI

Associate Professor
Yasuyuki BABA
(Shirahama Obs.)

Assistant Professor
Ryoukei AZUMA
Hideaki MIZUTANI
(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 of seaside road due to tsunami (Indonesia)

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.

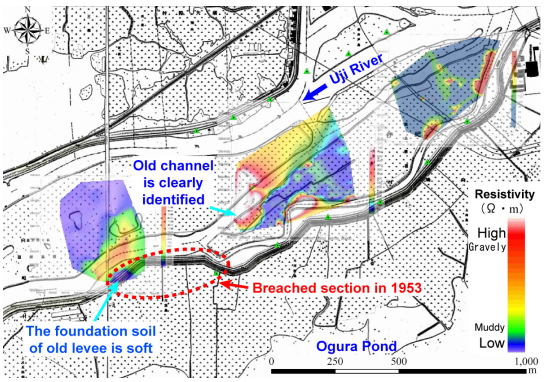


Fig. 2 : Contours of resistivity superimposed on to an old topographical map, published in 1921 by Kyoto City

Field Measurements on Oceanographical and Meteorological Phenomena

The offshore observation platform has great advantages for research activities of oceanographical and meteorological phenomena because of less influence by land area and good accuracy of measured results. Simultaneous observation/measurement in both sea and land area is important to comprehend the complicate land-coast interactions. Continuous and simultaneous observations in oceanographical and meteorological fields have been carried out by full use of the offshore observation tower at the bay mouth of Tanabe Bay. Furthermore, not only the observation tower but also observation boat are used for the field measurement activities as below.

- Long-term continuous measurements by using the offshore observation tower
- Intensive measurements in summer time
- Field measurements by using the observation boat

Fig. 3 : Observation tower at the bay mouth of Tanabe Bay and observation boat

REGIONAL WATER ENVIRONMENT SYSTEMS

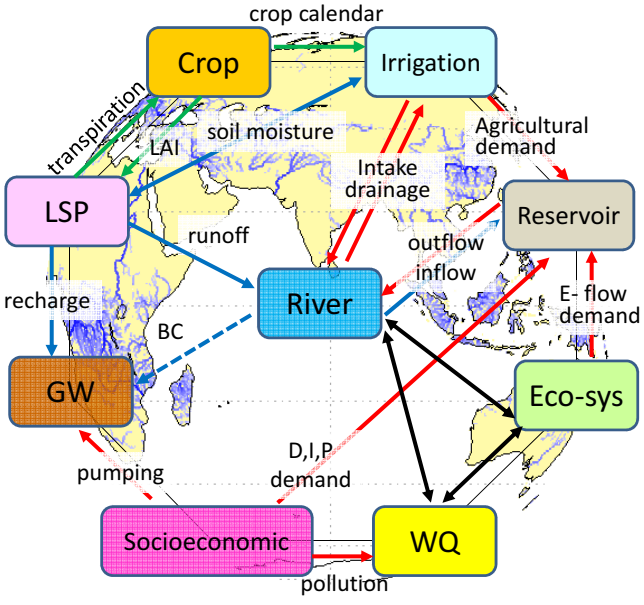
Professor	Associate Professor	Assistant Professor
Shigenobu TANAKA	**Kenji TANAKA**	**Toshio HAMAGUCHI**

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

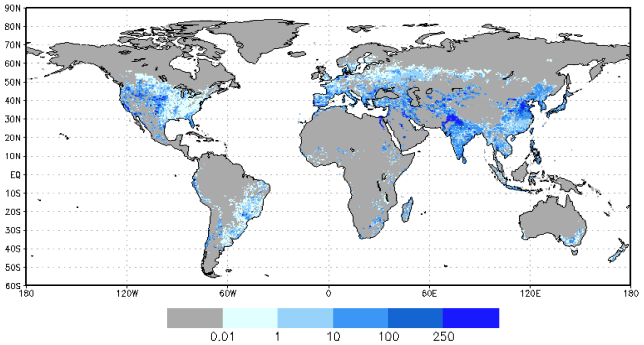
The "integrated water resources management model" consists of a distributed hydrological model, land surface process (LSP) model, groundwater (GW) model, water quality (WQ) model, sediment transport model, food chain model, crop growth model, reservoir operation model, socioeconomic model, etc. is being 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 to decide countermeasures, however, proactive approaches in the non-stationary condition are necessary. In order to monitor the water-related hazard, we are developing monitoring schemes. Further, we are assessing future water-related risk due to climate change in order to make appropriate political decisions.
- Climate Change Impacts on Water Resources
  Global warming may change the amount and patterns of precipitation, leading to change the phase of the winter season's precipitation from snowfall to rainfall. This could cause a great change in the pattern of water flowing into rivers. We aim to assess the changes in the available water resources of the major rivers in Japan and the world considering the changes in the water requirement under future socioeconomic and climate scenarios.
- Groundwater Management
  Future climate change may cause sea-level rise up to 80 cm or more affecting seawater intrusion to groundwater. Management for feasible and sustainable pumping of fresh water in coastal area is very important. We are proposing physically and environmentally effective countermeasures for mitigating seawater intrusion damages through our basin-scaled groundwater model in conjunction with runoff and its corresponding recharge.



Global distribution of agricultural water requirement

WATER RESOURCES ENGINEERING

Professor **Tomoharu HORI**

Assistant Professor **Daisuke NOHARA**

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.

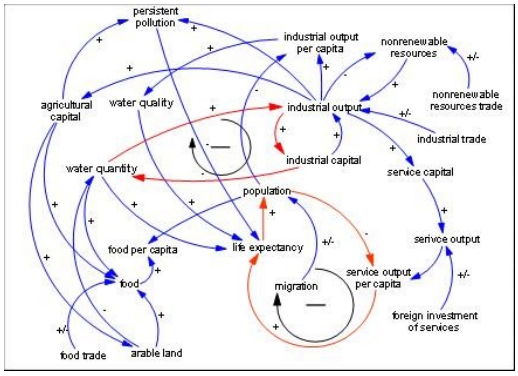


Fig. 1 : Water dynamics model considering water resources, population, industrial and agricultural outputs.

Real-time Water Resources Management Using Hydro-meteorological Information

Changes in water dynamics associated with driving forces such as climate change may threaten to reliability of water resources management systems. More systematic and effective operation of existing water resources management facilities with a long perspective is inevitable. Thanks to the advancement in monitoring and forecasting techniques, various kinds of real-time hydro-meteorological information have been provided. They vary from global meteorological observations from local hydrological forecasts, which can respectively and potentially include useful information for water resources management from flood to drought managements. In order to contribute to establishing more robust water resources management, we are tackling to develop real-time operation methods of water resources management systems by utilizing various real-time hydro-meteorological information sources with effective combination based on their characteristics such as temporal and spatial scales or updating frequency.

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.

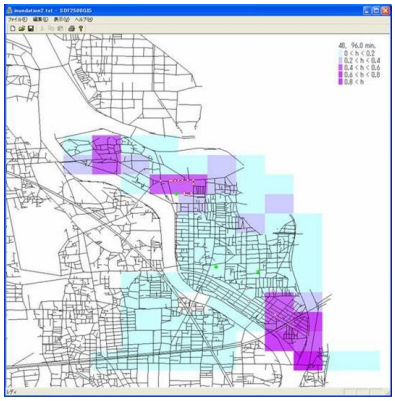


Fig. 2 : Flood evacuation simulation model based on digital modeling of street network.

Socio and Eco Environmental Risk Management

Professor **Tetsuya SUMI**
Associate Professor **Yasuhiro TAKEMON**
Associate Professor **Sameh Ahmed KANTOUSH**

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.

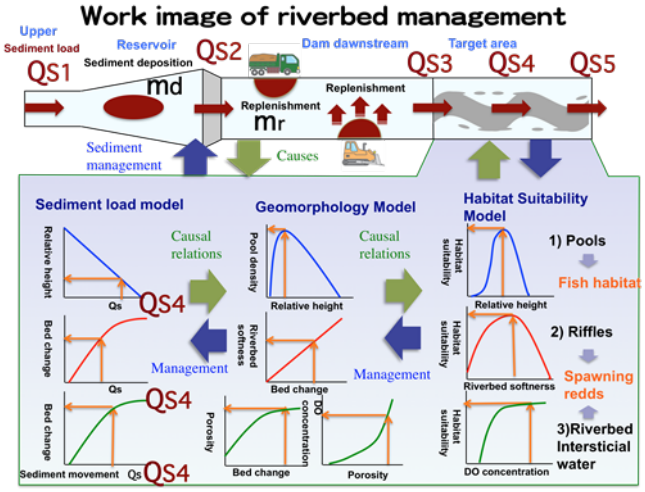
Asset management of dams and development of reservoir sediment management methods

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

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).

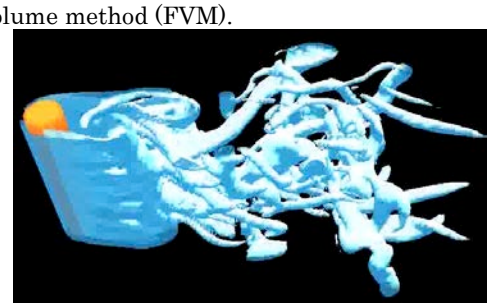


Fig. 1 : Wake flows behind a cylinder (iso-surface of vorticity)

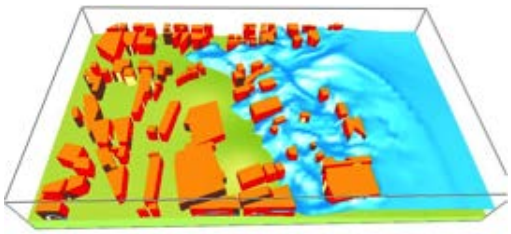


Fig. 2 : Three-dimensional Tsunami flows through buildings

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.

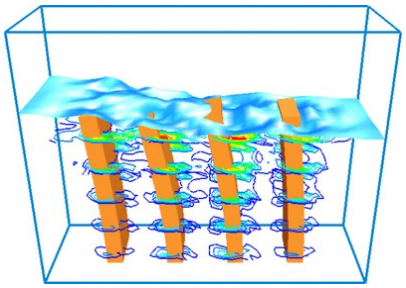


Fig. 3 : Deformation of elastic plates due to sloshing fluids

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).

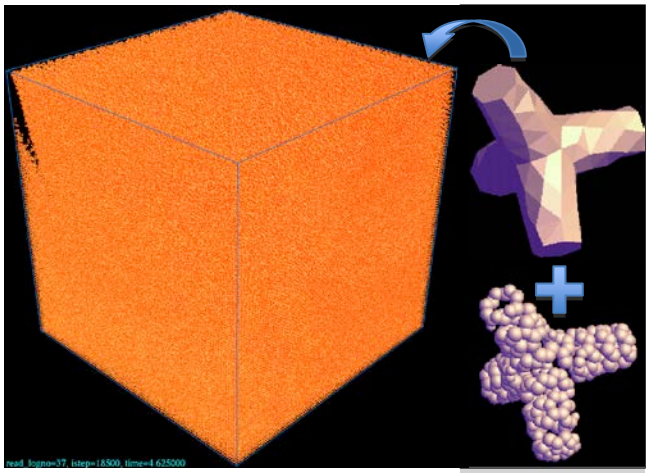


Fig. 4 : 1 million blocks in 3D cavity flows taking account of the collisions of blocks and fluid-structure interactions (4,096 parallel computations with CRAY XE6 in Kyoto University); right figures show each block and CDS included in a block.

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

Professor	Associate Professor	Assistant Professor
Makoto KIMURA	**Sayuri KIMOTO**	**Yasuo SAWAMURA**

Elucidation of Mechanical Behavior of Ground supporting civil structures

Geomaterials support all of the civil structures and environments as a ground. Therefore, we need to study the response of geomaterials to earthquakes, weathering, the changes of climate etc. accurately in order to build the civil structures and maintain environments safely. Furthermore, it is important to clarify the complicated soil-structure interaction and the mechanical behavior of structures. Our research activities focus deals on one hands with constitutive models for geomateials and on the other hand with the interaction between soil and structures through experiments and numerical analyses.

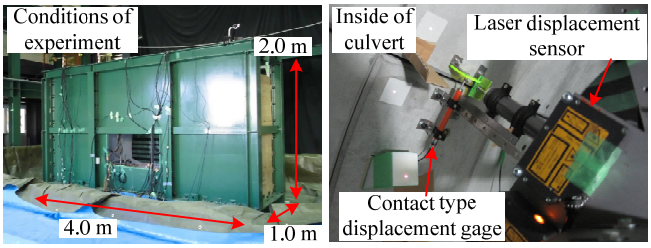
Elucidation of Soil-Structure Interaction and Construction of Design Approach

All civil structures are built on the ground. Therefore, when designing and constructing a civil structure, it is important how to evaluate the soil-structure interaction.

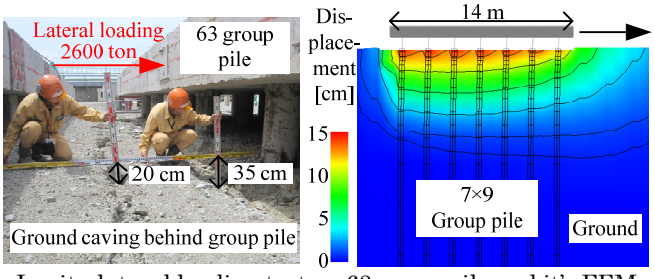
The soil-structure interaction is depends on the various factors, such as both rigid difference, nonlinearity, and the characteristics of external force. Accordingly, in order to comprehend these factors correctly, it is necessary to solve the mechanical behavior of soil and structures by sophisticated experiments and numerical analyses.

In recent years, furthermore, the design of civil structures has been made the shift to the performance based design from the specification based design, so we need to investigate not only the deformation and the damage but also the demand performance and the marginal state of structures.

Based on the above-mentioned subject, we are carrying out research for various civil structures, such as a group pile foundation, a culvert tunnel, and a reinforced earth through the many experiments and numerical analysis to elucidate the soil-structure interaction and construct the rational design approach.



Large scale shaking table test of precast arch culvert

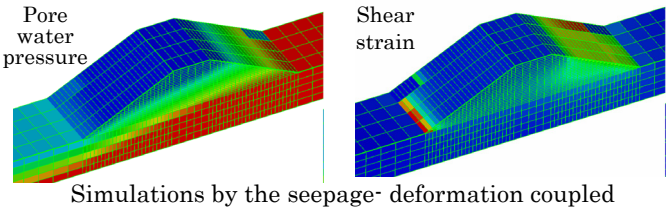


In-situ lateral loading test on 63 group pile and it's FEM

Constitutive modeling of geomaterials and numerical simulations

Geomaterials include improved soils mixed with chemical materials, such as, cement and water glass, as well as sand, clay, rock, and gas hydrate which has been sedimented in nature. They are basically made of grains, and the void is filled with water, air, and other material; geomaterials are multi-phase mixture. They are inherently inhomogeneous and exhibit a great variety of characteristics. Since we need an appropriate constitutive model which can describe mechanical behavior of material in order to simulate the deformation, failure phenomena, and liquefaction precisely, the development of constitutive model is inevitable for geomechanical engineering.

Furthermore, we are developing numerical methods to predict large displacement and failure regarding to geomaterials, such as, slope failure due to heavy rain and liquefaction regarding to earthquake disasters. Failure phenomena such as landslides and slope failure involve strain localization and the discontinuity of displacement.



Simulations by the seepage- deformation coupled

The simulation methods can be applied to the chemo-thermo-mechanically coupled problems by considering the heat transfer and phase changes between solid and fluid due to chemical reactions. For example, we have developed a numerical method to predict the deformation during gas hydrate dissociation.

Gas hydrate bearing sediments from Lake Baikal

Construction Engineering & Management LABORATORY

Professor	Associate Professor	Assistant Professor
Hiroyasu Ohtsu	**Thirapong Pipatpongsa**	**Takafumi Kitaoka**

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.

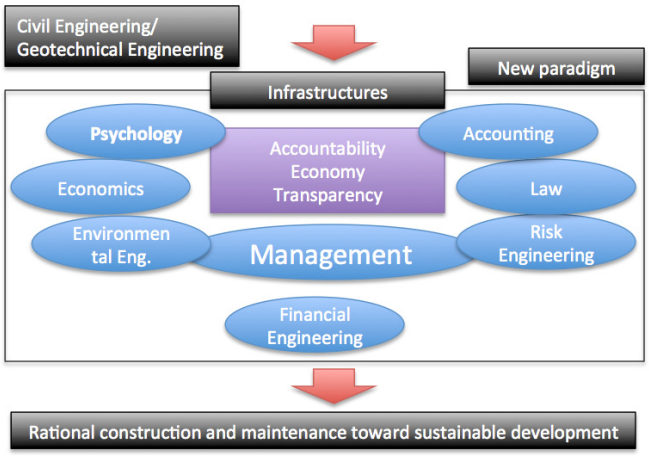


Fig. 1 : Conceptual configuration of our research.

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. Also, a stable arch formed across a pit is beneficial to the design of an undercut slope; therefore, prediction of the maximum stable undercut width is needed. The relationship between a stable width and an inclination of bedding plane is obtained experimentally to confirm the developed theoretical prediction.

GEOFRONT SYSTEM ENGINEERING

Professor
Mamoru Mimura

Associate Professor
Yosuke Higo

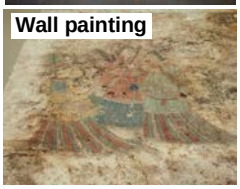
Construction, preservation and management of underground space considering the environment of geofront

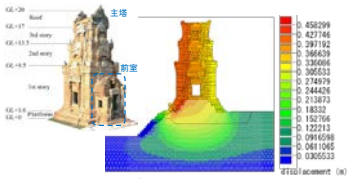
The utilization of underground space has been lately attracted social interests and it is significantly important to investigate the complicated coupled processes in soils and rocks, which widely distributed from ground surface to deep underground. In this laboratory, we develop advanced numerical simulation tools and measuring/monitoring systems and applied to many different problems in soil and rock mechanics fields.

Geotechnical contribution for the preservation and restoration of ancient tumulus and masonry structures

Historical monuments such as ancient tumulus/mound and masonry structures are weak against wind and rain, earthquakes, and damage caused by plants and animals and it is difficult to keep them intact for long time. In this research field, we investigate the preservation and restoration methodologies of historical monuments to maintain their authenticity based on soil/rock engineering aspects.

Bayon central tower



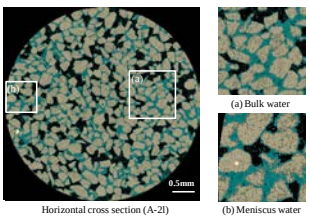


Takamatsuzuaka tumulus

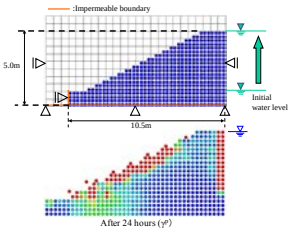
Prasat Suor Prat N1Tower
Angkor, Cambodia

Modelling deformation characteristics of geomaterials from micro to macro

Geomaterial is a multi-phase mixture composed of soil, water and air. It is important, therefore, 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.



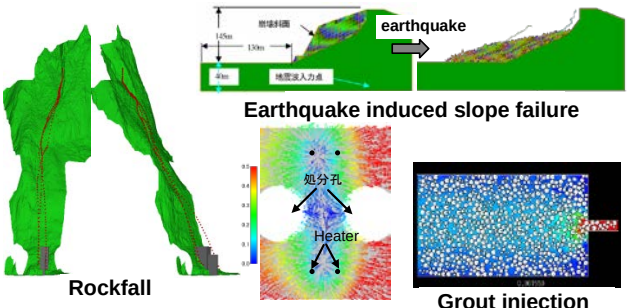
Microstructures of partially saturated soil visualized via μX-ray CT



Seepage-deformation analysis via Material Point Method

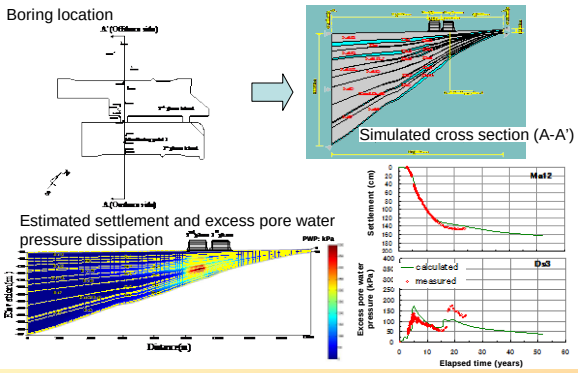
Development of DDA, NMM, DEM codes and their application to rock mechanics

In this research field, we developed discontinuum based numerical methods such as DDA, NMM and DEM to simulate large deformation including block separation and contact and applied to many different types of problems in rock mechanics field such as rockfall, slope stability, grout injection, T-H-M coupled processes of rock masses etc.



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 developed numerical simulation code 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.



International Urban Development

Associate Professor
Giancarlo FLORES

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.

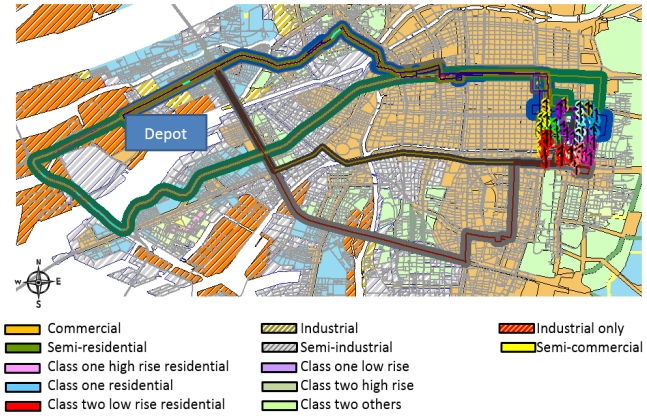


Fig. 1: Vehicle routing and land use

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.

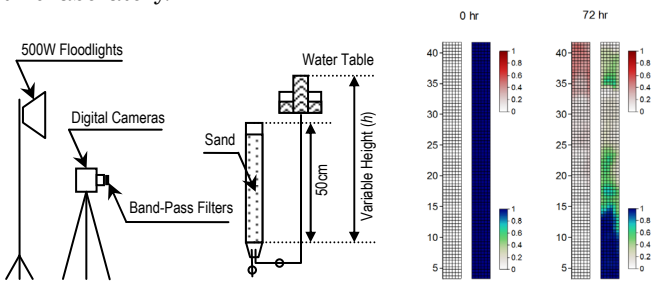


Fig. 2: Experimental setup for testing the migration of a contaminant in a one-dimensional column

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	Associate Professor	Assistant Professor
Susumu IAI	**Tetsuo TOBITA**	**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 a numerical simulation tool called FLIP (Finite element analysis program of LIquefaction Process) in which the multi-spring/cocktail glass model is implemented as a constitutive model for soil.

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.

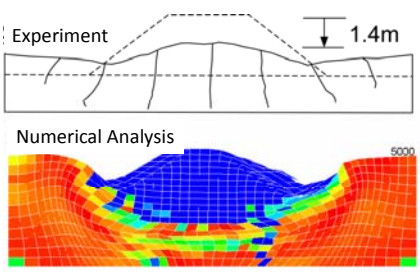
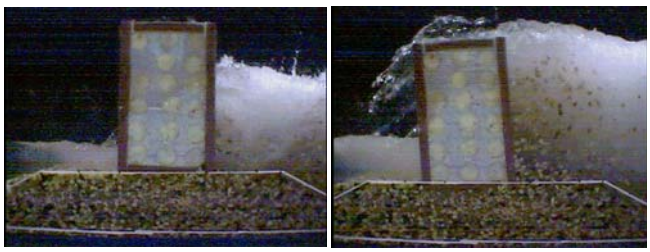


Fig. 1. Deformation of an embankment resting on liquefiable ground (Centrifuge experiment and numerical analysis)

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

Failure mechanism of the tsunami breakwaters due to tsunami

Many geotechnical structures were damaged by ground shaking and/or tsunamis during the 2011 Tohoku, Japan, earthquake. In the Sanriku ria coast, the offshore tsunami breakwater might have significantly reduced the tsunami inundation height and delayed the tsunami arrival time, however, it was found to be severely damaged. The cause of this failure was investigated in centrifuge studies. Images taken with a high speed camera (Fig. 2) showed that, as the water depth increased, a failure arc in the rubble mound under the caisson appeared, indicating ground deformation induced by the movement of the caisson with large scale water flow in the rubble mound. In the test, no significant scouring due to the flow of the tsunami was observed in the mound. The model caisson might have been rotated not only by the thrust force of the tsunami, but also by the deformation of the rubble mound, whose stiffness might have been significantly reduced by the decrease in the effective confining pressure due to large scale water flow. Thus, the mechanism of the tsunami breakwater failure may be due to the combined effect of thrust force of the tsunami and seepage by which the effective confining stress in the mound was significantly reduced.



(a) Tsunami arrival (b) Caisson deformation

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

ENVIRONMENTAL INFRASTRUCTURE ENGINEERING

Professor **Takeshi KATSUMI**

Associate Professor **Toru INUI**

Assistant Professor **Atsushi TAKAI**

Sustainable Geoenvironmental Engineering

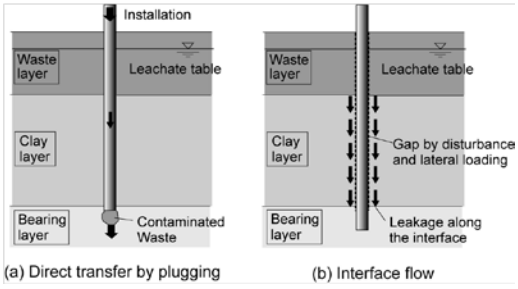
Environmental sustainability of the subsurface should be maintained for a long period of time since it is crucial for life and society. This laboratory mainly focuses on the study of recycling technologies of various wastes as geo-materials, remediation technologies for contaminated lands, and lowering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

Recovery from the Great East Japan Earthquake and Tsunami

On March 11, 2011, a great earthquake and tsunami severely affected East Japan, and generated a huge amount of disaster wastes and tsunami deposits. In this laboratory, the geoenvironmental and geotechnical characterizations of the disaster wastes and tsunami deposits are being experimentally studied to achieve a reduction of the final waste volume via their reutilization.

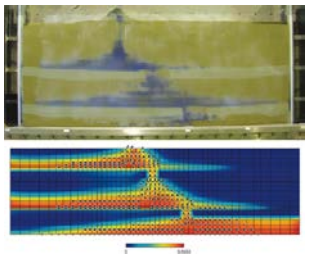
Proper Waste Disposal

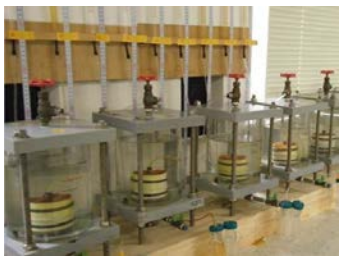
In order to build a recycling-based society, the 3R principle should be a strong driver of our life. Unfortunately, certain amount of wastes that are technically and economically difficult to recycle is going to be generated. Hence, to properly dispose such wastes to landfill sites so that we can use 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.



Conservation of the Geoenvironment

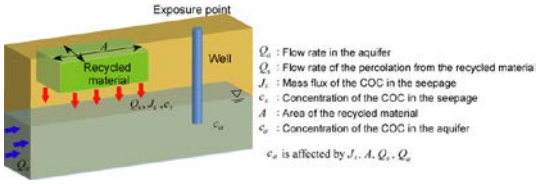
When selecting adequate techniques to solve soil and/or groundwater contamination problems, the mobility of the contaminants, their mechanisms, and the reliability of the countermeasures should be scientifically clarified. In this laboratory, the mobility of heavy metals and VOCs and their effective 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.





Contribution to the Reduction of Global Environmental Problems

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
Masayuki TAMURA

Associate Professor
Junichi SUSAKI

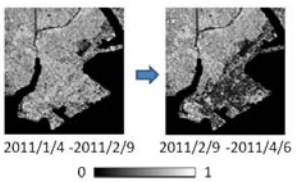
Assistant Professor
Yusuke KIMURA

Analysis and Utilization of Spatial Information

Research and education are conducted on methodologies for analysis and utilization of spatial information for disaster prevention, environmental protection, and urban planning. In particular, we focus on satellite remote sensing, 3-D digital photogrammetry, laser surveying, and geographic information systems for monitoring, modeling, and management of urban and natural environment.

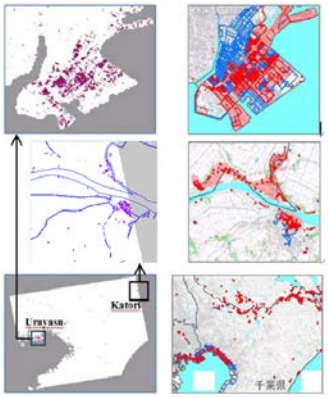
Assessment of disaster damage and environmental changes by remote sensing

Satellite or airborne sensors can regularly observe temporal changes of national land and environment at global or regional scale. In this project, we are developing methodologies for observing the current state and changes of Earth's surface using optical and radar sensors for disaster prevention and environmental protection.



Coherence change of radar images at Urayasu city. (Left) pre-seismic, (Right) co-seismic.

Soil liquefaction at Urayasu city.

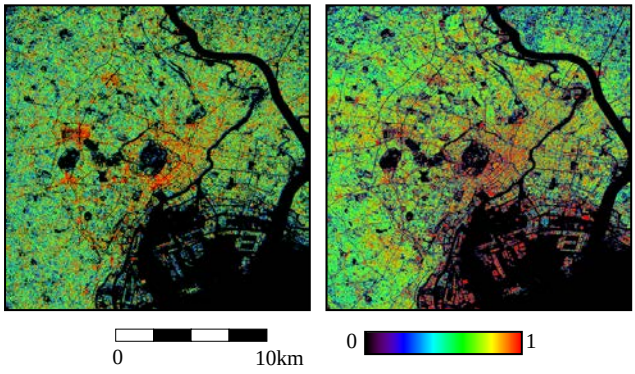


(Left) Detected soil liquefaction at Urayasu city and Katori city. (Right) Field survey data by MLIT and JGS.

Detection of liquefaction areas in Kanto region caused by the 2011 East Japan Earthquake. Liquefaction areas were detected using ALOS-PALSAR radar interferometry.

Assessment of urban environment using satellite imagery and airborne LiDAR

Rapid growth of megacities in developing countries can cause severe urban problems. Remote sensing has the potential to map urban areas and density. We are developing methods to estimate urban density using polarimetric synthetic aperture radar (SAR). It was found that the urban density estimated using satellite imagery has a high correlation coefficient with building-to-land ratio.



(Left) urban density estimated by using SAR data and (right) building-to-land ratio from GIS data in Tokyo area

Assessment of urban regeneration utilizing infrastructure facilities

In urban regeneration and local area planning for sustainable society, there are some public open spaces utilizing infrastructure such as road spaces and railroad corridors. We are developing methodologies of urban regeneration with infrastructure for analyzing spatial planning. Especially, we are focusing on plan-making process in each case, actual condition of urban planning systems, and ripple effect to surrounding areas.

Promenade on old port-railway (Kisha-michi in Yokohama) at left and linear park on old viaduct (High Line in New York) at right

Urban and Landscape Design

Professor	Associate Professor	Assistant Professor
Masashi KAWASAKI	**Yoshiaki KUBOTA**	**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 Historical 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.

Integration of Engineering and Architecture in Design of Infrastructures

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 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 Liveable 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. The research activities are carried by fusion of civil engineering and medical approaches. 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). This research is based on the concept that we human beings live in the physical environment as physical existence with human bodies. The results of our studies will provide the theories and methods to manage the sense of a place and redesign our environment. Our research also focuses on the formation of topos (social realm) through social activities on landscapes in order to seek a new framework of a community and help reconstruct self-sustaining local governance. This research is based on the concept that we human beings live in communities as social existence as well as the individual. The results of our studies will provide the useful theories and methods for policy making to improve social health, strengthen community, and increase civic engagement.

PLANNING AND MANAGEMENT SYSTEMS

Professor	Associate Professor	Assistant Professor
Kiyoshi KOBAYASHI	**Kakuya MATSUSHIMA**	**Masamitsu ONISHI**

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.

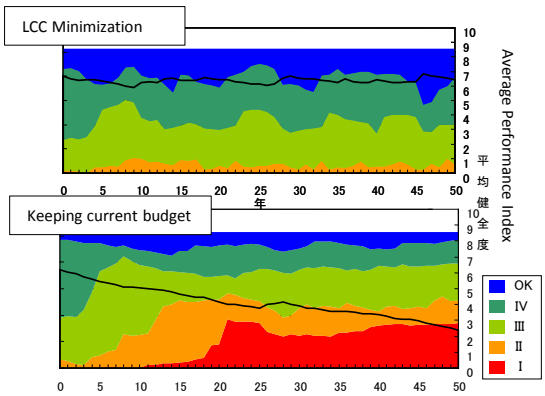


Fig 2. Life Cycle Cost Minimization using Bridge Management System

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

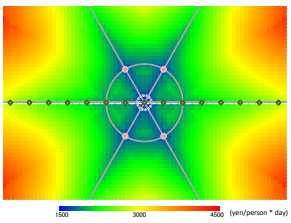
Professor	Associate Professor	Assistant Professor
Dai NAKAGAWA	**Ryoji MATSUNAKA**	**Tetsuharu OBA**

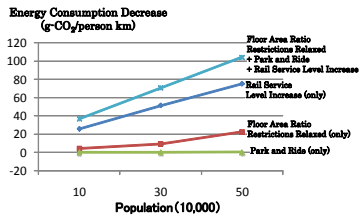
Empirical research to realize the appeal and vitality of cities

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.

Simulation of the relationship between urban structure and transportation

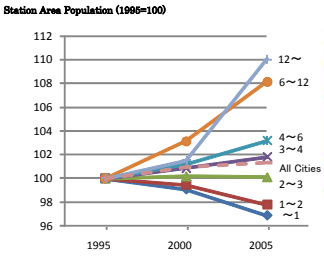
In order to understand the effects of the convenience of urban transportation systems on urban structure, urban structural analysis models are developed, and various urban scenarios are run through numerical simulation analysis. The figure below (left) shows the distribution of transportation costs from different areas to the center of a simulated city. With the introduction of road and rail infrastructure these costs change, affecting choices in living and working, as well as the overall structure of the city. The figure below (right) uses the same model and shows the effects that different transportation strategies have on environmental load. It shows reductions in energy consumption as a result of different transportation strategies, according to the size of urban population. We can clearly see that easing building floor area ratio restrictions and increasing rail service reduce energy consumption. It can be considered that the effect comes not only by a simple shift of transportation from the automobile to rail, but largely through location change and making cities more compact.

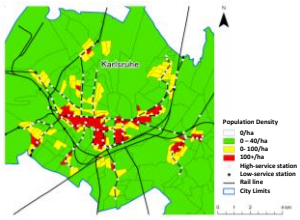




An international comparison of rail service level and urban structure

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.





Transportation system structures for bringing about urban vitality

Making public transportation more convenient has been shown to increase a city's density and reduce its environmental load. We have developed a real-world demonstration experiment for improving the convenience of public transportation. The southern area of Kyoto is very convenient for the automobile because of several expressway interchanges and other features. Public transportation is inconvenient in this area, and because of this urban density is low. Together with the Kyoto University Urban Policy Unit for Low-Carbon Society, our laboratory has been running a demonstrative experiment which directly connects Kyoto Station with the city's southern area. The partnership has started running the experiment for creating convenient public transportation, to later lead into continual operations. The left image shows the current situation of low-density land development, and the right image shows the "Kyoto Rakunan Express (R'EX)" bus which is currently in operation.

LOGISTICS MANAGEMENT SYSTEMS

Professor	Associate Professor	Assistant Professor
Eiichi TANIGUCHI	**Tadashi YAMADA**	**Yuki NAKAMURA**

Towards establishing efficient, environment friendly and safe urban freight transport systems

Cities in the twenty-first century should be sustainable cities that are able to enhance the global economic competitiveness, improve the quality of life and the environment. To achieve this goal, we need to recognize urban infrastructures including roads, railways and ports as urban systems. This laboratory studies efficient, environment friendly and safe urban freight transport systems and management for logistics systems.

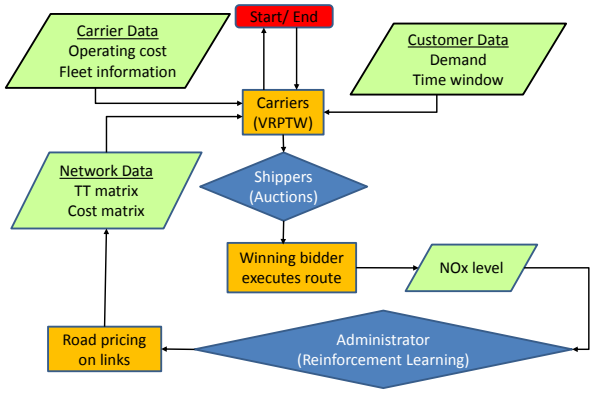
Efficient and Environment friendly Vehicle Routing and Scheduling leveraging ITS

The Vehicle Routing and Scheduling Problem is a popular tool to consider freight transport systems. The stochastic vehicle routing and scheduling model is applied based on historical travel time information provided by ITS (Intelligent Transport Systems). The result shows reductions of logistics costs and total travel time of freight vehicles. Thus, leveraging historical travel time information contributes to establish efficient and environment friendly urban freight transport systems. The exact solution algorithm for the vehicle routing problem with soft time windows is studied. In this algorithm, branch and price method based on the column generation algorithm and the branch and bound method is used to solve the problem optimally. Additionally, humanitarian logistics in huge disasters is tackled. The multi-objective vehicle routing model is developed. It incorporates minimization of human suffering and fuel consumption.

Measurement on urban freight policy using the multi-agent model

Multi-agent model consists of many agents in an environment and each agent acts autonomously based on their knowledge, goal, skill and plan.

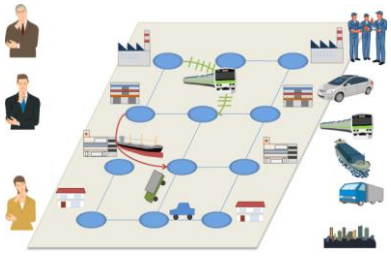
Four agents are considered as important stakeholders to the urban freight transport, freight carriers, shippers, administrators and residents. The multi-agent model is developed to evaluate effects of freight transport activities and urban freight policies such as road pricing, traffic regulation to trucks and load factor control. Some performance measures considered in this model are the environmental improvements in urban areas and surrounding areas and change of costs and benefits for freight carriers and shippers.



Supply chain network modeling

Decisions on goods distribution and freight transport have typically been made looking over an entire supply chain network (SCN). Therefore, accurate comprehension of what happens on the SCN, namely, to precisely describe the behavior of economic entities in the SCN and the resulting flow of products (and of raw materials as well), allows administrators and planners to understand the mechanism of the generation of goods movement as well as to investigate the effects of logistics-related measures.

This research aims at developing mathematical models (i.e., supply chain network equilibrium models: SCNE models) to comprehensively illustrate what comes about in the entire SCN, where the behaviors of manufacturers, wholesalers, retailers, consumers (i.e., demand markets) and freight carriers are described. The models can estimate the amount of products produced by manufacturers and transacted between the entities involved in the SCN, and the price of products.



There is a possibility of the SCN entities and traffic conditions on a transport network (TN) influencing each other's behaviors, since products are moved through the TN. This research also attempts to develop supply chain-transport supernetwork equilibrium (SC-T-SNE) models. With the behavior of TN users being incorporated, the models allow for endogenously determining transport costs based on freight carriers' decision-making, as well as for investigating mutual effects between behavioral changes in the SCNs and the TN. The models also have the potential to facilitate the optimal transport network design considering SCN-TN interaction in terms of efficiency and/or resiliency of the supernetwork.

INTELLIGENT TRANSPORT SYSTEMS

Associate Professor	Associate Professor	Assistant Professor	Assistant Professor
Nobuhiro UNO	**Jan-Dirk SCHMÖCKER**	**Toshiyuki NAKAMURA**	**Hiroki YAMAZAKI**

Creating intelligent and smart transport supported by IT to enhance the attractiveness of urban areas

We have been studying various approaches that are useful for designing transport networks and for effective operation, management and control of transport systems. We adopt a comprehensive approach in which both descriptive and normative modeling tools are incorporated. Our methodologies are based on statistics, operations research, marketing research as well as traffic and transportation engineering. Our overall goal is always to provide transport systems that improve the quality of life and are sustainable in the long run.

ITS information effect analysis using a driving simulator (DS)

We evaluate new ITS technologies using a driving simulator (DS). The DS can simulate various situations, such as signalized intersections and highway merging sections. Our DS provides a more than 180 degree field of view in the virtual reality space ensuring the perception of an actual driving experience. Acceleration effects and driver reactions can be replicated and monitored.

In current research we test the effect of two different information boards that notify highway drivers of a vehicle merging at a junction. The first one, a conventional character information board, is a simple system providing a single blink when the merging vehicle passes a certain point. The second system, a vehicle tracking information board, informs the drivers on the highway about the rough position of the merging vehicle with a flashing pictogram of the approaching car in line with it's movement. We observe the differences in driver responses, in particular changes in average speeds their variance among respondents.

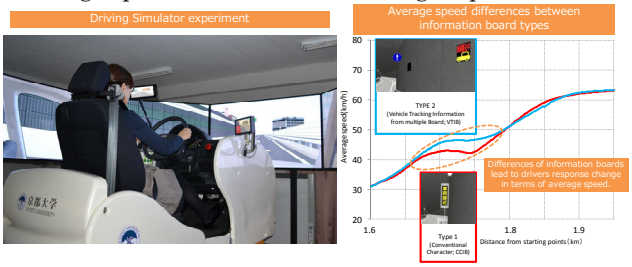


Fig.1: driving simulator experiment

Evacuation Model and Measures for Tsunami considering Car-usage

Triggered by the 11th March 2011 Tohoku earthquake and tsunami disaster, we study measures that could relieve the impact of a potential similar disaster in the Osaka Bay coastal areas. We focus on studying the appropriate use of vehicle to assist especially vulnerable population groups such as the elderly in the aftermath of such a disaster. We have proposed two measures for evacuation from the tsunami. The first is to use the shelters of Hanshin-Expressway(case-1). A second measure is an application of "contra-flows" (case-2). Under this measure traffic is only allowed to flow in one direction to facilitate faster evacuation from the tsunami endangered area.

Fig.2 and Fig 3 show the total evacuation time and the completed rate of evacuations against time ellasped, respectively. The results illustrate that through the measures the total evacuation time reduces, and the percentage of people that can be evacuated early increases. With the results of this study, we aim to help evacuation planning and to provide effective disaster counter-measures.

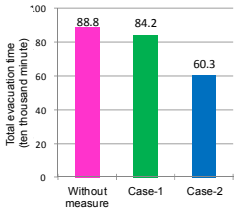


Fig.2 Total evacuation time

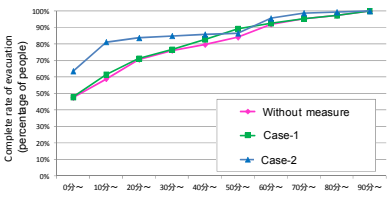


Fig.3 Evacuation rate by time

Public transport line loads and bus arrival real time information

Providing high quality public transport (PT) services can attract passengers and reduce congestion in cities. We consider two issues that are often perceived as obstacles to more often use PT. Firstly; we predict the effect of insufficient seats and overall vehicle capacity on passengers' choices. For this we develop mathematical modelling approaches. Secondly, we evaluate the effect of providing real time information (RTI) at bus stops and on mobile phones that accurately predict the arrival of vehicles.

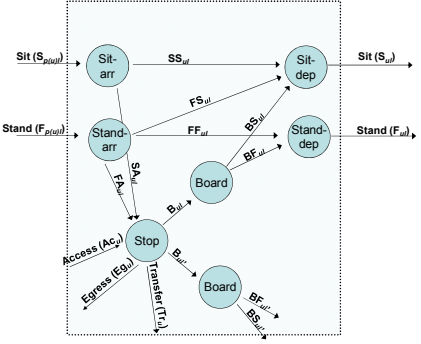


Fig.4 Network representation of a PT stop

Travel Behavior Analysis

Professor	Associate Professor	Assistant Professor
Satoshi FUJII	**Yusuke KANDA**	**Ayu MIYAKAWA**

Pragmatic social science regarding transportation, city, nation-state, and the environment

Although social science is today divided into economics, sociology and social psychology, it has originally been a pragmatic intellectual activity derived from a process in which human beings consider how to cope with a variety of social problems in the modern period. In the last 200 years though social science has become more isolated from the real issues in society. As a result, there are unfortunately a large number of today's problems regarding transportation and the city left with no actual methodology. Therefore this laboratory focuses on "pragmatic social science", that is, we deal with real issues relevant to transportation systems, urban and rural areas as well as whole nations. 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.

Fig. 1 : A test on responses to a social dilemma (left)

Pragmatic social science supporting the vitality of cities and nation

Civil engineering, urban and national planning aims to improve the facilities of urban or rural areas. For that purpose, "vitality" is a key: For example, community development (Machizukuri in Japanese) can be carried out by enthusiastic residents. Without such active residents, many cities would be devastated. We consider what action is 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.

Fig. 2 : A field study on the background of traditional and historical landscapes (left)

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.

DISASTER RISK MANAGEMENT

Professor
Ana Maria CRUZ

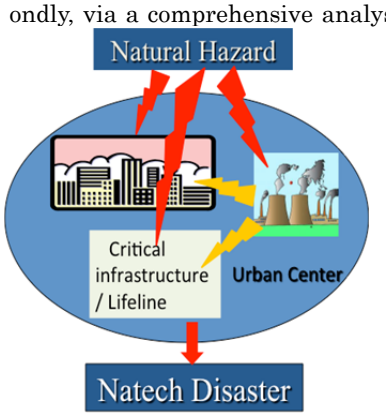
Associate Professor
Muneta YOKOMATSU

Natural and Technological Disasters: Building Resilience

Growing urban populations and industrialization have resulted in more people and property at risk from conjoint natural and technological disasters (known as Natechs). In particular, we study the risk posed by disaster impacts on industry, related infrastructures and secondary chemical accidents in order to develop risk reduction strategies and design adequate prevention and mitigation measures to reduce potential losses. We evaluate socio-economic impacts of disasters and its mitigation in an effort to reduce overall losses and increase societal resilience.

Improving Societal Resilience to Natech Risks (ResTO-TerRiN)

The Tohoku disaster provides a unique opportunity to study the effectiveness of industrial risk management planning, and emergency response at industrial facilities and government agencies in affected areas. The main goal of this research project is to improve the resilience of a territory against Natech accidents especially those due to flood / tsunami. We look at the problem from two viewpoints. First, the perspective of "vulnerability" and, secondly, via a comprehensive analysis of the notion of territorial or social resilience to Natech accidents using the MADS/MOSAR methodology. We study the mechanisms, failure modes and causes of Natechs; analyze their impact on emergency planning; and identify the necessary conditions both technical and organizational for a return to "normal".



Disaster Evacuation Planning in Areas Subject to Natech Risks

In this study we are concerned about disaster evacuation planning in area subject to high Natech risk. The purpose of this study is two fold: a. to assess the adequacy of evacuation routes and shelters in a case study area in Osaka identified as a Natech hotspot; and b. to raise awareness among local government officials, first responders and community members in the case study area concerning vulnerability to Natech risks and risk reduction strategies. We use and apply a semi-quantitative community-based Natech risk assessment methodology and the more detailed RAPID-N tool for analyzing and mapping Natech risk due to earthquakes. These results are then used to assess the existing evacuation routes and shelters, and to make recommendations on alternative routes. One of the project outputs is a set of Natech risk evacuation planning guidelines.

Economic Growth Theory under Disaster Risks

Catastrophic disaster brings long-term socio-economic impacts, whose severity depends on development level of the society, and also varies among income classes. People in developing countries can suffer from 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 the stochastic economic growth models to investigate the long-term macroeconomic impacts of disaster and to examine how inequality changes in the development process of disaster recovery and reduction through policy implementation.

Sustainable Management and Inheritance of Local Culture and Infrastructure

Every community develops its local culture and common assets such as rituals, conventions, cultural landscape, civil engineering facilities throughout the history. We focus on how residents' identity is formed and inextricably associated with their behavioral choices and local assets. Applying the concept of identity formation and the models of the institutional analyses that have been developed in areas of social psychology, economics and infrastructure planning, we try to derive an optimal institutional framework under which local culture and common assets are kept on being inherited with residents' sufficient motivation and economic condition.

Moreover we are concerned with sustainable development of agricultural communities in Ghana that are exposed to climate-change-triggered disasters. Furthermore, we investigate an efficient storage method of relief goods by considering spatial correlation of risks and transportation network.

Integrated Disaster Risk Management Systems

Professor
Hirokazu TATANO

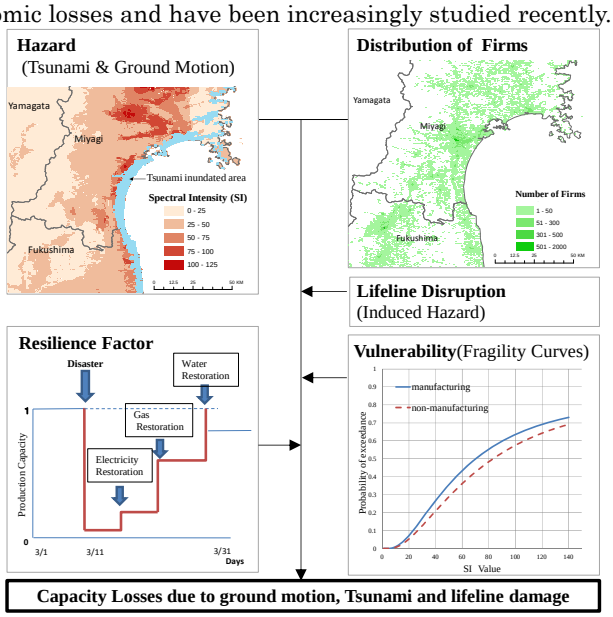
Associate Professor
Michinori HATAYAMA

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. We investigate an ideal model of disaster management system through informational, organizational and economic approaches. Considering disaster risk governance and/or management, public involvement and participatory approach to planning are also 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 an original information systems design method for integrated disaster risk management, especially by developing a spatial temporal database.

Economic Impact Assessment of Natural Disaster

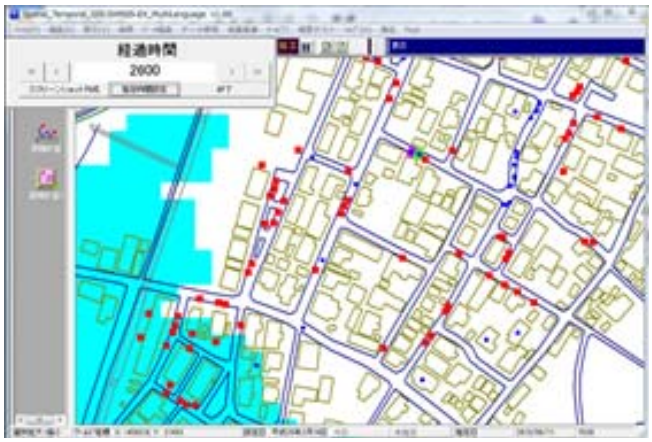
In order to enhance social resiliency against natural disaster, it is necessary to introduce integrated disaster risk management measures effectively. Establishment of methodology for design and estimation of effective alternatives against disaster is requested. In our laboratory, consistent measurement 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.



Disaster Management / Response Support System based on Advanced ICT

On March 11th, 2011, the Great East Japan Earthquake took place. Despite of such effort to prevent and reduce Tsunami impacts, the earthquake and tsunami killed nearly 20,000 people and bring about tremendous difficulty to Japanese society. Since Great Hanshin-Awaji Earthquake in 1995, application of advanced ICT for disaster response system is expected and a number of information systems were proposed, but didn't work sufficiently in the GEJE.

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 disaster response support systems such as information sharing system under unstable environment and disaster damage certification publish system and tried to implement them to local governments and regional communities to improve their coping capacities against disaster.



Tsunami Evacuation Evaluation System
based on Multi-Agent Simulation

Integrated Disaster Reduction Systems

Professor
Katsuya YAMORI

Assistant Professor
Shingo SUZUKI

Interdisciplinary approach to disaster reduction

The research field promotes research and practice to build a safe society by reducing disaster damage, particularly from social scientific point of view. A special attention is focused on creating an integrated risk management system in which both natural and social scientific approaches are combined. We also emphasize practical action research and implementation science.

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, and the earthquake in Tokyo Metropolitan Area.
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 Nakai Trough Earthquake and Tsunami

Fig.1 Examples of disaster education materials," Cross road," and "Bosai Duck," developed in the laboratory

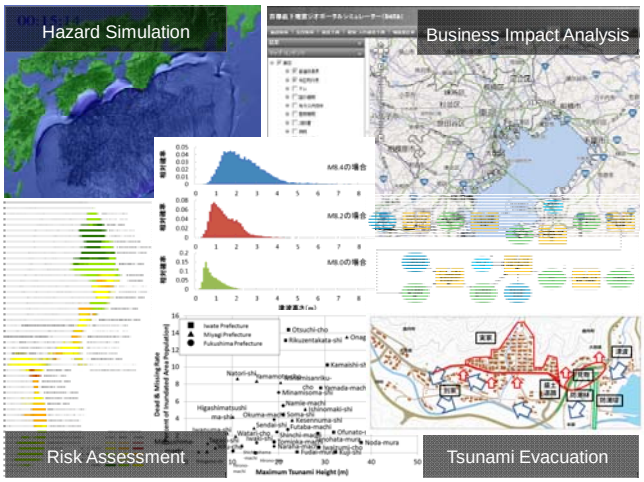


Fig. 2 Examples of computer simulator to estimate hazards and damages caused by the expected Nankai Trough Earthquake and Tsunami.

Disaster Information and Intelligence Lab.

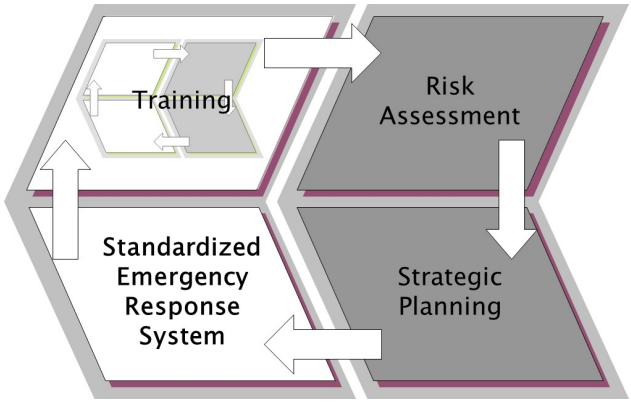
Professor
Haruo HAYASHI

Disaster Response as Information Management Process

In the wake of a disaster, people learn new behaviors in response to the new reality and need a process through which their positions can be accepted in society. Responding to a disaster is an information processing process in which individuals and society have to decide how to comprehend and respond to the reality of what has happened. Our research seeks to gain a better understanding of the information processing process through which people respond to disasters, based on the Business Continuity Management framework of 1) risk assessment, 2) strategic planning, 3) standardized risk management systems, and 4) training that seeks to reduce.

Comprehensive Risk Management System for Business Continuity

Researches on business continuity management such as 1) Multi-hazard risk assessment tool, 2) Strategic disaster reduction planning scheme with stakeholder involvement, 3) Standardized emergency response system based on Incident Management System, ICS, and 4) Training for effective emergency response.



Framework for Business Continuity Management

Long Term Recovery Process

It needs at least ten years to complete recovery from catastrophic disasters. Researches on recovery processes about Kobe earthquake (1995), 2004 Niigata Earthquake, the 911 terrorist attack (2001), Indian Ocean Tsunami (2004), Hurricane Katrina (2005), and the 311 East Japan Earthquake Disaster (2011) are conducted. We are also working with impacted communities for long term recovery planning, evaluation on recovery, and individual recovery assistance.

Recovery of New York from the 911 disaster

Trend Reader®

Trend Reader analyzes customer generated digital data about social response to disasters.

News article analysis on the 311 Tohoku Earthquake Disaster using Trend Reader