

## High-Resolution Radiation Mapping to Evaluate Fukushima Derived Contamination Migration.

\*Peter George Martin<sup>1</sup>, David Richards<sup>1</sup>, Yosuke Yamashiki<sup>2</sup>, Thomas Scott<sup>1</sup>

1. University of Bristol, 2. Kyoto University

In March 2017, the accident at the Fukushima Daiichi Nuclear Power Plant (FDNPP) will have reached its sixth anniversary. Over these six years, close to 160,000 people that were initially displaced by the radiological release have yet to return to their homes within the vast plume-affected region. Whilst much work studying the nature of the contamination has occurred, alongside its environmental behaviour, in addition to the remediation of parts of this contaminated zone –much detail is still to be understood with regards to the physical transport of the contributing radiocesium, the rate at which it occurs and the total environmental “budget” .

To assess this evolving distribution of radiocesium, high-resolution radiation mapping conducted over a three year period has been performed on a site within the heavily contaminated litate Village. This time-resolved radiation mapping, coupled with various modelling scenarios, has provided information on the mobility of material within the environment, its residence time as well as the rate of input into the Abukuma River network that dissects the region.

Through the use of an unmanned aerial vehicle (UAV) developed at the University of Bristol (UK), the radiation distribution across the site was determined without the effects of any operator induced attenuation. The aerial platform also permitted the mapping of radiological contamination over portions of the site not physically possible, or with considerable access limitation.

The results of the radiation mapping over time highlighted the changes in activity apparent on the 100 × 150 meter site. Remediation of the majority of the northern extent has proven to be effective in significantly reducing the dose-rate measured –with the waste material relocated to a single point ( “Bail Store” ), for subsequent removal.

Radioactivity levels to the south of the site, are shown to still exhibit elevated levels of radioactivity attributable to contamination from radiocesium. Whilst no remediation efforts were observed to have occurred here, the value anticipated to exist (as a result of a reduction entirely from radioactive decay) was greater than that measured. Through the application of a model to simulate previously measured depth dispersion (and associated attenuation) [1] [2] the value measured was still significantly less than that predicted. This loss is attributed to transport away from the site via the stream that dissects it –hence providing a budget to the riverine flux of radiocesium contamination.

As well as work on monitoring and modelling contamination on sites such as this in litate Village, the system has also been applied to studying the transport of contamination away from the large storage sites containing the surface materials removed as part of the remediation works. The impact of precipitation and groundwater flow in these scenarios is of significant importance to the safe, long-term storage of these wastes.

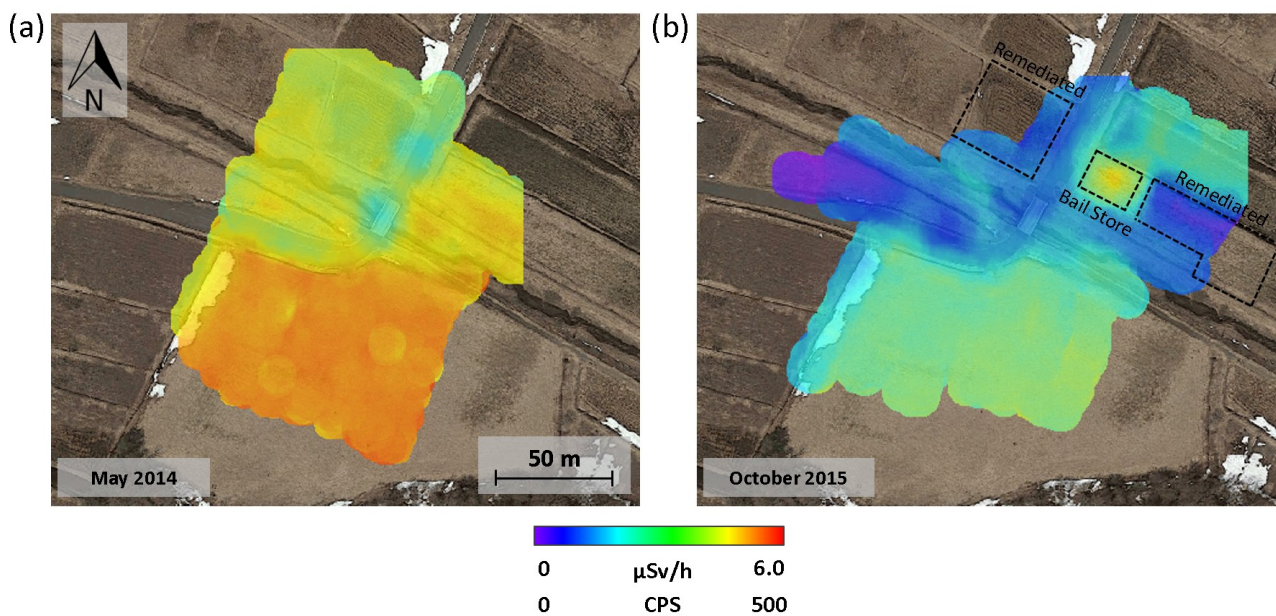
*Figure: Results of the time-resolved radiation mapping over the litate Village site; the effectiveness of the*

remediation is apparent, as is the increased activity brought about by the location of the radiological wastes forming the Bail Store. The reduction in activity to the south of the site is apparent, but lower than that achieved through either remediation or expected solely as a result of radioactive decay or ground infiltration (and induced attenuation).

[1] H. Kato, Y. Onda, and M. Teramage, "Depth distribution of  $^{137}\text{Cs}$ ,  $^{134}\text{Cs}$ , and  $^{131}\text{I}$  in soil profile after Fukushima Dai-ichi Nuclear Power Plant Accident.," *J. Environ. Radioact.*, vol. 111, pp. 59–64, Sep. 2012.

[2] T. Ohno, Y. Muramatsu, Y. Miura, K. Oda, N. Inagawa, H. Ogawa, A. Yamazaki, C. Toyama, and M. Sato, "Depth profiles of radioactive cesium and iodine released from the Fukushima Daiichi nuclear power plant in different agricultural fields and forests," *Geochem. J.*, vol. 46, no. 4, pp. 287–295, Nov. 2012.

Keywords: Fukushima, contamination, migration, radiation mapping, gamma-spectrometry



# 全球湖リポジトリの開発と地球環境変化による水質への影響評価 Development of Global Lakes & Reservoirs Repository (GLR) and their application for predicting estimating water quality changes in lakes and estuaries induced by global climate changes

\*山敷 庸亮<sup>1</sup>、黒木 龍介<sup>1</sup>、Yadav Shweta<sup>2</sup>

\*Yosuke Yamashiki<sup>1</sup>, Ryusuke Kuroki<sup>1</sup>, Shweta Yadav<sup>2</sup>

1. 京都大学大学院総合生存学館、2. 京都大学大学院工学研究科

1. Global Water Resources Assessment Laboratory - Yamashiki Laboratory Graduate School of Advanced Integrated Studies in Human Survivability Kyoto University, 2. Graduate School of Engineering, Kyoto University

Global Lakes & Reservoirs Repository (GLR) was developed in order to promote better comprehension of the status of lakes & reservoirs on a global scale. Basic information for each lake is stored, together with the whole surface shape of each lake & reservoir. For some lakes, bathymetry data is stored, which enables three-dimensional numerical simulations using Biwa-3D. Using this, data three lakes (Lake Biwa, Lake Tahoe and Lake Toba) are calculated by their vertical mixing structure.

The whole database is used to apply basic parameters; it is also used with simpler ecological models in order to discuss potential impacts on lakes & reservoirs of global-scale climate change. Fluxes like continental hydrological fluxes from international rivers, associated with large-scale successive reservoirs, such as the La Plata river basin, are being estimated by combining GRL with continental-scale hydrological models.

The water quality of those lakes including ecological status is to be assumed by using satellite remote sensing. Only limited application is now applied into the reference lake.

キーワード：全球湖リポジトリ、貯水池、衛星リモートセンシング

Keywords: GLR, Reservoirs, Satellite Remote Sensing

## Freshwater balance of the Indonesian Seas

\*木田 新一郎<sup>1</sup>

\*Shinichiro Kida<sup>1</sup>

1. 九州大学・応用力学研究所

1. Research Institute for Applied Mechanics, Kyushu University

The seas surrounding the Indonesian Archipelago receive one of the largest freshwater input around the globe. Where does this freshwater go? Our knowledge on the mass balance of the Indonesian Seas has significantly progressed over this decade or so but the freshwater balance remains an open question. Numerical model experiments that focus on the Indonesian Archipelago will be presented and they show that significant part of the precipitated water exits to the Indian Ocean as part of the Indonesian Throughflow. The monsoonal winds play a major role through Ekman transport. The Sunda strait is also found to play a comparable role as the other major straits, which matches well with recent satellite observations showing significant freshening at the surface near the Sunda strait. The origin of the freshwater for this outflow through the Sunda strait, however, appears to be the South China Sea or the Java Sea rather than the Indonesian Seas. Part of the freshwater input over the Indonesian Seas is likely exported to the Indian Ocean through Ekman transport or mixed down to subsurface water due to tidal mixing and exit as part of the Indonesian Throughflow.

## 古火星溪谷における水文シミュレーション

# Hydrological Simulation of Vallay formation in Hesperian Marsian Surface

\*山敷 庸亮<sup>1</sup>、佐藤 啓明<sup>3</sup>、黒木 竜介<sup>1</sup>、宮本 英昭<sup>2</sup>、逸見 良道<sup>2</sup>

\*Yosuke Yamashiki<sup>1</sup>, Hiroaki Sato<sup>3</sup>, Ryusuke Kuroki<sup>1</sup>, Hideaki Miyamoto<sup>2</sup>, Ryodo Hemmi<sup>2</sup>

1. 京都大学大学院総合生存学館、2. 東京大学大学院工学系研究科、3. 京都大学工学部

1. Global Water Resources Assessment Laboratory - Yamashiki Laboratory Graduate School of Advanced Integrated Studies in Human Survivability Kyoto University, 2. Graduate School of Engineering, The University of Tokyo, 3. Faculty of Engineering, Kyoto University

火星の、古代ノキアス代[Noachian epoch]においては、大気が存在し、今より温暖な気候が維持されたという説がある。火星で見つかったいくつかの溪谷には、太古の昔、水文プロセスにより形成されたであろう地形が見つかっているが、最近形成されたものではないとの説が有力である。続くヘスペリア代[Hesperian epoch]は寒く乾燥していたという説があるが、いくつかの溪谷はこの時期に形成されている。本発表においては、火星表面に水文土石流モデル(Hydro-debris2D)を用いた数値計算を行い、古代の火星に雨が降ったならどのような河川地形が形成されるかを数値実験したものである。

キーワード：火星、ヘスペリア代、水文土石流モデル

Keywords: Mars, Hesperian epoc, Hydro-Debris 2D

## Water and sediment discharge from four small mountainous rivers in Zhejiang province: The roles of basin area, rainfall and human activities

\*shasha Lu<sup>1</sup>

1. Second institute of oceanography, SOA

As a separate area whose water system flowing into sea, Zhejiang Province discharging water and sediment into sea is mainly through mountainous rivers and has different characteristics from other parts of China. Variations of water and sediment discharge from 4 small mountainous rivers were examined and compared from 1957 to 2008 at the monthly and yearly scales. The results showed that the 4 mountainous rivers presented a similar variability. High/low sediment discharge was always coupled with high/low water discharge in both scales of monthly and yearly. And high water and sediment discharge occurred in the flood season. Rainy season and typhoon season were the main period of flood in Zhejiang Province, with a mean water discharge of 75.4% and sediment discharge of 92.2% into sea. The more sediment discharge than water is caused by the high-increasing sediment yield during the huge flood. The total water and sediment discharges of the 4 individual rivers depend on the areas of the 4 river basins, while the variation trends of the water/sediment discharge are controlled by the rainfall. The human activity, principally the construction of reservoirs, significant increased the water discharge in the dry season and decreased it in the flood season, and decreased the total sediment discharge in addition.

Keywords: water discharge, sediment discharge, mountainous river

## Modeling of Extreme Freshwater Discharge from the Kyushu-Region First-Class River Basins

\*黒木 龍介<sup>1</sup>、山敷 庸亮<sup>1</sup>、宮澤 泰正<sup>2</sup>、Varlamov Sergey<sup>2</sup>、Gupta Hoshin<sup>4</sup>、Troselj Josko<sup>3</sup>  
\*Kuroki Ryusuke<sup>1</sup>, Yosuke Yamashiki<sup>1</sup>, Yasumasa Miyazawa<sup>2</sup>, Sergey Varlamov<sup>2</sup>, Hoshin Gupta<sup>4</sup>,  
Josko Troselj<sup>3</sup>

1. 京都大学大学院 総合生存学館、2. 独立行政法人海洋研究開発機構、3. 京都大学 防災研究所、4. アリゾナ大学 水文学部

1. Kyoto University, the Graduate School of Advanced Integrated Studies in Human Survivability, 2. Japan Agency for Marine-Earth Science and Technology, 3. Department of Civil and Earth Resources Engineering, Graduate School of Engineering, Kyoto University, Japan, 4. The University of Arizona, department of hydrology and water resources

We investigated the effects of extreme fluvial outflow events on river months to salinity distribution in the coastal zone of the Kyushu-district Japanese coast. We created a set of hourly simulated river outflow data from first-class Japanese river basins flowing to the Pacific Ocean for targeted a event of typhoons from 16/09/2011 to 22/09/2011, and used it with a coupled hydrological-oceanographic model for estimation of the circulation and salinity distribution in coastal zones. The coastal ocean circulation was simulated by using a coupled hydrological oceanographic model JCOPE-T by inputting freshwater from our model “Cell Distributed Runoff Model Version 3.1.1 (CDRMV3.1.1)”, which simulated discharges for the case of the typhoon passage of real time freshwater input from the rivers. By using Shuffled Complex Evolution method developed by University of Arizona (SCE-UA method), that is one of the optimization method for hydrologic model, we could success to optimize 5 parameters, soil roughness coefficient, river roughness coefficient, effective porosity, saturated hydraulic conductivity, and effective rainfall, and successfully reproduced peak discharge prediction of extreme typhoon events on river months.

キーワード : SCE-UA法

Keywords: SCE-UA method

# An Ultra-high Resolution Ensemble Numerical Weather Prediction: Case Study of the Hiroshima Heavy Rainfall Event in August 2014

\*大泉 伝<sup>1</sup>、齊藤 和雄<sup>2</sup>、レ デュック<sup>1</sup>

\*Tsutao OIZUMI<sup>1</sup>, Kazuo Saito<sup>2</sup>, Le Duc<sup>1</sup>

1. 国立研究開発法人海洋研究開発機構、2. 気象研究所

1. Japan Agency for Marine-Earth Science and Technology, 2. Meteorological Research Institute

This study aims to examine whether ultra-high resolution ensemble numerical weather predictions are able to produce a more accurate forecast. A case study was a heavy rain event that induced massive debris flow in Hiroshima, August 2014. The Japan Meteorological Agency non-hydrostatic model was run on the “K” computer.

The forecasts with 51 ensemble members were performed on two domains: an inner domain (500 km square) with 500 m grid spacing one way nested inside an outer domain (1600 x 1100 km) with 2 km grid spacing, each with 51 ensemble members. Each member on the inner domain receives boundary conditions from the corresponding member on the outer domain.

The best result of the 2km grid spacing model showed an intense rain band at the similar position to the observed rain band. However, in the worst result of the 2 km grid model, the weak rainband appeared northeast of the observed rainband. In contrast, all of the 51 ensemble member of the 500 m grid spacing model showed the rainband at the similar position to the observation. These results demonstrate that the high-resolution ensemble forecast has the ability to better prediction.

キーワード：豪雨予測、高解像度、京コンピュータ

Keywords: heavy rain forecast, high-resolution, K supercomputer



# Mutual Interaction of Human-Impacted River Runoff under Risks of Eutrophication and ENSO Extremes at the Scales of Lakes and Reservoirs

Mendondo Eduardo<sup>2</sup>、\*山敷 庸亮<sup>1</sup>

Eduardo Mario Mendiondo<sup>2</sup>, \*Yosuke Yamashiki<sup>1</sup>

1. 京都大学大学院総合生存学館、2. サンパウロ大学サンカルロス工学部

1. Global Water Resources Assessment Laboratory - Yamashiki Laboratory Graduate School of Advanced Integrated Studies in Human Survivability Kyoto University, 2. Sao Carlos School of Engineering, University of Sao Paulo, SHS/EESC/USP

Human-impacted ecosystems affect both river runoff and inherent risks to society. At significant spatiotemporal scales, lakes and reservoirs gather a complexity of multiple risks with opportunities for decision-making under uncertainty. However, a reminder for classical and novel challenges of whichever-scale model addressing these problems is needed. In this contribution, we discuss some theoretical and practical problems, with solutions, related to the mutual interaction of both human-impacted river runoff with risks. Ranging feedbacks from local-to-global water-systems, we here mainly enhance yardsticks at the scales of lakes and reservoirs. We introduce sections, extracted from Japan-Brasil research partnership programs, adapted to the needs of international initiatives like UNESCO-IHP-IIWQ, ILEC and Pantha Rei. Firstly, eutrophication and climate-driven extremes like ENSO hazards are becoming as relevant as problem-oriented hotspots of classical approaches in poor or ungauged systems. Updating from a former review (i.e. Mendiondo, 2008\*\*\*), on the one hand, we depict how eutrophication-under-ENSO risk stressors, multiple restoration measures, treatment costs, and planning scenarios do help to better model and manage those inherent risks under different adaptation strategy options. On the other hand, we present example of demonstrative pilot programs, viable to be replicated under regional and global approaches, to control and mitigate eutrophication of urban-affected reservoirs. Finally, we share resilience matrix of indicators and variables which help allied global management initiatives towards stakeholder`s empowerment.

\*\*\* Supplementary Material:

[http://wldb.ilec.or.jp/ILBMTrainingMaterials/resources/eutrophication\\_challenges\\_presentation.pdf](http://wldb.ilec.or.jp/ILBMTrainingMaterials/resources/eutrophication_challenges_presentation.pdf),

[http://wldb.ilec.or.jp/ILBMTrainingMaterials/resources/eutrophication\\_challenges.pdf](http://wldb.ilec.or.jp/ILBMTrainingMaterials/resources/eutrophication_challenges.pdf)

キーワード：貯水池、富栄養化、極端事象

Keywords: Reservoir, Eutrophication, Extremes

## Modeling of Extreme Freshwater Outflow from the North-Eastern Japanese River Basins to Western Pacific Ocean

\*Josko Troselj<sup>1</sup>, Takahiro Sayama<sup>2</sup>, Toshiharu Sasaki<sup>1</sup>, Kaoru Takara<sup>2</sup>, Sergey M. Varlamov<sup>3</sup>, Yasumasa Miyazawa<sup>3</sup>, Ryusuke Kuroki<sup>4</sup>, Yosuke Yamashiki<sup>4</sup>

1. Kyoto University, Graduate School of Engineering, Department of Civil and Earth Resources Engineering, 2. Kyoto University, Disaster Prevention Research Institute, 3. Japan Agency for Marine-Earth Science and Technology, Application Laboratory, 4. Kyoto University, Graduate School of Advanced Integrated Studies in Human Survivability

We investigated the effects of extreme fluvial outflow events on river mouths to salinity distribution in the coastal zone of the north-eastern Japanese coast. We created a set of hourly simulated river outflow data from 9 first-class Japanese river basins flowing to the western Pacific Ocean for targeted two events of typhoons (Chataan and Roke) and used it with a coupled hydrological-oceanographic model for estimation of the circulation and salinity distribution in coastal zones. The coastal ocean circulation was simulated by using a coupled hydrological oceanographic model JCOPE-T, comparing the case with using climatological mean monthly discharges as freshwater input from rivers with the case using our hydrological model CDRMV3.1.1 simulated discharges for the case of typhoon Roke passage as freshwater input from the 9 rivers. By using SCE-UA method we successfully reproduced peak discharge prediction of extreme typhoon events on river mouths. The results show an importance of detailed information on extreme river outflows for developing accurate nowcasting coupled river-ocean models for real time prediction of extreme flood events. The results suggest that our models that were calibrated on typhoon Roke and Chataan can be successfully used to predict runoffs from other extreme precipitation events. The salinity reproduction prediction in the coastal zone became more realistic than without including total river outflow. The proper simulation of extreme discharge events can be used to improve coastal and ocean modeling, especially modeling which is sensitive to reproducibility of the salinity distribution in coastal areas.

Keywords: salinity distribution, extreme discharge, coastal zone, SCE-UA method, river-ocean coupled model, nowcasting

Bckgr: Hourly Salinity [PSU] for HS; 20110926 22:00 JST (ANL); Dep=1 layer

