Department of Civil Engineering

Kobe University

New Civil Engineering ——
Toward Safety and Symbiosis of
Urban and Regional Systems

September 2017

The Aim

- Dept. of Civil Engineering aims at creating a safe and secured society in harmony with the environment, through the construction and preservation of fundamental social facilities.
- Civil Engineering Education is about helping the creation of an environment of cities and territories safe to natural and social disasters, and living in symbiosis with nature, through the preservation, lifetime management and revival of city facilities.

Structure and Divisions

- The Department of Civil Engineering consists of two divisions: the Human Safety Engineering Lab and the Environmental Symbiosis Engineering Lab.
- **Division of Human Safety Engineering** does teaching and research about urban safety against natural disasters and social disasters such as terrorism and accidents.
- **Division of Environmental Symbiosis Engineering** does teaching and research about the creation of an environment of cities and territories living in symbiosis with nature, as well as the preservation, lifetime management and revival of city facilities.

Structure and Divisions

- The Dept. of Civil Engineering features a strong collaboration with **the Research Center for Urban Safety and Security,** which was established after Hanshin-Awaji Earthquake in 1995. 7 of 28 faculties are with joint appointment.
- The Dept. has also been played a key role for establishing the academic framework "**Multidisciplinary Integration for Resilience and Innovation, MIRAI**", which create a new sphere to secure human life from huge natural and social disasters.

Structural Engineering

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Structural Engineering for Urban Safety

Dr. Tomohiro Miki, Associate Professor

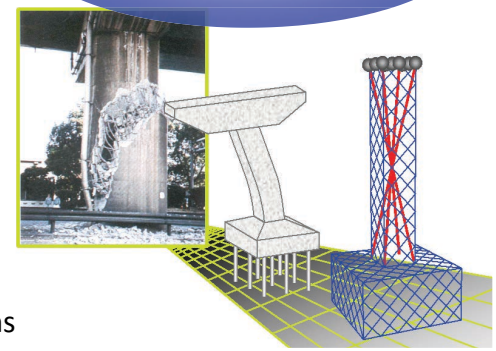
FINAL GOAL: **Advanced Structural Concrete Mechanics and Design**

Aging Structures

- Steel Corrosion
- Alkali-Silica Reaction (ASR)

Example: Corroded reinforced concrete beam and it evaluation by loading tests and extensive observations

Nonlinear Analysis



New Materials

Steel fiber reinforced concrete (SFRC)

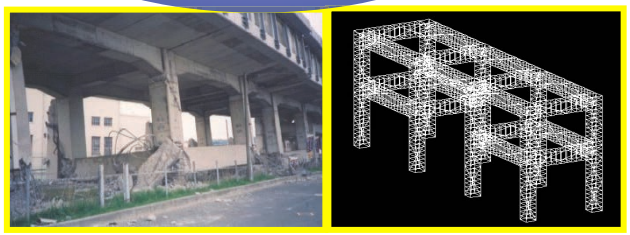
Ultra-high strength fiber reinforced concrete (UFC)

-Steel fiber
φ=0.2mm, L=15 mm
fu=2500N/mm²

+

-Cement
-Silica fume
-Silica sand

Seismic Performance



Damage of Shinkansen express train viaduct at Kobe earthquake and its seismic performance re-evaluation by using 3D Lattice Model

Experiment with Image Analysis

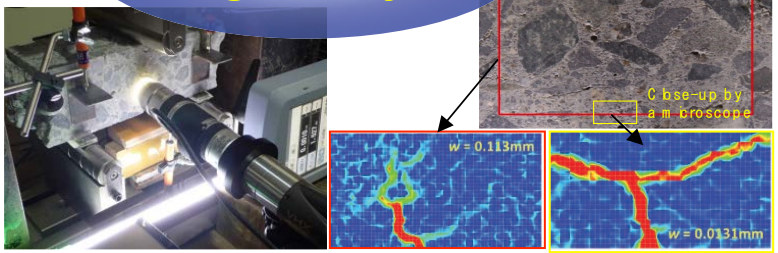


Image based detection for concrete fracture
Fracture properties of concrete damaged due to ASR in tension was evaluated based on loading tests and an image analysis.

New Technology

Design and application in the seismic regions
- Prestressed Concrete
- Precast Concrete structural members

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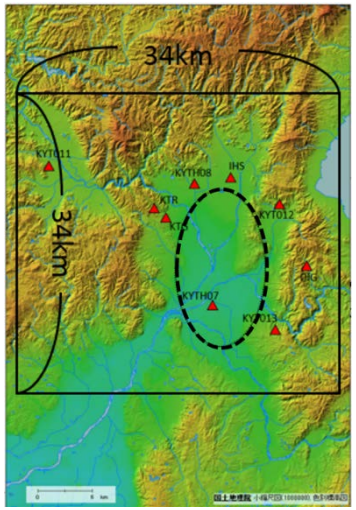
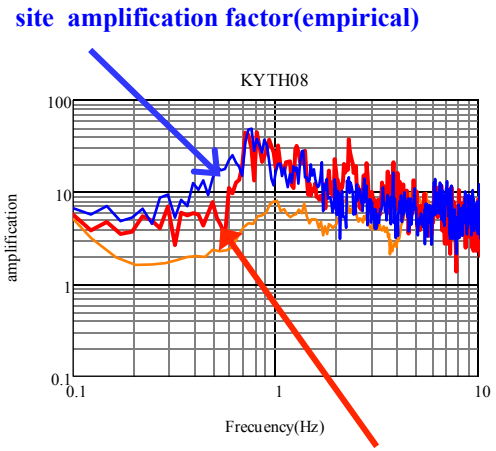
Earthquake Engineering

Dr. Takashi Nagao, Professor

Evaluation of earthquake ground motion and site amplification factor

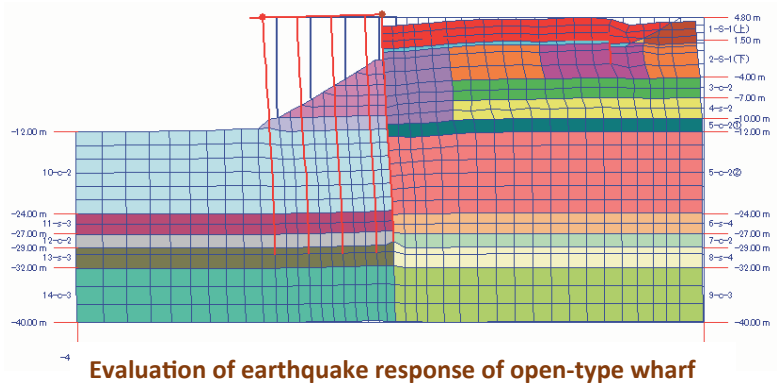


3 dimensional earthquake response analysis

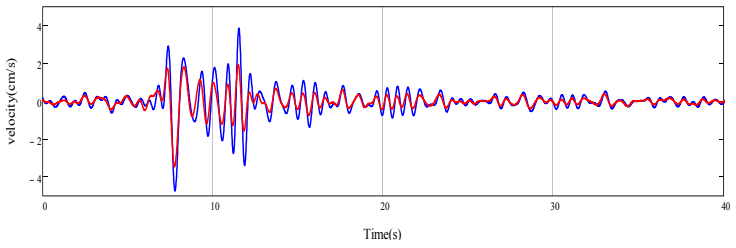


Evaluation of site amplification factor

Evaluation of earthquake resistance of structures



Evaluation of earthquake response of open-type wharf



Analysis & Empirical

Evaluation of earthquake ground motion

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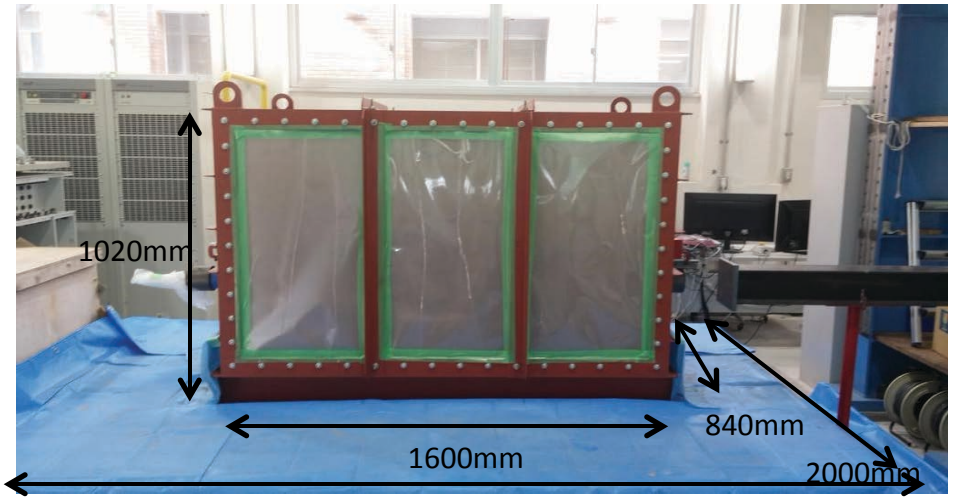
Earthquake Disaster Mitigation Engineering

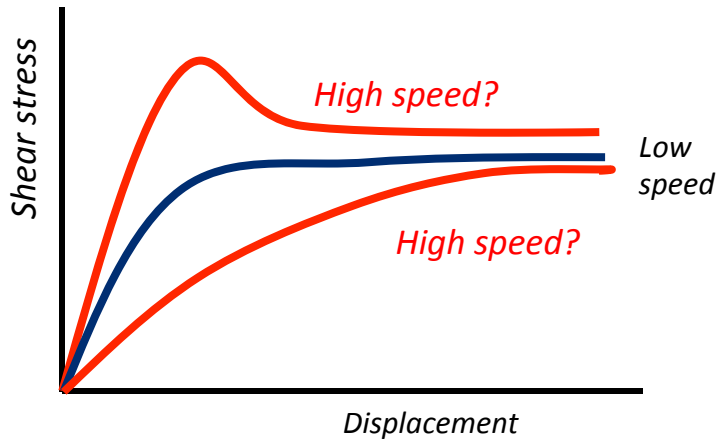
Dr. Yasuko Kuwata, Associate Professor

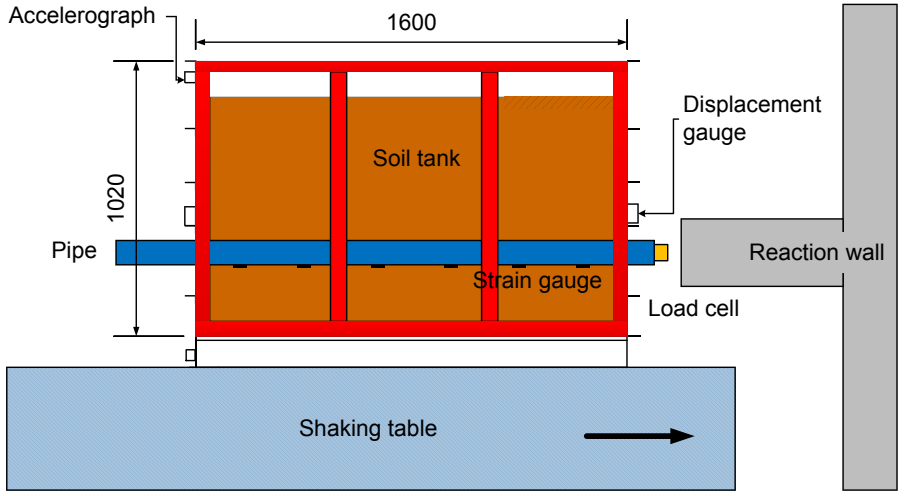
Experimental study on dynamic soil friction along a buried pipe

This study attempts to clarify the velocity dependency of soil friction from a pipe pulling test using a shaking table.



Shaking table 3000mm





Vertical view

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Urban Preservation Engineering

Dr. Hidenori Morikawa, Professor

Assessment of Existing Prestressed Concrete Bridges subject to Chloride Attack

①Evaluation of Brittle Failure and Corrosion Progress of Tendons
（Stress Corrosion Cracking Test, SSRT Test, Fractography） → Figure.1
②Probability Analysis of Corrosion Cracking of Tendons → Figure.2
③Structural Reliability Analysis of Prestressed Concrete Bridges

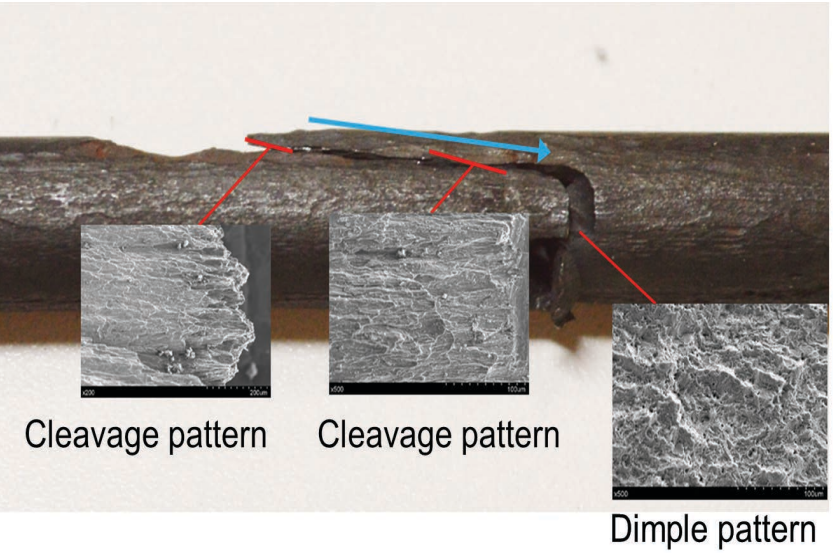

Fig.1 Fractography of facture Surface

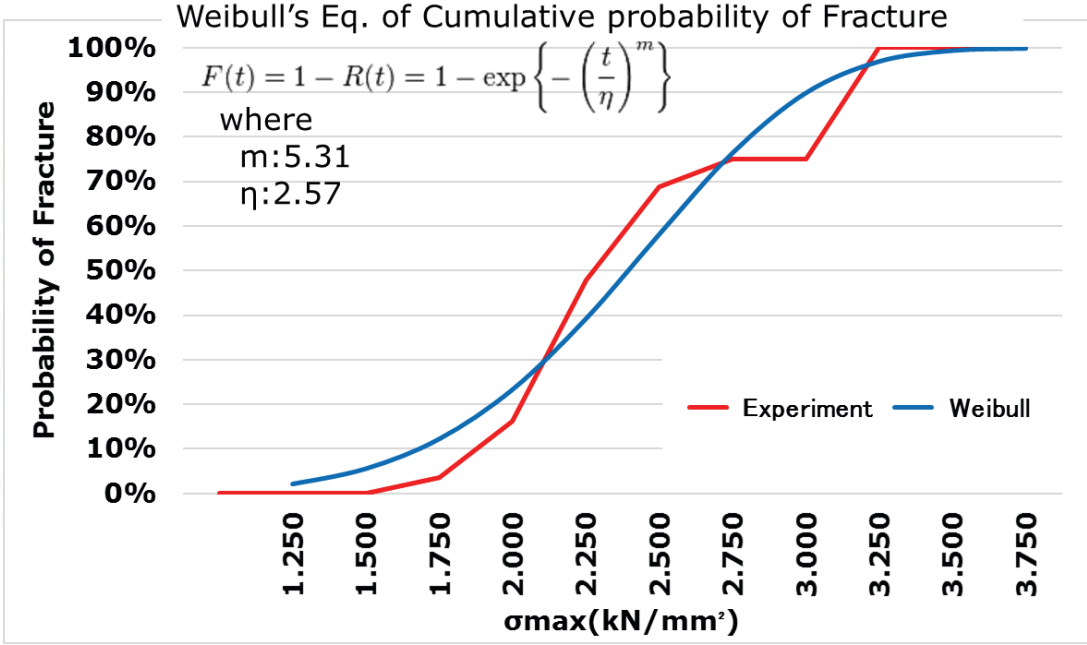

Fig.2 Fracture modeling related to apparent maximum stress

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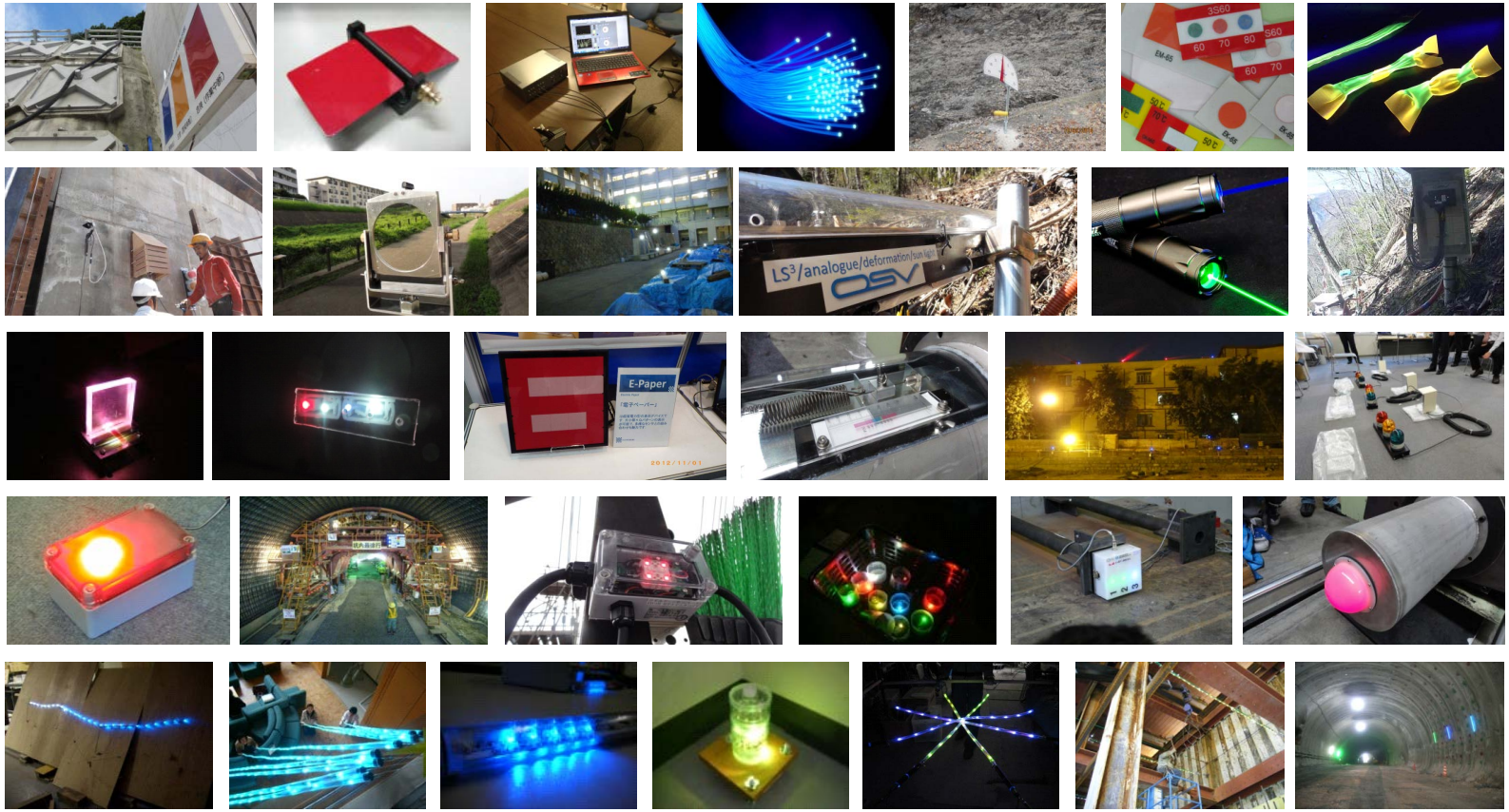
Urban Preservation Engineering

Dr. Shinichi Akutagawa, Professor

Professor Akutagawa is promoting a new monitoring scheme called “On-Site Visualization (OSV)” and its use would lead to better understanding of what is really going on for the monitored structures, faster detection of abnormalities, quicker reactions to minimize further structural damages, and realization of safer working and living environment for workers and citizens. This method can be applied to all fields of disciplines including civil, mining, mechanical engineering, agriculture, fishery, forestry and etc.



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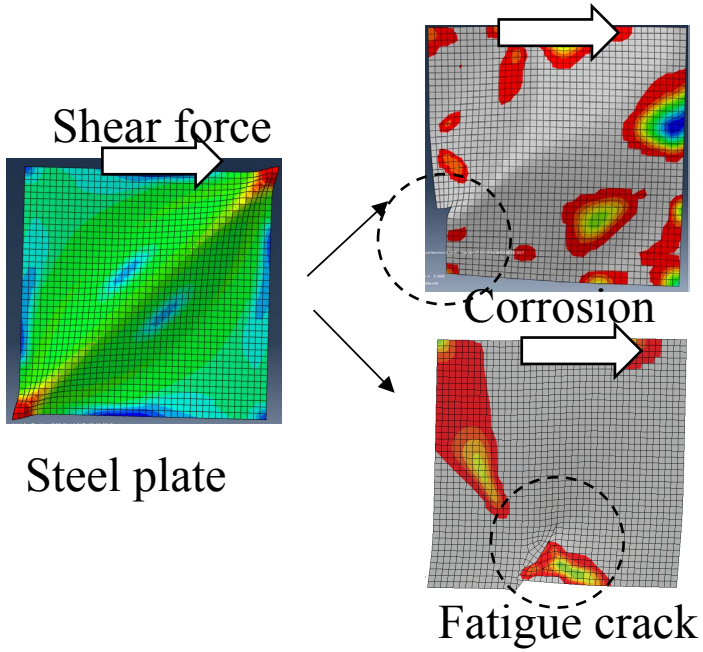
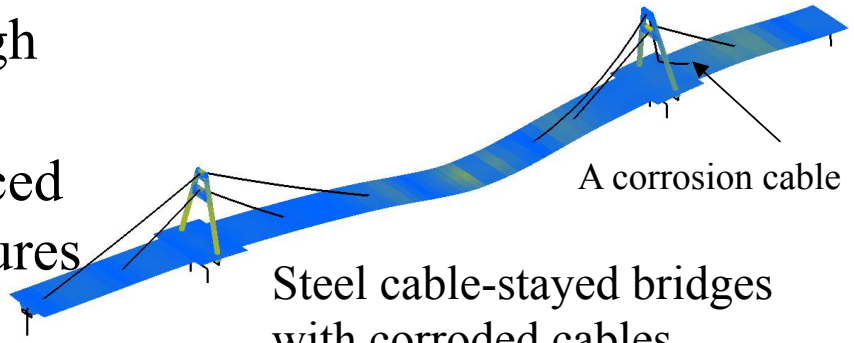
Urban Preservation Engineering

Dr. Kunitaro HASHIMOTO, Associate Professor

Main research topics (Keywords; Bridge Engineering, Steel Structure, Hybrid Structure, FRP)

1. Maintenance of Steel Bridges
    1. Estimation of load carrying capacity of damaged steel plates by fatigue cracks or heavy corrosion
    2. Estimation of load carrying capacity of steel cable-stayed bridges with corroded cables
2. Development of new type steel or hybrid structures
    1. Development of steel pier with high seismic performance
    2. Application of FRP (Fiber reinforced polymer) material to bridge structures





Steel cable-stayed bridges with corroded cables

Geotechnical Engineering

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Geotechnical Engineering for Urban Safety

Dr. Satoru Shibuya, Professor

❒ Keywords:

Development of geotechnical site investigation

Development of soil testing

Development of aseismic reinforcement of geo-structures

Mitigation of natural slope failure

Reuse of recycled materials in geotechnical engineering

(e.g., steel slag, coal ash etc.)

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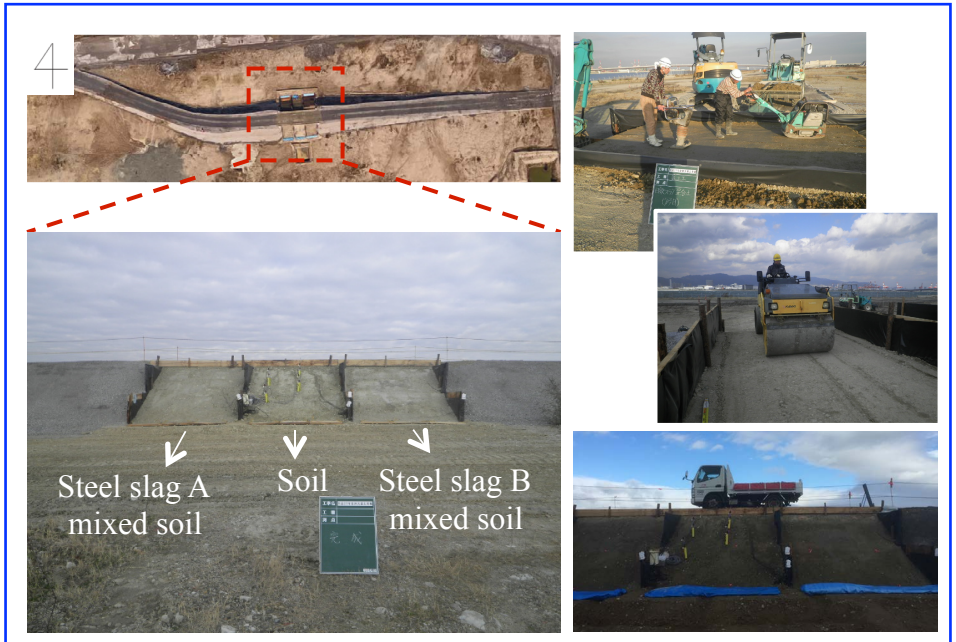
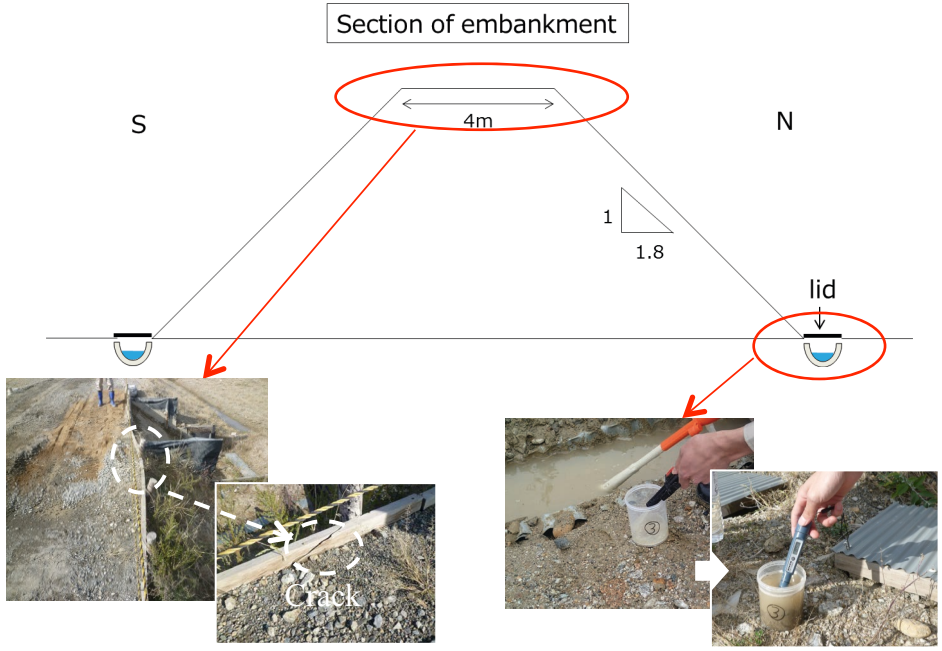
Geotechnical Engineering for Urban Safety

Dr. Satsuki Kataoka, Assistant professor

In this study, a full-scale embankment made with the mixture of steel slag and fine-grained soil was constructed, and the effect of alkaline leaching water from the embankment caused by rain and deformation caused by traffic load including large trucks were also investigated.



A full-scale embankment



Condition of the surface of the road section on the embankment (embankment of soil).

The pH measurement of water taken from the side ditches of the embankment.

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Geotechnical Engineering for Disaster Reduction

Dr. Tomohide Takeyama, Associate Professor

Liquefaction Analysis Considering Variation in Boring Survey

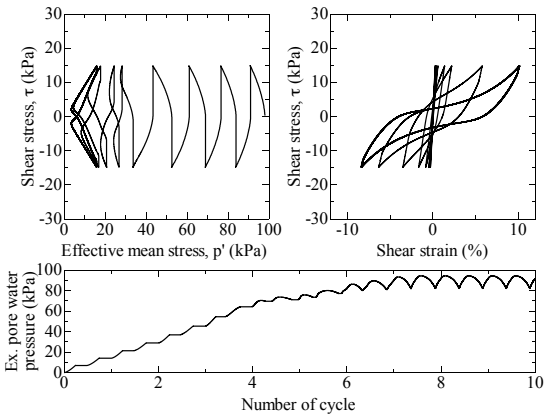
1. Introduction

The supercomputer “K” is used to simulate the processes of earthquake occurrence, structural response, and disaster response for the entire city by integrating the fundamental technologies such as earthquake ground motion prediction, earthquake response analysis, automatic generation of urban digital data, etc. This research aims to estimate liquefaction in a wide area with high accuracy by FEM.

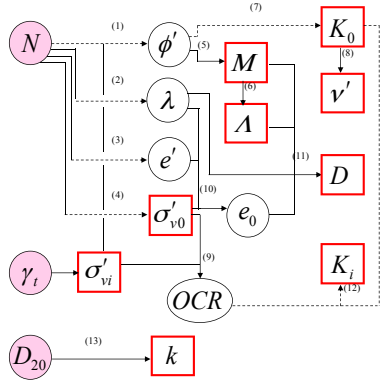
2. Constitutive model and material parameters

An elasto-plastic constitutive model that can express the process of liquefaction due to earthquakes is employed in this study.

The material parameters necessary to the constitutive model is estimated from SPT-*N* value and the plasticity index I_p by utilizing the database of the boring survey results. However, there are variations in the boring survey results. In this study, this variation is given as the probability distribution and the possibility of liquefaction is examined.



Simulation of cyclic simple shear

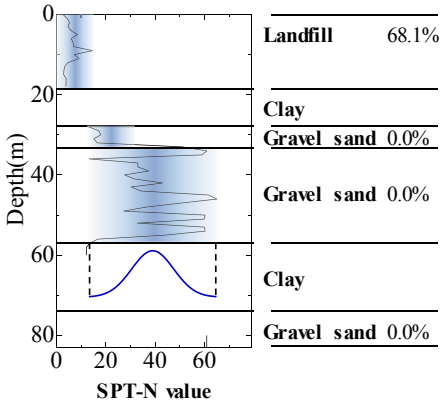


Estimation of parameters by *N* value

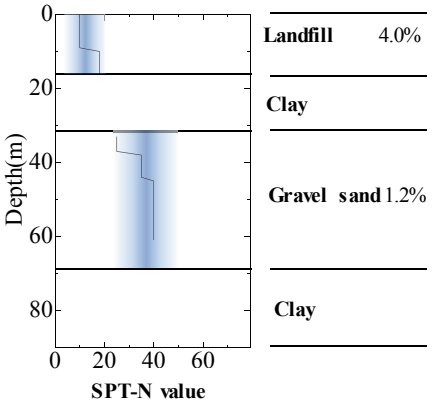
3. Estimation of liquefaction probability

Liquefaction analysis was carried out in consideration of variations in *N* values for two locations in Port Island and Rokko Island.

As a result, the liquefaction probability was calculated in landfill soil at 68.1% in Port Island and 4.0% in Rokko Island. This is consistent with observed facts during the Great Hanshin-Awaji earthquake in 1995. In Kobe City, there is a database of boring survey results of more than 10,000 locations. We’d like to conduct liquefaction analysis by using the all data.



North-west part of Port Island



South-west part of Rokko Island

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Geomechanics and Geoenvironmental Engineering

Dr. Atsushi Iizuka, Professor

Soil-water-gas coupling formulation

Geo technology

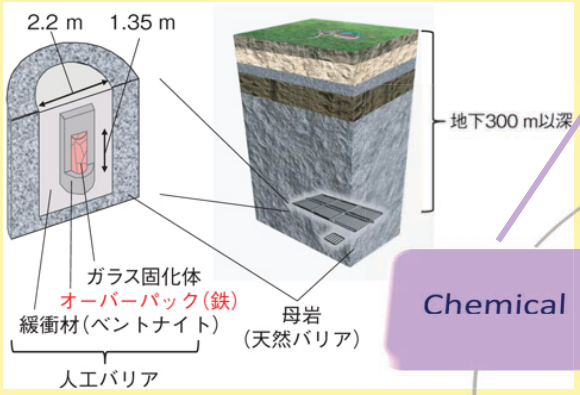
Chemical

Geophysics

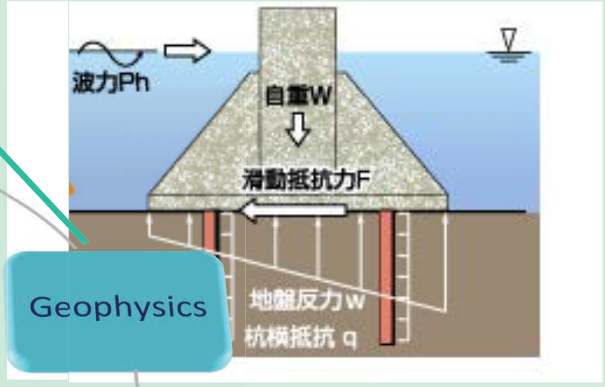
Marine geology

Seismology

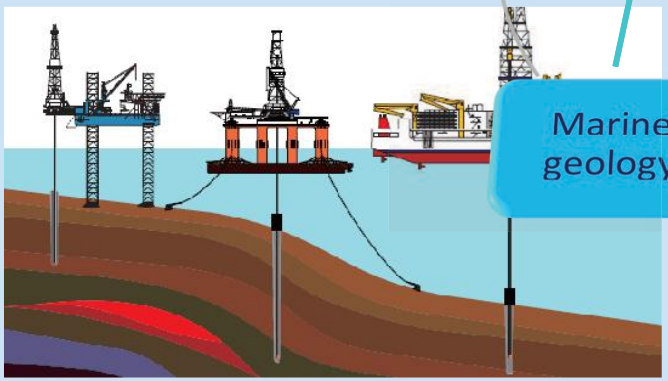
Geological disposal of radioactive material



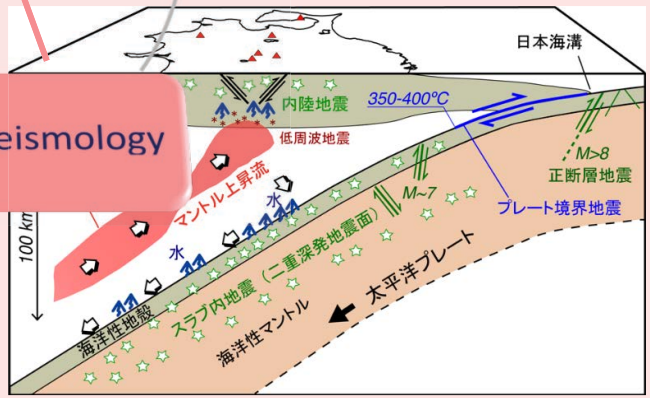
Bearing capacity of deep seabed ground



Seabed stability due to resource development



Mechanism of huge earthquake occurrence



Geotechnical Engineering for Disaster Reduction

Dr. Shinya Tachibana, Lecturer

Multi-physics Simulation in Geotechnical Engineering

Multi-physics is a computational discipline which treats simulations that involve multiple physical models or multiple simultaneous physical phenomena.

The aim of his research is to develop a multi-physics simulator for approach to geotechnical and geo-environmental problems such as safety assessment for the disposal of radioactive waste. His research combines concepts from advanced mathematics, mechanical theories, and numerical methods to create mathematical models and corresponding computer simulations that highlight complex behaviors of multi-functional materials on various length and time scales.

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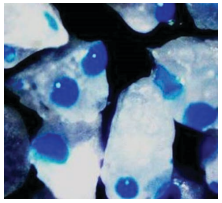
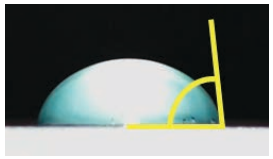
Geosphere Environmental Engineering

Dr. Shoji Kato, Associate Professor

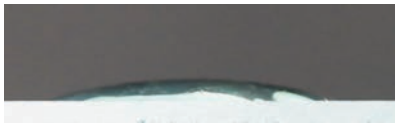
Characterization of geotechnical properties of non-wettable soils and its application for capillary barrier



Spatial distribution of water for non-wettable sand



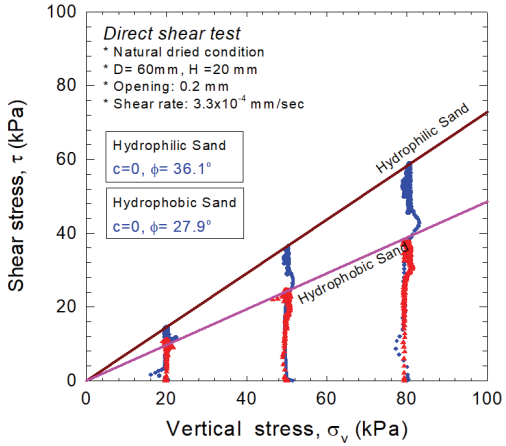
Non-wettable Θ = 13°



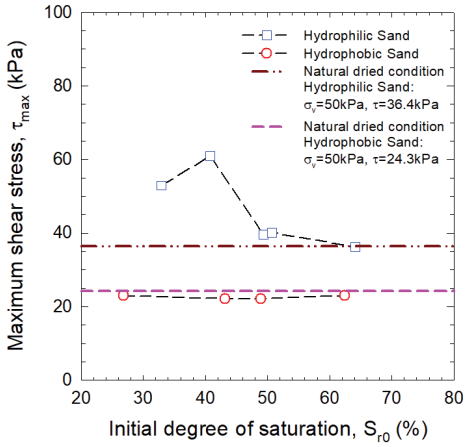
Wettable Θ = 85°

< Contact angle(Θ) on the surface >

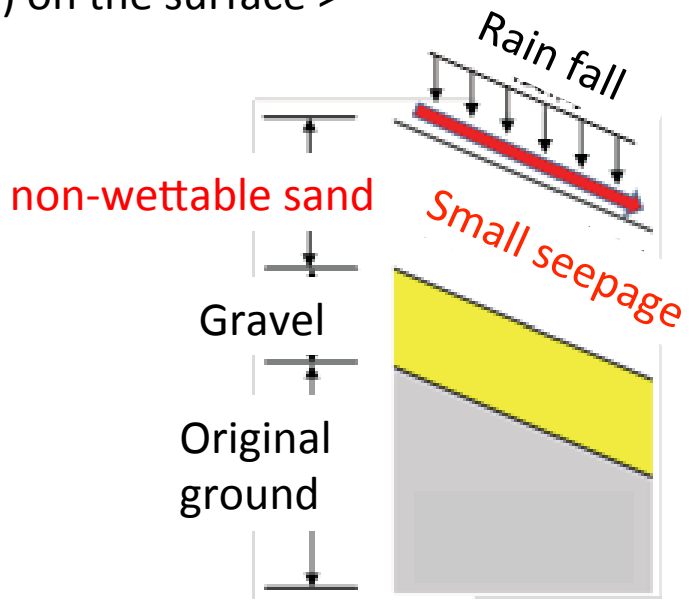
- **Direct Shear Test**



< Direct Shear Test in natural dried condition >



< Variation of τ_{max} according to the initial S >



application for capillary barrier

Hydraulic Engineering

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Disaster-prevention Engineering for River Basin

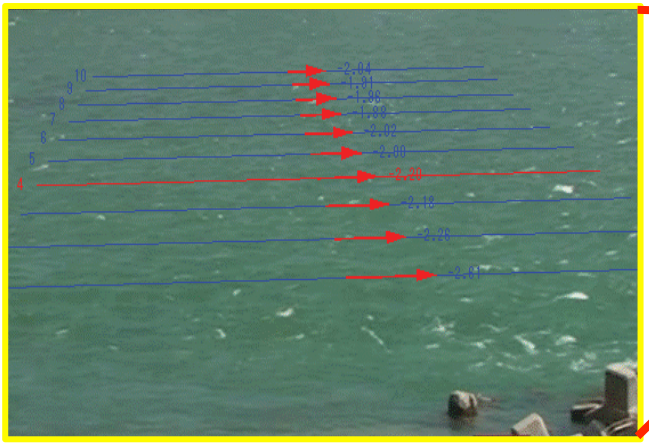
Dr. Ichiro Fujita, Professor

Main Project

◇Development of river flow measurement system by image-based techniques

- Utilize river surface flow movies obtained by monitoring camera or UAV
- Develop an image analysis technique STIV(Space-Time Image Velocimetry)
- STIV was commercialized as KU-STIV, officially used in many rivers in Japan and Queensland state, Australia introduced the system as a gauging method

Mean velocity distributions along the search lines can be measured automatically and in realtime



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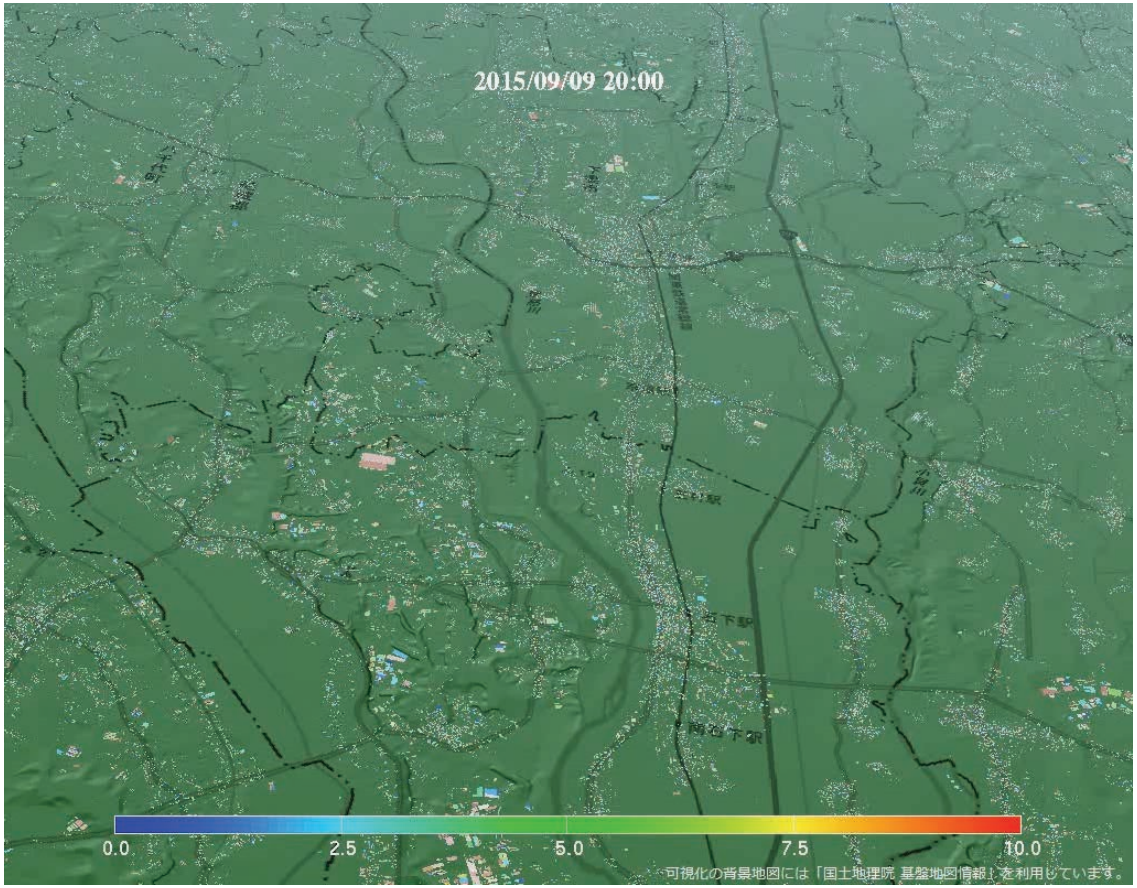
Disaster-prevention Engineering for River Basin

Dr. Kenichiro Kobayashi, Associate Professor

Development of a rainfall-runoff/ flood-inundation model to mitigate the flood disasters in the world

Simulation of Kinugawa flood disaster using K supercomputer (5m resolution)



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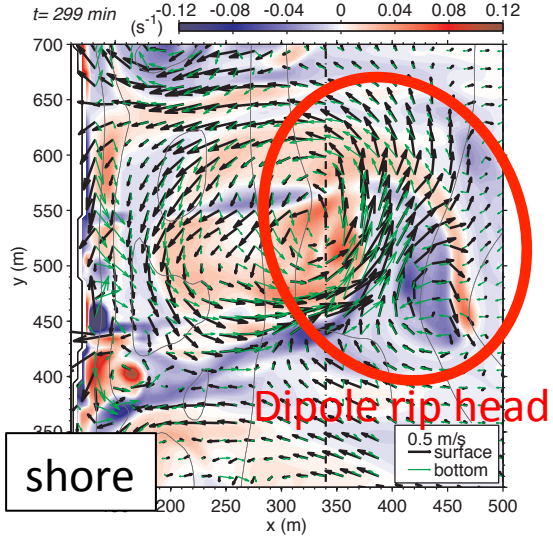
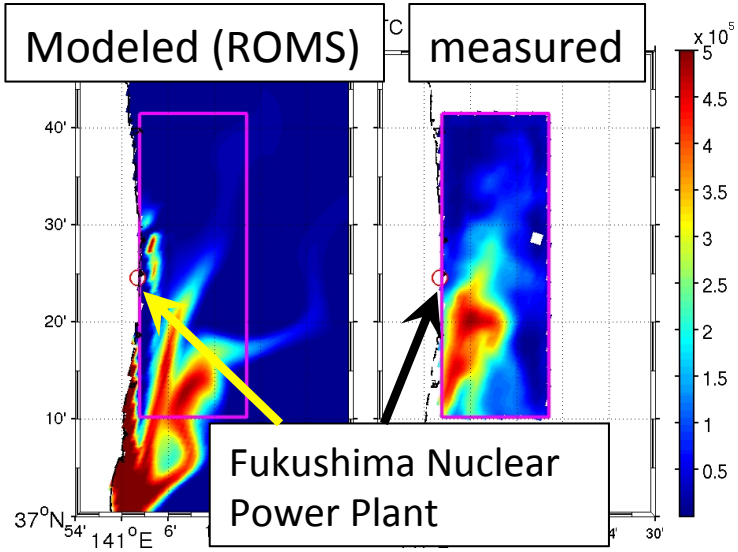
Environmental Fluid Engineering

Dr. Yusuke UCHIYAMA, Professor

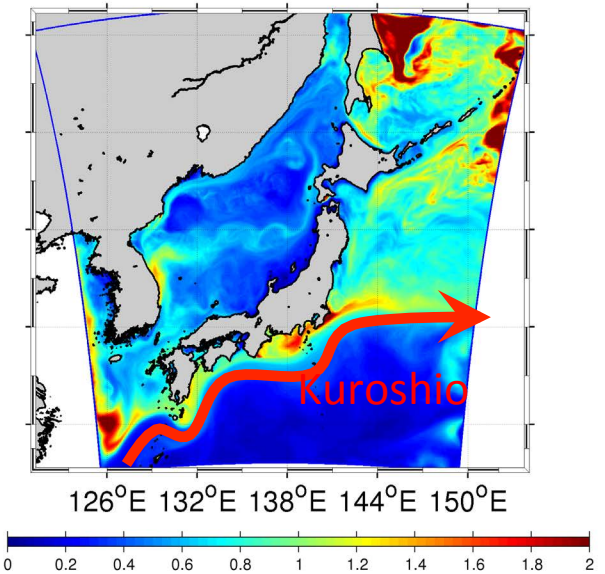
Goal: offer scientific and engineering supports for desirable aquatic environment, disaster prevention, optimal utilization of coastal areas.
Approach: numerical modeling (ROMS), theoretical GFD, and analyses of satellite remote sensing and *in situ* measurement.



3-D turbulent rip currents on a beach at Duck, NC, USA. (Uchiyama *et al*., 2017, *J. Geophys. Res. Oceans*)



Oceanic dispersal of ^{137}Cs [Bq/m^3] after the Fukushima Nuclear Accident (Uchiyama *et al*., 2014, *J. JSCE Ser. B*)



Climatological chlorophyll [μg/L] in upper ocean around Japan (Uchiyama *et al*., 2017, *J. Geophys. Res. Oceans*)

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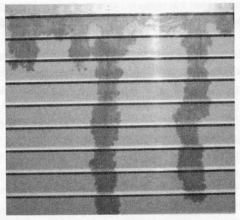
Environmental Fluid Engineering

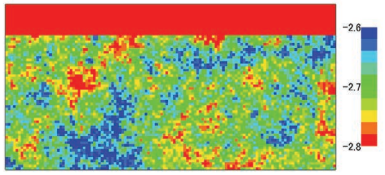
Dr. Masahiko SAITO, Assistant Professor

Research topics

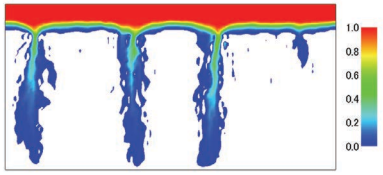
- Simulation of seepage flow and solute transport in non-uniform fields



Fingered flow



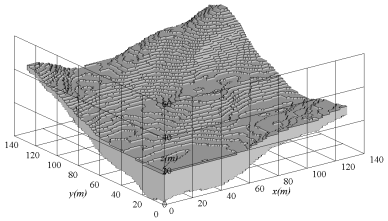
Distribution of $\log_{10}k_s$

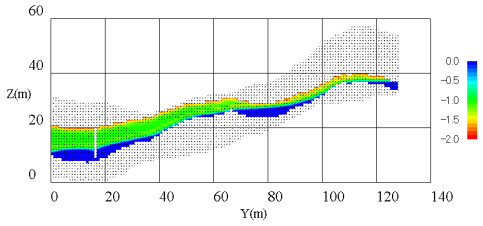


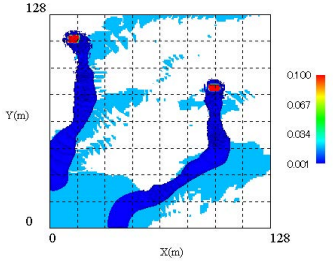
Distribution of concentration

(Example-1) Numerical simulation of fingered flow in non-uniform porous media

- Environmental groundwater modeling







(Example-2) Numerical simulation of rainfall infiltration and mass transport in the mountainside

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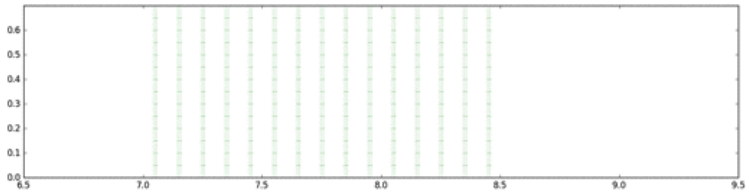
Aquatic and Environmental Engineering

Dr. Keisuke Nakayama, Professor

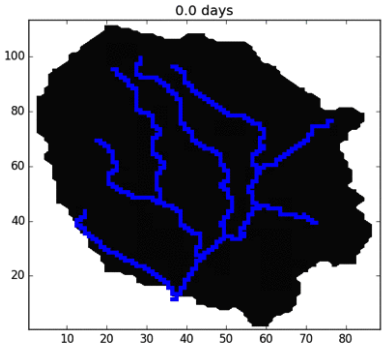
Our study purposes are to improve water quality and to sustain sound ecological system in an aquatic environment by including the influence of climate change.

Theme 1: absorption of CO2 by eelgrass in coastal regions



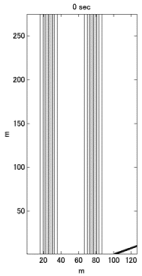
eelgrass in a uniform flow

Theme 2: mass transport in a river basin by using an object oriented programing and the Bayesian theorem

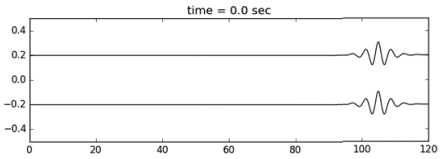


water volume in an infiltration layer (black & white) and water depth in a river network

Theme 3: surface and internal wave model by using the variational principle

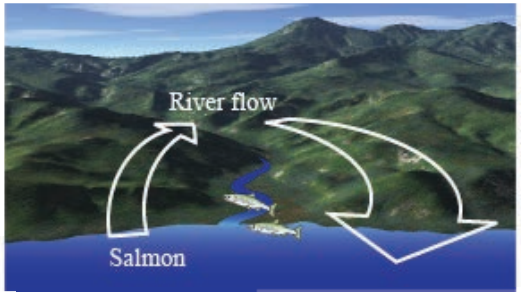


soliton resonance



breather

Theme 4: nutrient cycle between an inland and the ocean by using the stable isotope analysis



Runs of salmon are thought to play a large role in the sustainability of nitrogen cycling in ecological systems

Theme 5: stratified flow field analysis

plunging breaker of internal solitary waves

fissions of internal solitary waves

Engineering Application of Meteorology and Hydrology

Dr. Satoru OISHI, Professor

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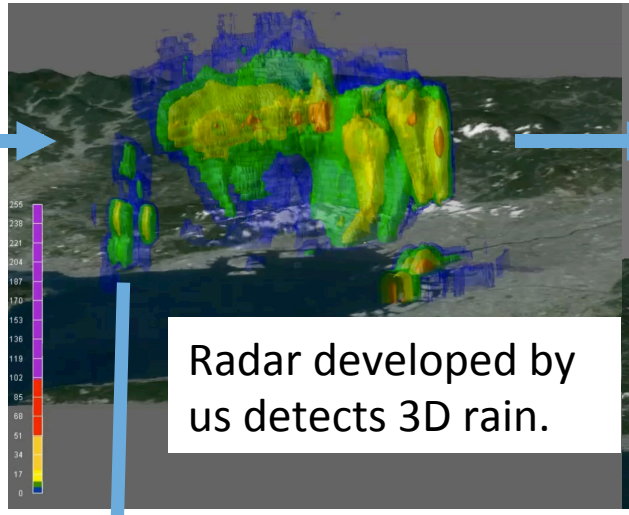
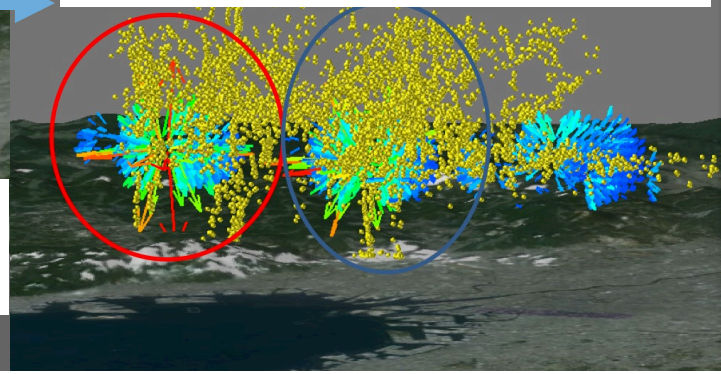


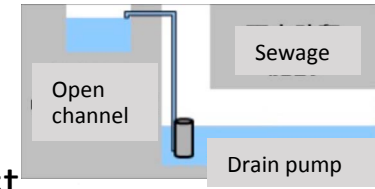
Radar developed by us detects 3D rain.

Electric field in the atmosphere is estimated

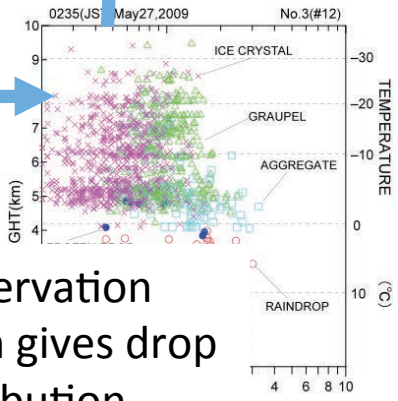


GNSS measures water vapor

Quantitative Precipitation Estimation(QPE)



Short term rainfall forecast



Field observation campaign gives drop size distribution.

Application

- Flood warning
- Sewage real time management

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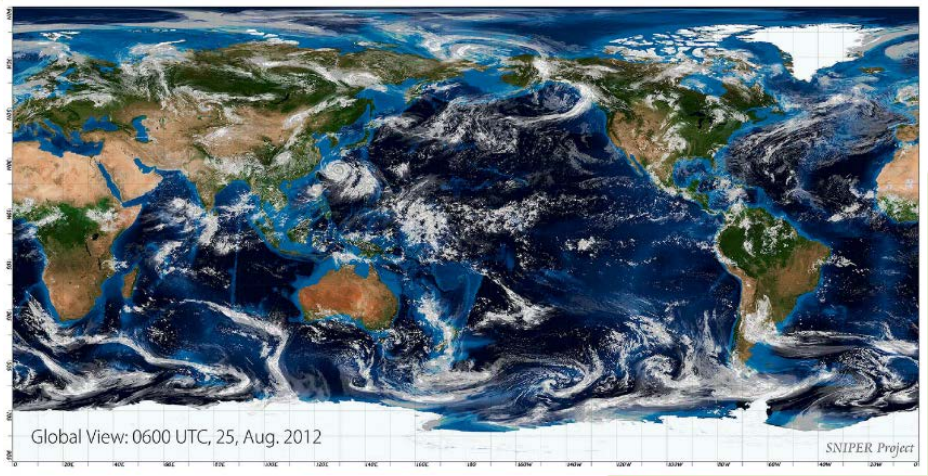
Computational Climate Science Research

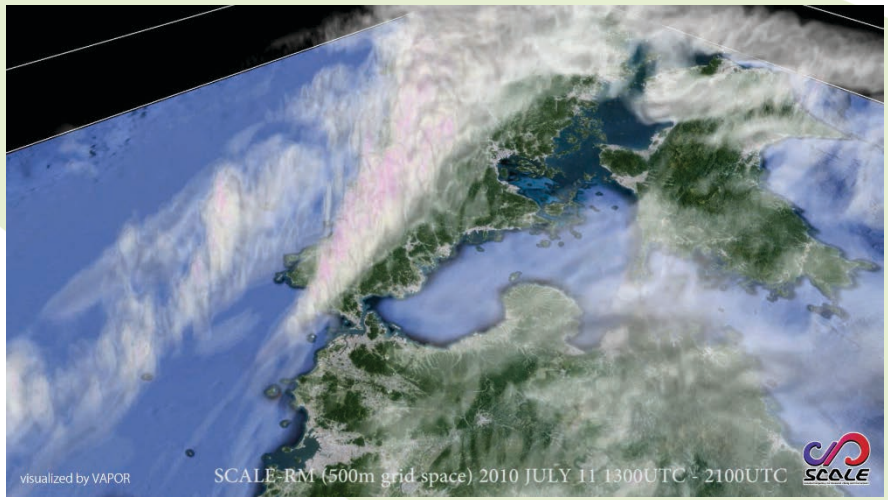
Dr. Yoshiyuki Kajikawa, Professor responsible for Computational Climate Science



From **G**lobal to **R**egional, we are challenging to investigate the climate change by large scale numerical simulation and diagnostic Data analysis. We also closely collaborate with Computational Climate Science Research Team in RIKEN Advanced Institute for Computational Science.

Upper: Horizontal view of the total mixing ratio of condensed water contents **in sub-kilometer** global atmospheric simulation.

Right: 3D visualization of the total mixing ratio of condensed water contents over Western Japan in 500m regional climate simulation.



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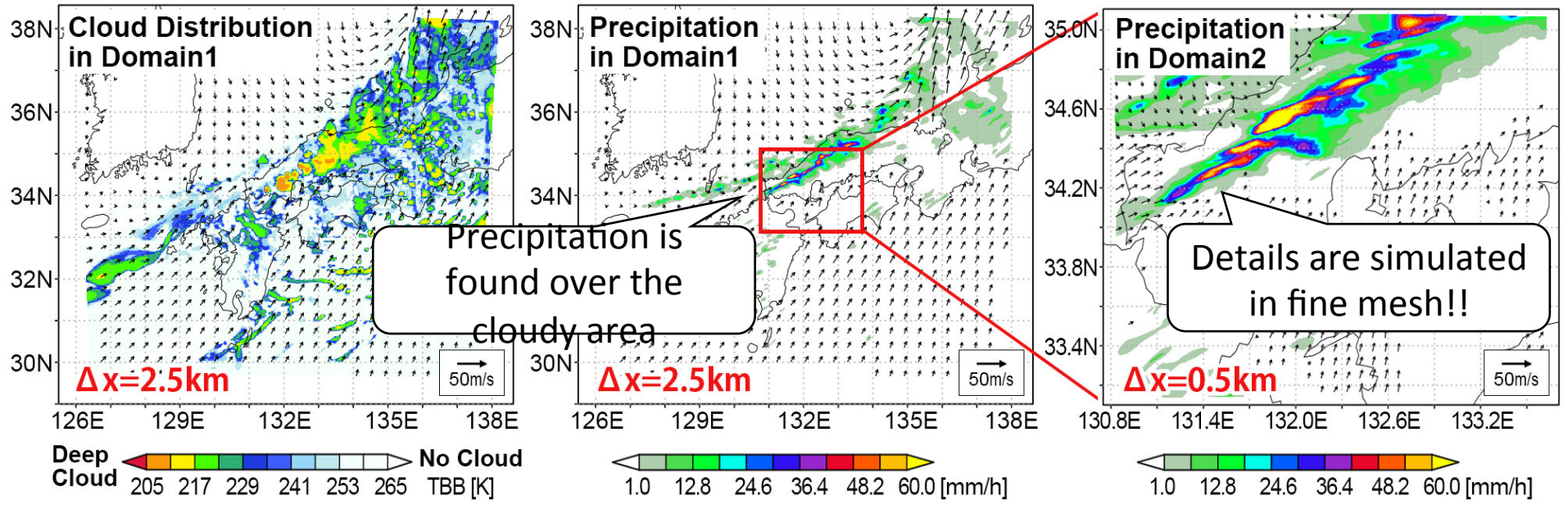
Mesoscale Meteorology

Dr. Ryuji Yoshida, Project Assistant Professor

Numerical Simulation of Heavy Rain Case at 11 July 2010 in Japan



- SCALE-RM is used for this simulation; developed by our team.
- Numerical simulation is useful to understand the structure and mechanisms of heavy rain for disaster prevention and mitigation.

Infrastructure Planning

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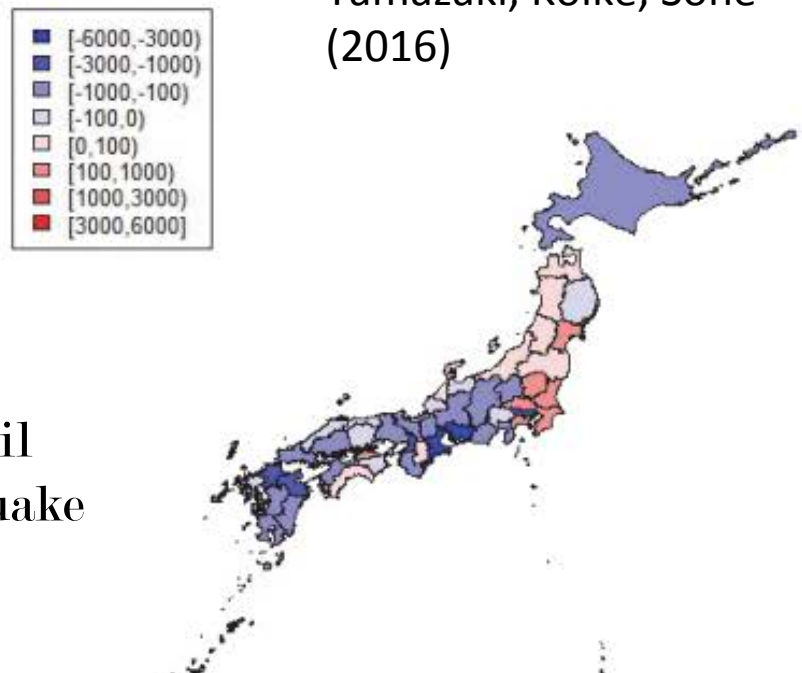
Infrastructure Planning & Management

Prof. Atsushi Koike; Assoc. Prof. Toshimori Otazawa;
Assoc. Prof. Hajime Seya

Socio-economic impacts evaluation of infrastructures

- We develop theories and methods for social impacts evaluation of infrastructures based on:
  Spatial econometrics approach,
  Urban economics approach, and
  Spatial computational general equilibrium (SCGE) approach.

Yamazaki, Koike, Sone (2016)



Example of an application of SCGE model:
Economic damage assessment of shutdown of oil refineries due to Nankai Trough great Earthquake

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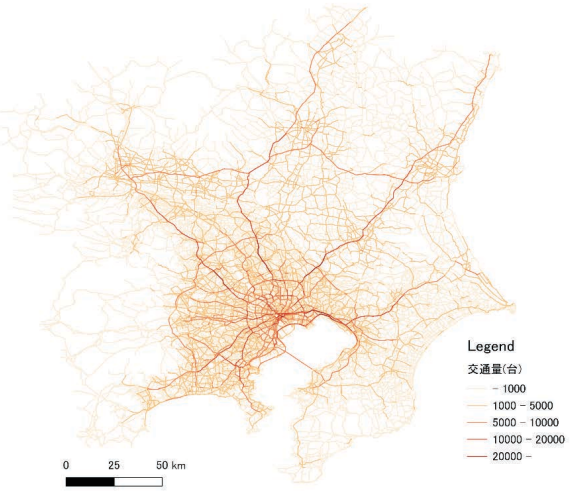
Transport Systems Engineering

Dr. Takamasa Iryo, Professor

Research topics include:

- Transport network analysis
- Big-data studies in transport
- Models and VR experiment for pedestrians' behaviour analysis.

  - Large-scale traffic simulator on HPC with demand models included to mitigate congestion after a disaster
  - Analyses of transport data such as nation-wide vehicle probe data and transit smart-card data
  - Mathematical and computational studies of dynamic traffic assignment and information transmissions dynamics



Output of traffic simulator

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Transport Systems Engineering

Dr. Hideyuki Kita, Professor

Research interests consist of the following two major topics.

(1) Traffic flow analysis by taking driving behavior into consideration.

- Game theoretic modeling of merging and lane changing behavior for safer and smoother road designing and traffic control with ICT.
- Subjective quality-of service evaluation based on the driver's perception.

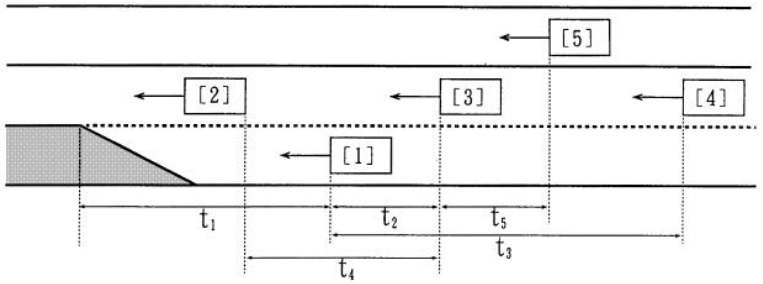

Fig. 2. Explanatory variables.

(2) Planning and design of sustainable public transport system especially in rural areas.

- Accessibility index to secure the opportunity of activities of residents for basic life.
- Develop a planning methodology to maximize the capability of communities

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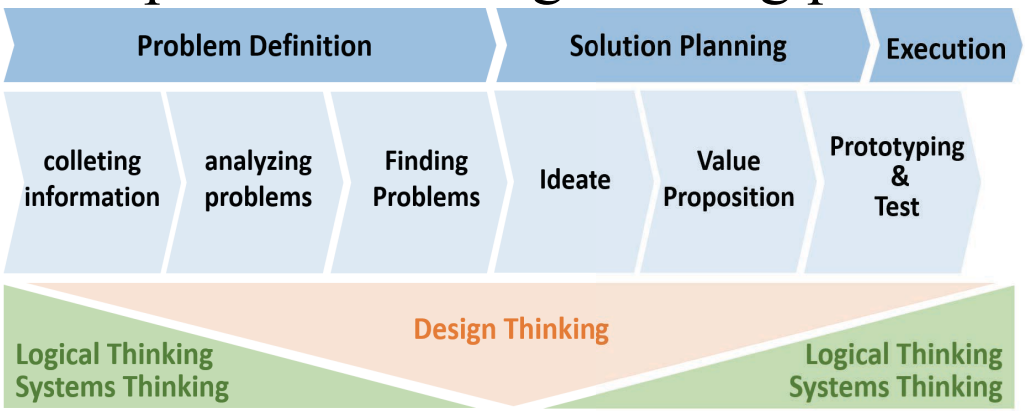
Value Engineering

Keiko Gion, Ph.D., Assistant Professor

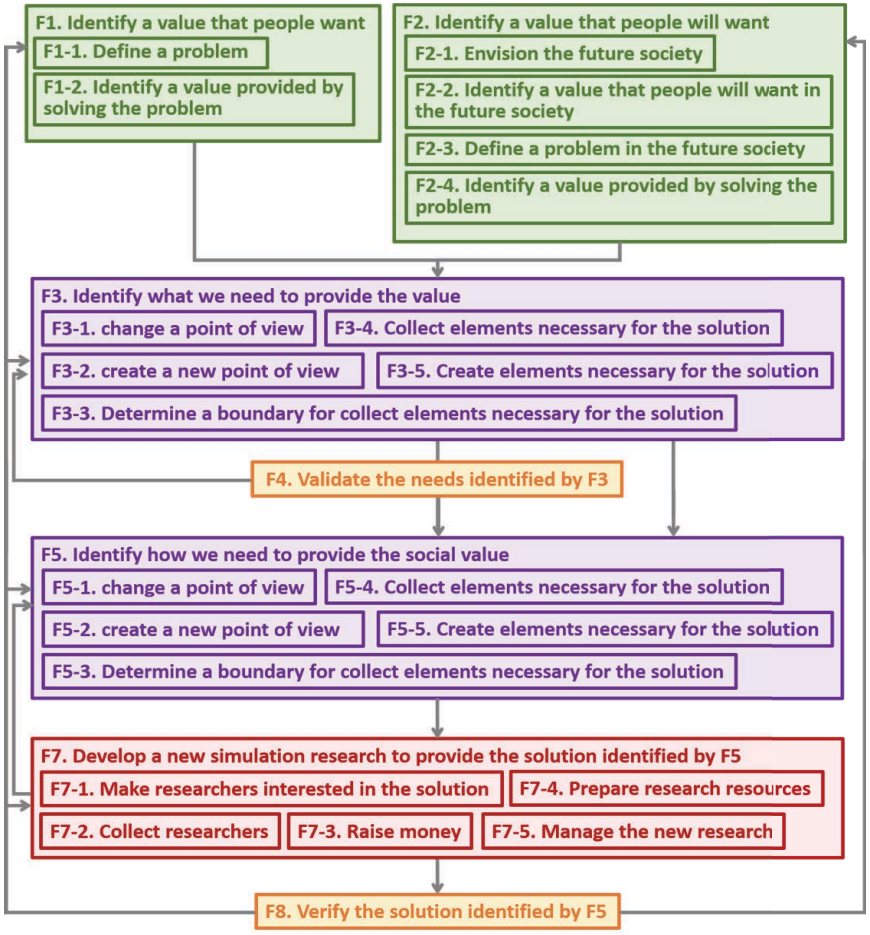
The problem-finding/-solving process



Value creation is an innovative process of discovering what and how to produce and deliver through ongoing processes of problem finding and problem solving.

My research interest is development of new systems and frameworks for the value creation.

A new system for connecting simulation research projects and value creation



Further Information

Graduate School of Civil Engineering
Department of Civil Engineering

http://www.eng.kobe-u.ac.jp/en/department/civil.html

The Research Center for Urban Safety and Security (RCUSS)

http://www.rcuss.kobe-u.ac.jp/English/index-e.html

Acknowledgments:
The slides were originally prepared by Prof. Hideyuki Kita in Sep. 2017