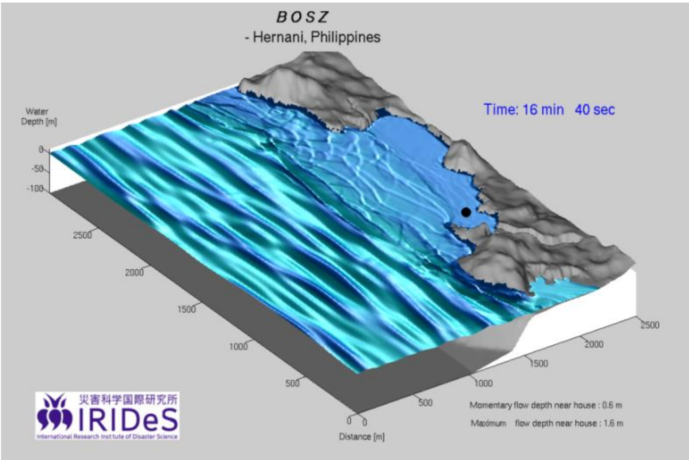
第２回水災害軽減のための流体力学の活用：台風シミュレーション及び被害評価

2nd International workshop on the application of fluid mechanics to disaster reduction: Cyclone (hurricane/typhoon/extra-tropical) modeling and damage assessment



March 16-17, 2015

Sendai Civic Auditorium (Shimin Kaikan), Sendai, Japan

Organized by the International Research Institute of Disaster Science (IRIDeS) at Tohoku University; Funded by IRIDeS and JSPS

Public forum of the 3rd UN World Conference on Disaster Risk Reduction

UN World Conference on Disaster Risk Reduction
2015 Sendai Japan

TOHOKU
UNIVERSITY

IRIDeS
International Research Institute of Disaster Science

東北大学は第3回国連防災世界会議を支援しています。

Workshop program and essential information

Monday March 16, 2015
Speaker series and discussion

Location: Sendai Civic Auditorium (Shimin Kaikan), 1st floor, Conference Room #1

Time	Speaker	Affiliation	Talk title
9:00-9:10	Jeremy Bricker	Tohoku U.	Introduction
9:10-9:30	Karl Kim	University of Hawaii	Learning from Disaster: Co-Benefits of Tsunami, Storm Surge, and Sea Level Rise Mitigation and Adaptation Strategies
9:30-9:50	Seth Guikema	Johns Hopkins University, Maryland, USA	Hurricanes, Climate Change, and Power System Impacts
9:50-10:10	Tori Tomiczek	University of Notre Dame, Indiana, USA	Hydrodynamic Damage Scheme and Fragility Functions for Hurricane Sandy's Effects in Coastal New Jersey
10:10-10:30	Takuya Miyashita	Kyoto University, Japan	Hydrodynamic Forces by Tsunami and Storm Surges Acting on City Scale Model
10:30-10:50	Mathew Francis	AECOM Consulting Engineers, Utah, USA	FEMA HAZUS Building Code Losses Avoided - Hurricane Winds
10:50-11:00	discussion		
11:00-12:00	catered lunch		
12:00-12:20	Nobuhito Mori and Tomohiro Yasuda	Kyoto University, Japan	Modeling of Super Typhoon Haiyan and Related Storm Surge and Waves
12:20-12:40	Hisamichi Nobuoka and Tomohiro Yasuda	Ibaragi University, Japan	Costal Flood behavior due to Typhoon Haiyan in Hernani based on Field Surveys and Interviews
12:40-13:00	Volker Roeber	Tohoku University, Japan	Amplification of Destructive Waves by Coral Reef during Typhoon Haiyan, Philippines
13:00-13:20	Maarten van Ormondt	Deltares, Delft, The Netherlands	Understanding the mechanisms that led to coastal flooding during Cyclone Haiyan
13:20-13:40	Masashi Watanabe	Tohoku University, Japan	Sediment transport due to storm surge and waves during Typhoon Haiyan in the Philippines
13:40-14:00	discussion		
14:00-15:00	break		
15:00-15:20	Seth Lawler and Celso Ferrera	George Mason University, Virginia, USA	Application of ADCIRC + SWAN to assess geospatial potential of wetlands to attenuate storm surge damage and hurricane flooding in the Chesapeake Bay
15:20-15:40	Troy Heitmann	University of Hawaii	Dispersion Preserving Numerical Schemes for Coastal Wave Propagation
15:40-16:00	Bagus Adityawan	Tohoku University, Japan	Dam Break Flow Simulation Using Simultaneous Coupling Method (SCM)
16:00-16:20	William Pringle	Kyoto University, Japan	Two-way coupled modeling of wave breaking dynamics and inundation under storm waves
16:20-16:40	Fabien Retif	University of Montpellier, Montpellier, France	Storm surge modelling from the ocean to the beach during typhoons crossing Taiwan
16:40-17:00	discussion		
17:00-18:00	catered dinner		
18:00-18:20	Kwok Fai Cheung	University of Hawaii	Integration of Coastal Inundation Modeling from Storm Tides to Individual Waves
18:20-18:40	Guillaume Auger	Ritsumeikan University, Japan	Simulation of sewage dispersal in Lake Biwa in using a particle tracking approach
18:40-19:00	Hubert Chanson	University of Queensland, Brisbane, Australia	Bores, Surges and Hydraulic Jumps: from tidal bore field measurements to tsunami-induced bore propagation - can we trust hydraulic modelling?
19:00-19:20	Taro Arikawa	Port and Airport Research Institute, Japan	Consideration of failure mechanism of seawall under storm surge
19:20-19:30	discussion		

Location of March 16 workshop: Sendai Civic Auditorium (Shimin Kaikan), 1st floor, Conference Room #1（仙台市民会館、会議室１）

Seninar location address:　4-1 Sakuragaoka Koen, Aoba-ku, Sendai (仙台市青葉区桜ヶ岡公園　４－１）

Photo of Sendai Civic Auditorium

Tuesday March 17, 2015

Study tour of areas rebuilding from tsunami damage in Miyagi Prefecture

This is a joint event with Prof. Kanako Iuchi's workshop "Recovery after mega-disasters: people, community, and planning"

Meeting location: 6am at Iwamatsu Ryokan (for guests staying at Iwamatsu), or 6:45am on HiroseDori in front of the KokubunCho gate

Location	Time	
Sakunami Iwamatsu Ryokan	6:00	depart
Sendai HiroseDori Kokubuncho Gate	6:45	depart
Service area break	bring your own breakfast	
Kessennuma	10:00	arrive
Kessennuma	10:30	depart
Nakajima Kaigan	11:00	arrive
Nakajima Kaigan	11:30	depart
Minamisanriku Shizugawa Takano Kaikan	12:15	arrive
Minamisanriku Sun-Sun Market	12:45	lunch at market
Minamisanriku Shizugawa	13:30	depart
Onagawa hospital	15:00	arrive
Onagawa city hall and public housing	15:30	arrive
Onagawa	16:00	depart
Ishinomaki levee construction site	16:30	arrive
Ishinomaki levee construction site	16:45	depart
Sendai Port evacuation tower	17:45	arrive
Sendai Port evacuation tower	18:00	depart
Sendai Station	19:00	arrive
Sakunami Pizza Restaurant	20:00	arrive
Sakunami Iwamatsu Ryokan	21:00	arrive

Guests staying at Iwamatsu Ryokan will be provided with onigiri (rice balls) for breakfast.

Learning from Disaster: Co-Benefits of Tsunami, Storm Surge, and Sea Level Rise Mitigation and Adaptation Strategies

Karl Kim, Ph.D, Professor of Urban and Regional Planning Executive Director,
National Disaster Preparedness Training Center University of Hawaii

Using data and strategies from Hawaii and other communities impacted or threatened by natural hazards, this presentation focuses on the co-benefits of an "all-hazards" approach to coastal disaster risk reduction. In addition to integrating different storm, tsunami, and flooding models, the research examines different structural and non-structural approaches to risk reduction. Land use strategies, siting, resilient building design, as well as other policies for managing coastal hazards are considered. While early detection and warning systems, as well as evacuation (both vertical and horizontal) plans and programs are an integral part of increased coastal resilience, the need to consider longer term strategies for mitigation of hazards and threats is especially relevant given both the understanding and management of low probability events as well as uncertainties regarding threats, risks, and vulnerabilities. Approaching these problems from a holistic, place-based, multi-hazard, and multi-agent perspective provides the greatest opportunities for risk sharing and collective management of coastal hazards.

Hurricanes, Climate Change, and Power System Impacts

Seth Guikema
Associate Professor
Johns Hopkins University
Department of Geography & Environmental Engineering (primary)
Departments of Civil Engineering and Earth & Planetary Science
(joint appointments)

ABSTRACT:
Hurricanes regularly impact power systems along the U.S. coast, leading to large-scale loss of power. Recent examples include Hurricane Irene with 6-7 million people without power and Hurricane Sandy with 8-10 million people without power at the peak outage period. Many of the most vital systems and organizations in the U.S. are highly dependent on the functioning of the power system. A critical component of adequately preparing for and responding to these storms is having estimates of the magnitude and spatial distribution of the impacts prior to the event so that electric utilities, other power-dependent utilities, and government agencies can plan appropriately for their emergency response efforts. This talk summarizes work done over the past 7 years to develop accurate power outage prediction models for hurricanes. The current model is an ensemble data mining method trained and validated with spatially detailed outage data form over 10 past hurricanes. The predictive accuracy of the model in past hurricanes has been strong. The talk then presents recent work that examines the potential for climate changed induced changes in the hurricane environment to lead to changes in risk to power systems over time. These changes are estimated both in aggregate along the entire US coastline and more locally at the level of cities and communities.

Hydrodynamic Damage Scheme and Fragility Functions for Hurricane Sandy's Effects in Coastal New Jersey

Tori Tomiczek, E.I.T., M. ASCE, PhD Candidate,[1] Andrew Kennedy, PhD, M.ASCE[1], Yao Zhang, PhD[1], Margaret Owensby, PhD Candidate[1], Mark E. Hope, PhD[1], Ning Lin, PhD[2], Abigail Flores[1]

Abstract

Hurricane Sandy was the deadliest and most destructive Atlantic hurricane in 2012, causing 286 deaths and over $68 billion dollars (USD) in damage in the Caribbean and Eastern United States (Blake, et al. 2013). Following the storm, a local damage reconnaissance survey in Ocean County, New Jersey (between 39.94° and 40.1° N latitude) characterized damage for 380 residential structures. A standardized damage classification scheme was modified to assess damage occurring to specific structural components (roof, walls, foundation, attached structures, openings, and house interiors) and classify a house into one of seven overall damage states. This methodology will be useful in standardizing damage assessment procedures in future field surveys and will allow damage data from other surveys to be compiled into a large damage database for the improvement and validation of damage prediction models.

A 2D Boussinesq-Green-Naghdi hydrodynamic model simulated conditions during the strongest hour of the storm; hydrodynamic outputs were correlated with relative damage experienced by coastal houses. Figure 1 depicts the computed water depth time series at two locations in Ortley Beach, NJ: Figure 1a at an oceanfront home that was completely destroyed by Hurricane Sandy and Figure 1b at a home situated one block inland from the ocean that experienced relatively minor exterior damage. The mean water depth, d_s, the maximum water depth $(h+\eta)_{max}$, and the maximum wave height calculated using common design standards, $1.55d_s$, (ASCE, 2010, FEMA, 2011) are plotted in Figure 1. Results indicate that assumptions from design standards based on average conditions are not appropriate parameters for estimating wave-related damage to coastal residences. Further, Figure 1 provides evidence that urban roughness and shielding effects from oceanfront homes play important roles in wave and storm tide dissipation, thus preventing severe damage from occurring to inland homes. Engineering methods to implement surge and wave-dissipating structures will reduce damage to homes in future tsunami or typhoon events.

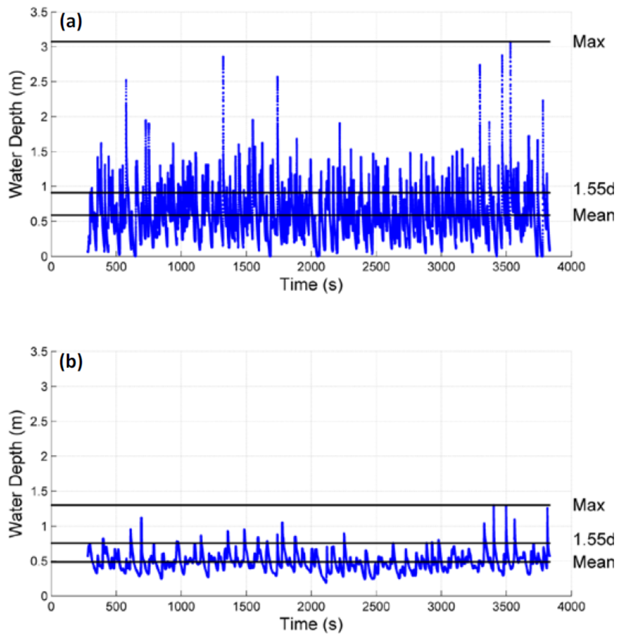


Figure 1: Time Series of Water Depth for (a) ocean fro house, destroyed, and (b) inland house, minor damage

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Finally, a fragility model was derived that predicts expected degree of damage occurring to coastal residences with reliability comparable to previously derived fragility models (Tomiczek, Kennedy, and Rogers, 2014). Water velocity and relative shielding of homes were identified as critical parameters influencing a given damage state. This fragility model is a significant step for which to predict damage caused by future hurricanes, and can be used by practicing engineers to design and fortify coastal communities so as to mitigate damage caused by such storms.

References

ASCE (2010). *Minimum Design Loads for Buildings and Other Structures,* ASCE/SEI, 21-80.

Blake, E.S., Kimberlain, T.B., Berg, R.J., Cangialosi, J.P., and Beven, J.L. II. (2013). "Tropical Cyclone Report: Hurricane Sandy (AL 182012), 22-29 October 2012." *National Hurricane Center.* 1-157.

FEMA. (2011a). *Coastal Construction Manual.* (FEMA P-55). Washington, D.C.

Tomiczek, T., Kennedy, A., and Rogers, S. (2014). "Collapse Limit State Fragilities of Wood-Framed Residences from Storm Surge and Waves during Hurricane Ike." *J. Waterway, Port, Coastal, and Ocean Engineering*, **140**(1). 43-55.

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Hydrodynamic Forces by Tsunami and Storm Surges Acting on City Scale Model

Takuya Miyashita[1], Nobuhito Mori[1*], Tomohiro Yasuda[1], Hajime Mase[1] and Daniel T. Cox[2]

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Abstract

The 2011 Tohoku Earthquake Tsunami showed complex tsunami behavior along the Japanese coast. The tsunami propagations in the city were different from rural area and indicated importance of hydrodynamic force estimation and locations of buildings, houses and streets. The fragility of buildings and houses is generally parameterized by water surface elevation and there is no difference between tsunami and storm surge for application use. However, the hydrodynamic forces between tsunami and storm surge can be different if the intensity is significantly large.

This study examines physical experiments and numerical simulations to estimate characteristics of surface elevation and velocity of tsunami and storm surge in a real city condition. The sensitivity of city structures to surface elevations and velocities is analyzed both tsunami and storm surge conditions. The city structures shows significant changes of dynamic forces depends on the locations of buildings and streets.

FEMA HAZUS Building Code Losses Avoided – Hurricane Winds

Mathew Francis, AECOM Consulting Engineers, Salt Lake City, Utah, USA

As technical support the need to quantify risk of natural hazards in the US under Presidential Policy Directive-21, FEMA is performing a national study to model building code adoption related losses avoided on a parcel level basis. The modeling includes hurricane wind, flood and seismic hazards, performed on a parcel level basis (level 2 study) in the popular Hazus Multi-Hazard (MH) platform. The pilot study and regional demonstration study of the Southeastern United States involving modeling 17 million buildings is complete, and the national methodology was completed in October 2014.

The presentation will provide an overview of the approach to characterizing modern International Code Council (I-code) provisions launched in the year 2000, in comparison to prior building codes used by individual jurisdictions. Details will be provided for the hurricane wind modeling, assigning varying degrees of damage under various loadings for selected Wind Building Characteristics (WBC's) used to modeling structures in Hazus as reflected in the I-code wind provisions.

The need for orienting building codes to be better aligned with loss drivers and the challenges with developing histories of adopted wind hazard maps and various building code versions will be explained in context of regional construction practices and legacy code variations prevalent in the thousands of jurisdictions with hurricane wind exposure in the US. The methodology for managing metadata and geospatial based presentation of results will be illustrated as well as presention of building code benefits in terms of Average Annualized Losses (AAL) avoided, useful to the insurance industry.

Also included will be a brief overview of planned changes to wind provisions in the American Society of Civil Engineers (ASCE) 7 load standard used in the I-codes, and ASCE support for Hurricane Yolanda recovery, as well as other current research by FEMA, the insurance industry, and the National Institute of Standards and Technology (NIST) under the national wind hazards reduction program.

Modeling of Super Typhoon Haiyan and Related Storm Surge and Waves

Nobuhito Mori[1,*], Tomohiro Yasuda[1], Eric Cruz[2], Andrew Kennedy[3], Sooyoul Kim[4], Kenzou Kumagai[5], Yoko Shibutani[1], Izuru Takayabu[6], Tetsuya Takemi[1], Kazuhisa Tsuboki[7]

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[2] The University of the Philippines Diliman, Philippines
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Abstract

Typhoon Haiyan, which struck the Philippines in November 2013, was an extremely intense tropical cyclone that had a catastrophic impact. The minimum central pressure of Typhoon Haiyan was 895 hPa, making it the strongest typhoon to make landfall on a major island in the western North Pacific Ocean. Characteristics of Typhoon Haiyan and its related storm surge are estimated by numerical experiments using numerical weather prediction models and a storm surge model. A series of Typhoon dynamic downscaling by WRF, CReSS and MRI-NHM and empirical modeling was conducted to predict and hindcast of Typhoon Haiyan and related storm surge and wind waves.

Based on the analysis of best hindcast results, the storm surge level was 5-6 m and local amplification of water surface elevation due to seiche was found to be significant inside Leyte Gulf. The numerical experiments show the coherent structure of the storm surge profile due to the specific bathymetry of Leyte Gulf and the Philippines Trench as a major contributor to the disaster in Tacloban. The numerical results also indicated the sensitivity of storm surge forecast. Effects of global warming is examined based on pseudo-global warming experiments considering sea surface temperature increase. The results will be presented at the conference.

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Costal Flood behavior due to Typhoon Haiyan in Hernani based on Field Surveys and Interviews

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The movie presented by Plan International NGO in Hernani showed us heavy impact of coastal flood due to Typhoon Haiyan on 8th November 2013. This presentation is a part of the survey's results by the special team of Japan Society of Civil Engineers, in December 2013 and January 2014, to understand the movie and this flood scientifically.

Water levels of the coastal flood according to witness of residents were measured in two Barangays with interviews on the flood behaviors. The point where the movie was taken was specified with measurements of some length of houses those appeared in the movie. One police man told the detail phenomena in Hernani from the previous evening to the time of flood, who had been in police station at the first floor of the town hall close to a beach of sea. These results confirm us the behavior of the coastal flood in Hernani.

Amplification of Destructive Waves by Coral Reef during Typhoon Haiyan in the Philippines

Volker Roeber and Jeremy D. Bricker
International Research Institute of Disaster Science, Tohoku University, Sendai, Japan

Many coastal communities are at constant risk from typhoons and storm surges. Though coastal resilience has generally improved over the past decades throughout more accurate and detailed storm forecast systems and coastal defenses, some dangerous wave phenomena are not accounted for in hazard assessment and evacuation plans.

Typhoon Haiyan, which struck the Philippines in November 2013, revealed such a situation where a tsunami-like bore destroyed the village of Hernani in Eastern Samar. The destructive waves came at surprise to many villagers and researchers as the coast near Hernani is sheltered by a shallow and broad fringing reef with steep bathymetry offshore. The lack of a shallow continental shelf prevented the generation of wind-driven storm surge and the coral reef was expected to serve as an efficient protection from swell waves.

However, under the extreme storm conditions of Typhoon Haiyan individual waves overtopped the reef and the release of bound infra-gravity waves during wave breaking in turn favored strong surf beat amplification over the reef. Superposition of incoming wave groups with the oscillating water body nearshore caused tsunami-like surges of much longer period than regular swell waves that were responsible for the destruction of the village and its coastal defense structures.

We have replicated the local bathymetry and topography based on data gathered during a field survey. We have computed the wave conditions during the peak of the typhoon with the Boussinesq-type model, BOSZ, and the RANS-type model, OpenFOAM. Both models show the surf beat is strongly dependent on the local reef dimensions. The incoming swell waves nonlinearly interact with the resonating water body and lead to local exacerbation of both flow depth and flow speed compared to hypothetical scenarios without any fringing reef.

We will discuss the model results and provide further insight into the mechanisms that are responsible for such kind of counter-intuitive natural phenomenon.

Understanding the mechanisms that led to coastal flooding during Cyclone Haiyan

Maarten van Ormondt (Deltares, Unesco-IHE) and Dano Roelvink (Deltares, Unesco-IHE)

Cyclone Haiyan left a trail of widespread destruction after it hit the Philippines on November 8, 2013. It was the strongest storm ever recorded at landfall, and the deadliest Philippine cyclone on record, killing at least 6,300 people in that country alone. Most fatalities occurred as a result of coastal flooding. The physical mechanisms that led to this flooding varied widely from place to place. Tacloban City appears to have been hit by a 'classic' storm surge, with strong southerly and easterly winds pushing waters up into the shallow San Pedro and San Pablo Bay. The town of Basey, at the northern shore of the bay, first saw the water in the bay receding as a result of strong offshore-directed winds, after which it was hit by a series of a tsunami-like waves. On the open coast in the province of Eastern Samar, the continental shelf is narrow, which strongly limits the development of a storm surge. In this area, many towns were destroyed by what appears to have been (infragravity) wave run-up.

Here, we present the results of our hydrodynamic modeling study in which we attempt to quantify the contribution of the various mechanisms (such as wind set-up, wind set-down, wave set-up, infragravity wave run-up) that caused the coastal flooding. For this purpose, a cascade of different nested hydrodynamic models was set up, ranging from regional coupled Delft3D-SWAN models to high-resolution XBeach models along the open coast of Eastern Samar, that are used to compute the infragravity wave run-up.

Sediment transport due to storm surge and waves during Typhoon Haiyan in the Philippines

Masashi Watanabe[1*], Jeremy D. Bricker[2], Kazuhisa Goto[2], Fumihiko Imamura[2]

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A geological field survey in the Philippines after Typhoon Haiyan showed that the inland extent of sand transported by the storm surge was smaller than during the 2011 Tohoku-oki tsunami. In Tanauan in Leyte Gulf, the inland limit of the sand deposit extended 0.2km from the shoreline, while inundation extended 2.6km from the shoreline. On the other hand, the inland limit of sand deposit after the 2011 Tohoku-oki tsunami extended 4.3 km from the shoreline, while inundation extended 5.0 km from the shoreline. Therefore, in this study, we used a numerical model to determine why the extent of sand deposition during the typhoon was much less than the extent of inundation, while during the tsunami the extent of sand deposition was only slightly less than the extent of inundation

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We used Delft-3D and SWAN to calculate the pressure-, wind-, and breaking-wave-induced storm surges, wave field, and sediment transport during Typhoon Haiyan. The computed bed shear stress was large near shoreline and decreased inland. Therefore, sand dunes near the shoreline were eroded, transported inland, and deposited within 0.2 km inland of the shoreline. When we carried out simulations without waves, deposited sediment thickness was much smaller than field survey results, bed shear stress was small even near shoreline, and erosion/sedimentation was generated where a sand layer was not observed. From these results, we revealed that waves were responsible for eroding the sand dunes near the shoreline. Since waves did not penetrate far inland, neither did the sand deposit. Therefore, sand was transported only up to 0.2 km inland from the shoreline.

Application of ADCIRC + SWAN to assess geospatial potential of wetlands to attenuate storm surge damage and hurricane flooding in the Chesapeake Bay

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Storm surge resulting from tropical and extra-tropical storms is a perennial threat to infrastructure along the coastal areas of the mid-Atlantic region and the Chesapeake Bay in the United States. It is believed that coastal wetlands act as a natural buffer, attenuating the devastating consequences of storm surge and mitigating the impact to infrastructure that are protected by these areas. Laboratory studies have been conducted relating the frictional resistance of vegetation typical to wetlands of the mid-Atlantic region, however few field studies exist to corroborate experimental results or apply appropriate spatial scaling. To improve knowledge in the area of flow resistance through wetland ecosystems in storm conditions, we have modeled surge in the Chesapeake Bay with the coupled hydrodynamic-wave model (ADCIRC+SWAN) using a combination of synthetic storms and hindcasts of historical storms that have affected the region. Following model validation using historical records, we conducted a sensitivity analysis of friction parameterization and spatial scaling to improve calibration of this model in wetland areas. Results from modelling are then compared with water level data collected over the past year in a parallel field study conducted in protected wetlands (included in the model at 10m resolution) of the Chesapeake Bay. Geospatial and statistical analyses were then carried out to develop a relationship between wetland land cover and hurricane flooding to produce a spatial perspective on the potential for wetlands to attenuate storm surge. Results from this study will improve the ability of decision makers to evaluate the benefits of wetlands from a flooding and storm-surge attenuation perspective.

Dispersion Preserving Numerical Schemes for Coastal Wave Propagation

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The severity of coastal inundation, resulting from tsunami runup and storm surge events, continues to threaten coastal communities throughout the world. Researchers continue to develop and improve numerical models capable of refining our knowledge and improving our understanding of the underlying physics. The ever increasing availability of computational resources has further permitted the use of high fidelity phase-resolving models for practical applications. Boussinesq-type models, for example, serve as an indispensable tool in the study of wave dynamics affiliated with inundation studies [1].

Numerical challenges arising from the discretization of Boussinesq-type equations are most apparent in resolving surf zone processes, where wave breaking and runup processes are depicted as discontinuous. Numerical methods used to overcome discontinuous obstacles are often dissipative and/or dispersive in order to preserve numerical stability. Recently, the application of shock capturing conservative numerical methods to these processes has led to robust and accurate solutions [2]. Beyond the surf zone, theoretical advances in Boussinesq-type equations continue to push computational boundaries further offshore to better resolve both linear and nonlinear transformation throughout intermediate depths. However, if the same numerical methods utilized in a discontinuous region are applied over an extensive computational area, wave propagation characteristics are hindered, leading to false positive assessments of the wave dynamics at the surf zone boundary.

The dispersion relation preserving scheme of [3] emphasizes wave propagation in the discretization of the governing equations by minimizing the error associated with numerical dispersion over a given range of frequencies and wavenumbers, such that the phase is accurately represented in the solution. Its implementation in water wave models represents an important advancement in coastal engineering research. We present a numerical model that implements this discretization scheme to the Boussinesq-type numerical model BOSZ [2]. As a net result, both linear and nonlinear processes are resolved with improved accuracy leading to an enhanced understanding of coastal processes.

References:

[1] Li, N., Roeber, V., Yamazaki, Y., Heitmann, T., Bai, Y., Cheung, K.F., 2014. Integration of Coastal Inundation Modeling from Storm Tides to Individual Waves. Ocean Modeling, 83, 26-42.

[2] Roeber, V., Cheung, K.F., 2012. Boussinesq-type Model for Energetic Breaking Waves in Fringing Reef Environments. Coastal Engineering, 70(1), 1-20.

[3] C.K.W. Tam, J.C. Webb, (1993). Dispersion-relation-preserving Finite Difference Schemes for Computational Acoustics, Journal of Computational Physics, 107, 262.

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Dam Break Flow Simulation Using Simultaneous Coupling Method (SCM)

Mohammad Bagus Adityawan[*]

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Yuta Mitobe[*]

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This study presents numerical simulation of dam break induced flows using Simultaneous Coupling Method (SCM). SCM is based on shallow water equations (SWE) coupled with k-ω model that estimates bed stress from the boundary layer. SWE is solved using finite volume scheme that is able to handle shock and discontinuity. The calculated depth averaged velocity from SWE is assumed as the free stream velocity and used to estimate bed stress directly from the boundary layer. Therefore, SCM has the benefits of a more accurate bed stress assessment than the conventional method (i.e. Manning). The results from the simulation is compared and verified with measurement data. The method is able to produce known behavior of bed stress under unsteady flow. SCM is a valuable tool in assessing bed stress induced damages in water related disasters.

TWO-WAY COUPLED MODELING OF WAVE BREAKING DYNAMICS AND INUNDATION UNDER STORM WAVE CONDITIONS

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ABSTRACT

To improve our understanding of the wave breaking dynamics, inundation and impacts with buildings for damage assessments and to better prepare at-risk coastal towns, I present a model coupling approach considering the two-way interaction between two phase-resolving models to maximize the computational efficiency while accounting for the correct physical processes. The coupling takes places between a shallow water based depth-averaged model with dispersion correction and a Reynolds-averaged Navier-Stokes solver. The depth-averaged model becomes concerned with the generation and modeling of the waves in the offshore/nearshore area (the majority of the computational domain) because of its calculation efficiency and accuracy in the computation of the free surface. The RANS solver can be used to investigate the dynamics of the flow on a fine grid as the waves break and move onshore. Here, I investigate a simplified setup on a composite beach leading to a flat section with a single rigid structure placed in the wake of the incoming wave. Comparisons with experimental data and the depth-averaged model in terms of inundation depth, flow velocities, vertical velocity profiles and impacts with onshore structures are shown. It is hoped that the greater detail in modeling of the flow dynamics can result in some new findings that will help in damage assessments and town planning while the coupling regime allows current limitations of each individual model constituent to be overcome and therefore more likely to be a practically adopted tool.

Storm surge modelling from the ocean to the beach during typhoons crossing Taiwan

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Keywords : storm surge, wind, wave, current, typhoon, extreme phenomena

The context of Taiwan provides a large wide of meteo-marine factors with complex bathymetries, warm currents and extreme meteorological events. We model the 3D hydrodynamics from the regional scale down to the beach along the Wan-Tzu-Liao barrier, a 8 km long sandy system located south-western Taiwan during 1.5 years, including a full typhoon season. The simulation is based on SYMPHONIE (Marsaleix et al., 2006, 2008, 2009), a robust 3D circulation model dealing with most of the oceanographical forcings (winds, air/sea fluxes, tides,...), global scale circulation and waves. Wave parameters required for modeling wave-induced current are provided by the last version (version 4.18) of WAVEWATCH III (Tolman, 2008, 2009; Ardhuin et al., 2010) which is now extended to nearshore scales. The circulation model and waves model are executed on this same polar grid thus avoid interpolation costs. The nesting of two grids (ocean grid Figure 1A and coastal grid Figure 1B) allows for the different scales driving hydrodynamics in the Taiwan strait and the Wan-Tzu-Liao barrier to be correctly simulated. Finally, the time series that were computed by the numerical simulation of the water elevation at the nearshore are converted to a storm surge on the shore by a surge level model. During the KUN-SHEN project (ANR, NSC), hydrodynamics of the Wan-Tzu-Liao sand barrier was measured using a tidal gauge, ADCP instruments (at 18 m depth, 7 m depth and 4 m depth) and pressure sensors in the immersed and emerged beach. This set of data provides complete and continous measures during a monsoons season, a mid season and a typhoons season (October 2011 - November 2012)(Figure 1A-C) in the nearshore area. To further validate the accuracy of our modelling, we compare the instantaneous water levels, the current intensity near the bottom and close to the surface against measurements. By this way, the implemented simulation provides a proper way to analyze the wave transformation to the coast and the changes in the instantaneous water elevation controled by waves and other forcings (wind, tides,...) during extreme phenomena.

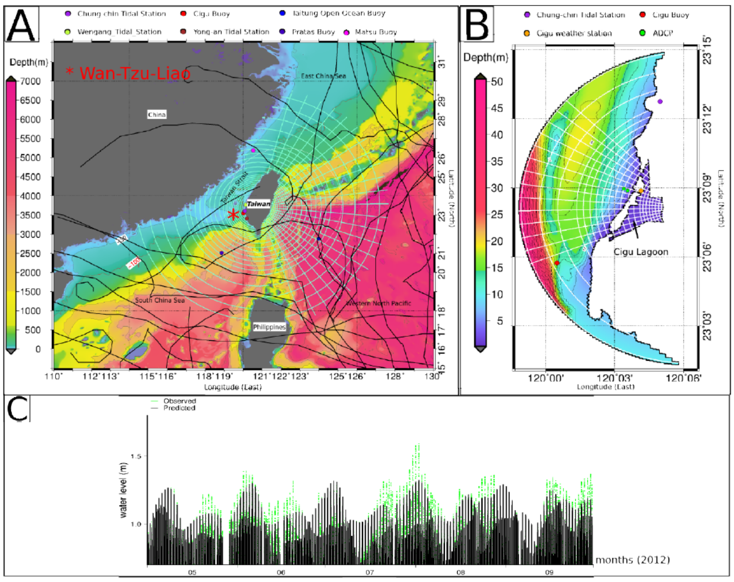

Figure 1: A) The regional polar grid with a nearshore resolution of 460 m and 5.6 km at the offshore, the instruments position and the typhoons's tracks during the 1.5 years simulated period (2011/09-2012/12); B) The coastal polar grid with a nearshore resolution of 100 m (in front of the sand barrier) and 275 m at the offshore and the instruments position; C) Storm surge measurements (observed in green and predicted in black) during the typhoon season at the Chung-chin harbor.

Integration of Coastal Inundation Modeling from Storm Tides to Individual Waves

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ABSTRACT
Modeling of storm-induced coastal inundation has primarily focused on the surge generated by atmospheric pressure and surface winds with phase-averaged effects of the waves as setup. Through an interoperable model package, we investigate the role of phase-resolving wave processes in simulation of coastal flood hazards. A spectral ocean wave model describes generation and propagation of storm waves from deep to intermediate water, while a non-hydrostatic storm-tide model has the option to couple with a spectral coastal wave model for computation of phase-averaged processes in a near-shore region. The ocean wave and storm-tide models can alternatively provide the wave spectrum and the surface elevation as the boundary and initial conditions for a nested Boussinesq model. Additional surface-gradient terms in the Boussinesq equations maintain the quasi-steady, non-uniform storm tide for modeling of phase-resolving surf and swash-zone processes as well as combined tide, surge, and wave inundation. The two nesting schemes are demonstrated through a case study of Hurricane Iniki, which made landfall on the Hawaiian Island of Kauai in 1992. With input from a parametric hurricane model and global reanalysis and tidal datasets, the two approaches produce comparable significant wave heights and phase-averaged surface elevations in the surf zone for comparison. The nesting of the Boussinesq model provides a seamless approach to augment the inundation due to the individual waves in matching the recorded debris line along the coast.

Simulation of sewage dispersal in Lake Biwa in using a particle tracking approach.

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2: UC Davis, California, USA

Earthquakes often induce secondary disasters with considerable potential to threaten people's life and the ecosystem. We can think about the spillage of radioactive materials in the ocean after the Tohoku earthquake in 2011 for example. In this study we focus on Lake Biwa, which provides drinking water for 14 million people. The lake experiences storm with strong winds and heavy rains every year and is surrounded by treatment facilities. For mitigation purposes, we investigate the consequences of pollutant leakage into the lake. In our first approach, assuming the sewage to be similar to sediment, we simulate the leakage of sewage with a three-dimensional model that is validated against observation. This method provides information on the distribution of pollutant concentration all over the lake and over time. As a second approach we use a particle tracking algorithm instead of the sediment module, providing information about the distribution of the pollutant depending on the age of the sewage.

Bores, Surges and Hydraulic Jumps: from tidal bore field measurements to tsunami-induced bore propagation - can we trust hydraulic modelling?

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Abstract

The hydraulic jump is the sudden transition characterised by a sudden rise in free-surface elevation. In a steady flow, it is the change from a high-velocity open channel flow regime to a subcritical flow motion. In an unsteady flow situation, the process is called a hydraulic jump in translation or positive surge. A key feature of bores and jumps is that the flow properties may be solved using continuity and momentum considerations. A related process is a tidal bore propagating upstream in an estuarine zone, as the tidal flow turns to rising. It is a rapidly-varied unsteady open channel flow generated by the relatively rapid rise in water elevation at the river mouth during the early flood tide, when the tidal range exceeds 4.5 to 6 m and the funnel shape of both river mouth and lower estuarine zone amplifies the tidal wave (Fig. 1). Some related processes include the tsunami-induced bore and storm-surge induced bores. When a tsunami wave propagates upriver, its leading edge is led by a positive surge. The tsunami-induced bore may propagate into the riverine system far upstream, as observed in Japan in 1983, 2001, 2003 and 2011, during the 26 December 2004 tsunami disaster in the Indian Ocean, and in the River Yealm in United Kingdom on 27 June 2011. The development of a storm surge during the early flood tide with spring tidal conditions may yield a rapid rise in water level generating a marked bore front. The wind shear amplifies the tidal range and the phenomenon has been observed in Bangladesh where the storm events are called locally 'tidal bores'.

In this contribution, the author present some field measurements conducted in the tidal bores of the Garonne and Sélune River (France) in 2010, 2012 and 2013. Through four experimental campaigns, seven tidal bores events were documented with detailed sedimentary and turbulence measurements. The results provided some unique characterisation of the highly unsteady rapidly-varied flow motion and they are compared with laboratory model data and computational data. The comparison highlight a number of common features, together with some key differences restricting the extrapolation of the results to full-scale applications, including tsunami-induced bores. A key element is the uniqueness of each prototype event combined with complicated sedimentary processes leading to non-Newtonian fluid properties.

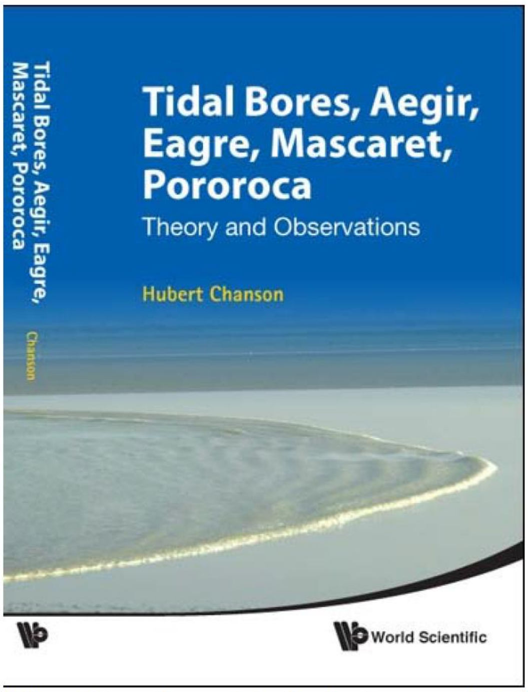


Fig. 1 - Tidal bore of the Sélune River (France) in the front cover of the book "Tidal Bores, Aegir, Eagre, Mascaret, Pororoca: Theory and Observations" (*World Scientific* 2011)

Consideration of failure mechanism of seawall under storm surge

Taro Arikawa
Port and Airport Research Institute, Yokosuka, Japan

Seawalls play an important role to prevent the high tide by storm surge. These seawalls were often destroyed by combination of high tides and high waves. For example, a storm surge by the typhoon in 2004 destroyed seawalls in the Seto Island Sea. 13 seawalls were destroyed, of which 10 were the leaning revetment type. But failure mechanism of seawall under the storm surge condition has not yet been determined.

In this study, at first, physical experiments were conducted to inspect destruction form by using the leaning revetments as an example, and processes of leaning revetments and its factors in putting emphasis behaviors of revetment’s bodies. Then, the effect on the inundation of high tide due to failures of seawalls were verified by using the numerical simulations. The results of the experiments confirmed that blocks touching the bottom of revetments had an effect of retarding sharp sliding, and destruction of the joint might occur if impulsive wave force acted on revetments in particular conditions. The resiliency of the seawalls against storm surge was considered through numerical results.

Transportation being arranged

In order to get all workshop attendees from place to place, we are arranging charter buses. The charter bus schedule will be as follows:

March 15
9:00 pm Leave Sendai Station east exit (meet on pedestrian deck just outside 2nd floor east exit bridge)
10:00 pm Arrive Iwamatsu Ryokan and meet to plan March 16 workshops.

March 16
7:45 am Leave Iwamatsu Ryokan
8:30 am Arrive Sendai Civic Auditorium (Prof. Bricker's workshop)
8:45 am Arrive Kawauchi B bldg. (Prof. Iuchi's workshop)
7:45 pm Leave Sendai Civic Auditorium (Prof. Bricker's workshop)
8:00 pm Leave Kawauchi B bldg. (Prof. Iuchi's workshop)
8:45 pm Arrive Iwamatsu Ryokan and meet to summarize workshop conclusions.

March 17 All-day bus tour (detail above)
Night meeting at Iwamatsu Ryokan to summarize lessons learned from tsunami recovery study tour.

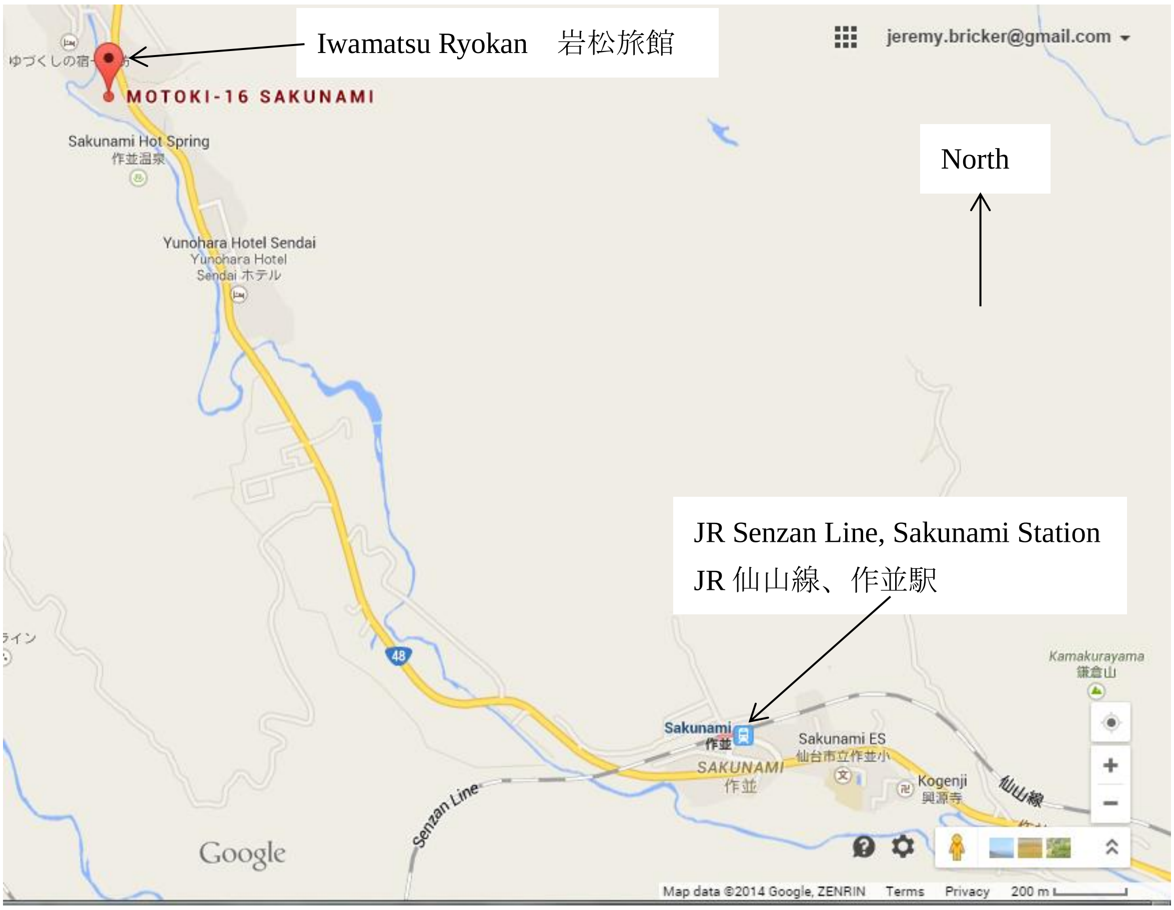
March 18
10:00 am Leave Iwamatsu Ryokan
11:00 am Arrive Sendai Station

If you decide to arrive and leave at times not convenient to this charter bus schedule, please take public transportation to Iwamatsu Ryokan and/or Sendai Civic Auditorium. Public transit information is given in detail on the following pages.


Photo of Iwamatsu Ryokan

How to get to the hotel from Sakunami Station (if you don't take the charter bus)

Iwamatsu Ryokan (hotel) in Sakunami Onsen 岩松旅館（作並温泉）
Address: Motoki-16 Sakunami, Aoba Ward, Sendai,
989-3431 宮城県仙台市青葉区作並元木 16
Phone: 022-395-2211



From Sakunami Station (作並駅), take the free shuttle bus to Iwamatsu Ryokan (about a 5 minute drive). Often there are shuttles in front of the station for many different hotels, so make sure you take the one marked Iwamatsu Ryokan (岩松旅館). If there is a problem, ask the station agent to phone the hotel at 022-395-2211, or phone Jeremy's cell at 080-9628-9902. From a non-Japanese phone, you can call Jeremy by dialing +81-80-9628-9902.

How to get to Sakunami Station from Sendai Station (if you don’t take the charter bus)

Senzan line trains usually leave Sendai station from Platform 7 or Platform 8. However, other lines use these platforms too, so make sure the train says Senzan line (仙山線), or that it's heading to either Yamagata（山形） or Sakunami (作並).

Sunday schedule	
Sendai station	Sakunami station
6:10	6:51
7:07	7:50
8:15	8:53
9:04	9:41
10:07	10:47
11:18	11:56
12:11	12:54
13:01	13:38
14:04	14:36
15:00	15:39
16:01	16:34
17:00	17:37
17:47	18:29
18:27	19:09
18:47	19:29
19:38	20:18
20:27	21:04
21:04	21:43
22:16	22:54

On all days, the last train to Sakunami leaves Sendai station at 22:16!
On all days, the first train to Sendai station leaves Sakunami at 6:19, and arrives Sendai station at 6:49.

The fare for a 1-way trip between Sendai station and Sakunami station is 496 yen.

How to get to Sendai Station from overseas

The easiest way to get to Sendai is to fly from wherever you are coming from to Sendai Airport. From Sendai Airport, take the Airport Access Line to Sendai Station. The one-way fare is 650 yen, and the full timetable is available in English and Japanese at http://www.senat.co.jp/20140315_timetable.pdf

If arriving at Sendai Airport by airplane, make sure to arrive in time to catch the 21:32 Airport Access Line train, which arrives at Sendai Station at 21:56, plenty of time to catch the last Senzan Line train to Sakunami at 22:16.

Another way to get to Sendai Station is by bullet train (Shinkansen). From Narita Airport, go to the JR rail counter, and buy a ticket all the way to Sendai station. The first part of this trip will be either a Limited Express train called the Narita Express (NEX) or a Rapid Service (Kaisoku) to Tokyo Station (about a 1 hour ride). At Tokyo Station, you will follow transfer signs for the Tohoku Shinkansen (the green Shinkansen sign). The Tohoku Shinkansen will come all the way to Sendai Station (a 1.5 to 2 hour ride, depending on the train). The 1-way rail fare from Narita Airport to Sendai station is approximately 13,000 yen. Timetables for these trains are available in English at http://www.jreast.co.jp/e/timetables/index.html

Make sure you get to Sendai Station in time to catch the last Senzan Line train to Sakunami at 22:16.

Emergency Contact Information

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Workshop homepage:
http://hydraulic.lab.irides.tohoku.ac.jp/app-def/S-102/2014/?page_id=268