Observed stable isotopes in precipitation and estimated water vapor origins across Japan throughout 2013

*Kimpei Ichiyanagi[1], Masahiro Tanoue[2], Kei Yoshimura[2], Tsuyoshi Kumamomidou

1. Kumamoto University, 2. The University of Tokyo

Stable isotopes in precipitation are useful tracers for understanding atmospheric water cycles, estimating water vapor origins. There are a lot of observational studies of stable isotopes in precipitation all over Japan, however, most observations were conducted only one point and only one year. This study investigated spatial and temporal variabilities of stable isotopes in precipitation across Japan and estimates their water vapor origins. Stable isotopes in precipitation were observed at 77 stations throughout 2013. The water vapor origins, that is where the water vapor evaporated from, were estimated by using the isotope-incorporated atmospheric general circulation model.
The Cluster analysis was used to distinguish the spatial grouping of seasonal variability of monthly mean Oxygen-18 anomaly from the annual mean values. Stations belong to the cluster 1, 2, and 3 were distributed mainly in the Pacific Ocean side of the Kanto and Chubu, the Chube mountainous area and North Japan, and the Sea of Japan side and West Japan, respectively. Cluster 1 was characterized extremely low anomaly in January. This was caused by the snowfall event when the Nagan-Low pressure system passed on 14-15 January. Cluster 2 showed clear seasonal variability, high in summer and low in winter. From the estimation of water vapor origins, the Pacific Ocean origin and the Sea of Japan origin were dominated in summer and in winter, respectively. Cluster 3 characterized that Oxygen-18 anomaly in June was much lower than those in May and July. The depletion in June became larger toward south, which had a negative correlation with the precipitation amount. Also, water vapor evaporated from the Indian Ocean which had low isotope values were higher toward south in June. The precipitation amount effect and rainout process of water vapor passage from the Indian Ocean to Japan might be controlling factors to stable isotopes in precipitation in June.

Keywords: stable isotopes, precipitation, water vapor origins

Inter-annual Mass Variability of Antarctic Ice Sheet and Gulf of Alaska Glaciers and their Relevance to Pacific Decadal Oscillation

*Byeonghoon Kim[1], Ki-Weon Seo[1]

1. Seoul National University

Recent studies from GRACE (Gravity Recovery and Climate Experiment) suggest that the ice mass variations of Antarctic Ice Sheet (AIS) and Gulf of Alaska (GOA) glaciers have inter-annual variability. In this study, we first investigate how those changes could be explained by two meteorological parameters: precipitation and temperature. For AIS, the change of cumulative precipitation from ERA-interim reanalysis is very close to the ice mass variation derived from GRACE, as previous researches already showed. For GOA glaciers region, the ice mass variation is simulated by a simple model using snow precipitation and surface temperature obtained from ERA-Interim. As this model reveals, the ice mass variation is greatly dependent on temperature. We further examine the influence of Pacific Decadal Oscillation (PDO) on Antarctic precipitation and the temperature change in GOA. As a result, a decadal or an inter-annual variability of ice mass change in both regions is directly or indirectly related to PDO. If the relations here stated prove to be true, they will probably serve to predict the ice mass variations of the two regions for the near future.

Keywords: Antarctica, Gulf of Alaska Glaciers, Ice Mass Change, Pacific Decadal Oscillation

Interannual Variability of Soil Moisture in European Russia and its Links to Regional Climate During Boreal Summer

*Igor I Zveryaev[1], Alexey V Arkhipkin[1]

1. Shirshov Institute of Oceanology, Moscow, Russia

Soil moisture data from the GLEAM (Global Land Evaporation Amsterdam Model) dataset for 1980-2014 are used to investigate the leading modes of interannual variability of soil moisture in European Russia during summer season. An EOF (Empirical Orthogonal Functions) analysis performed on the monthly means (i.e., separately for June, July and August time series) revealed three leading modes of soil moisture variability, characterized by the monopole (EOF-1), zonal dipole (EOF-2) and meridional dipole (EOF-3) patterns. These modes explain respectively 29-35%, 11-18% and 10-13% of the total variability of soil moisture. Analysis of correlations between the leading PCs (principal components) of soil moisture and indices of regional teleconnections suggests that there are not very strong, but statistically significant links between regional soil moisture variability and the Scandinavian teleconnection, the East Atlantic –Western Russia teleconnection and the Atlantic Multidecadal Oscillation. The leading PCs capture pretty well the large soil moisture anomalies associated with regional climate extremes (such as extremely dry conditions associated with the Russian summer heat wave in 2010). An analysis of links to regional climate revealed generally consistent patterns in which positive (negative) soil moisture anomalies are linked to cyclonic (anti-cyclonic) anomalies of sea level pressure, above (below) normal precipitation and negative (positive) anomalies of air temperature.

Keywords: soil moisture, European Russia, summer season, interannual variability

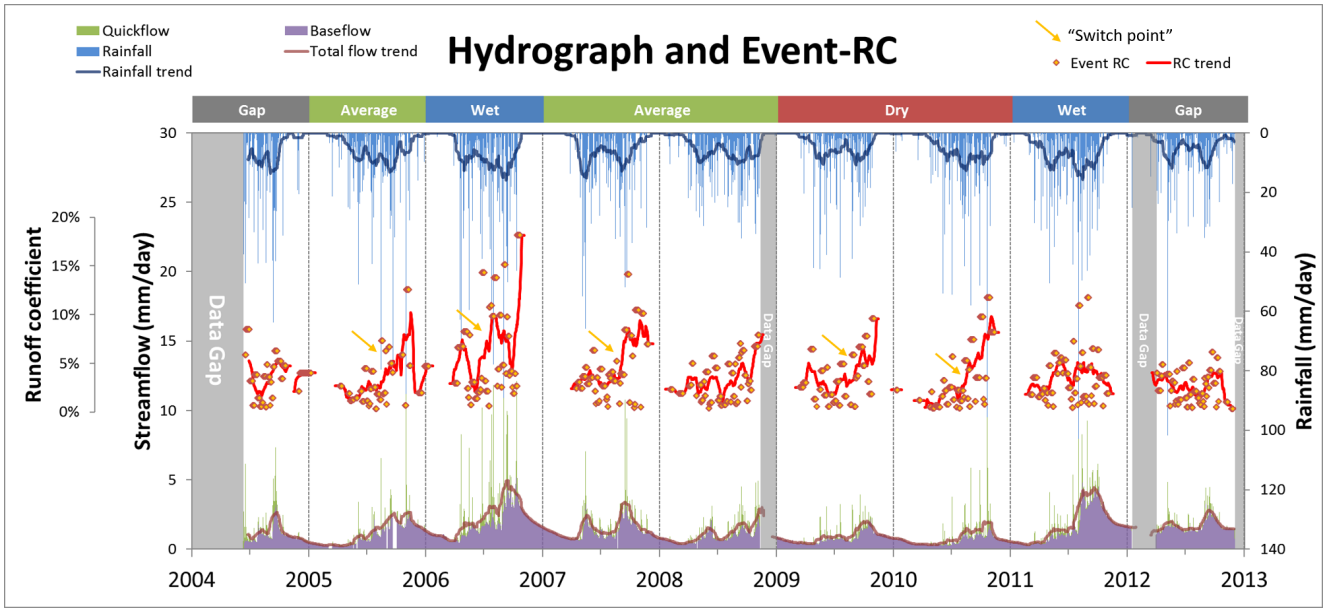
Seasonality in stream hydrograph of a montane watershed in northern Thailand: Is there a threshold condition that predicts mid-wet-season shift in rainfall-runoff relationship?

*Han Tseng[1], Thomas W. Giambelluca[1], Yin-Phan Tsang[2], Alan D. Ziegler[3]

1. Univ. of Hawai'i at Manoa, Dept of Geography, Honolulu, HI, United States, 2. Univ. of Hawai'i at Manoa, Dept of Natural Resources & Environmental Management, Honolulu, HI, United States, 3. National Univ. of Singapore, Dept of Geography, Singapore, Singapore

In this study, we examined the dynamics of the rainfall-runoff relationship in Mae Sa watershed, a montane catchment with mixed forest, agriculture, and peri-urban land covers in northern Thailand near the city of Chiang Mai. The Asian monsoon and tropical storms produce highly distinct wet-dry rainfall seasonality in this region. Wet season rainfall exhibits a bimodal distribution with peaks in early May and August-September, separated by a relatively dry period (June-July). Wet season streamflow of Mae Sa roughly follows the bimodal rainfall pattern, but the discharge tends to be much higher in the second than in the first rainfall peak, and in many cases, a storm of similar magnitude generates a much larger discharge event after approximately the midpoint of the wet season.
We analyzed daily hydrographs and used runoff coefficients (RCs) as an indicator of the watershed hydrological response to rainfall to examine the seasonal trend and interannual variations and explored the use of simple indices of catchment antecedent conditions to explain such rainfall-runoff dynamics. We obtained the daily time series of discharge measured at the catchment outlet and rainfall observations from the 11-gauge network in the 74.2-km^2 watershed from mid-2004 to 2012. Hourly rainfall records from each of the 11 rain gauges were first adjusted for lag time with respect to the stream discharge, based on the time difference between the peak discharge and the peak rainfall of isolated events at the specific station. The aligned 11 rain gauge hourly records were then spatially interpolated using Thiessen polygon method and integrated into a daily watershed rainfall time series. We separated the quickflow and baseflow components and identified individual quickflow events from the resulting daily rainfall and discharge time series. RCs were then calculated based on both the quickflow component (quickflow-RC = quickflow/rainfall) and the total discharge (total discharge-RC = discharge/rainfall) at the event scale as well as on a daily time step.
Analyses of the hydrograph and RC time series revealed a seasonal pattern where abrupt upward shifts or steep increases in the RCs were observed. The result suggests a “switch-point” in the rainfall-runoff relationship annual cycle, after which similar rainfall events generate higher discharge than earlier. While this switch-point generally occurs in the second half of the wet season, the occurrence and timing varied from year to year during the 8.5 years studied. This inter-annual variability in the occurrence and timing of the switch-point appears to be the related to the difference in annual rainfall amounts and the temporal patterns. For example, the shift in RC in 2007 and 2010, which have average or lower annual RF, are more obvious compared to 2006 and 2011, which have higher total RF and higher RC in the early stage of the wet season. Indices of the watershed antecedent conditions (e.g. cumulative rainfall, baseflow level at time of event) and event characteristics (e.g. rainfall intensity, event duration) were compared with RCs to further explore potential “threshold” conditions that might trigger the change in the watershed hydrological response.

Keywords: rainfall-runoff response, runoff coefficient, tropical monsoon climate, montane forest watershed, watershed hydrology



Prediction interval optimization of radial basis function artificial neural network streamflow forecast models

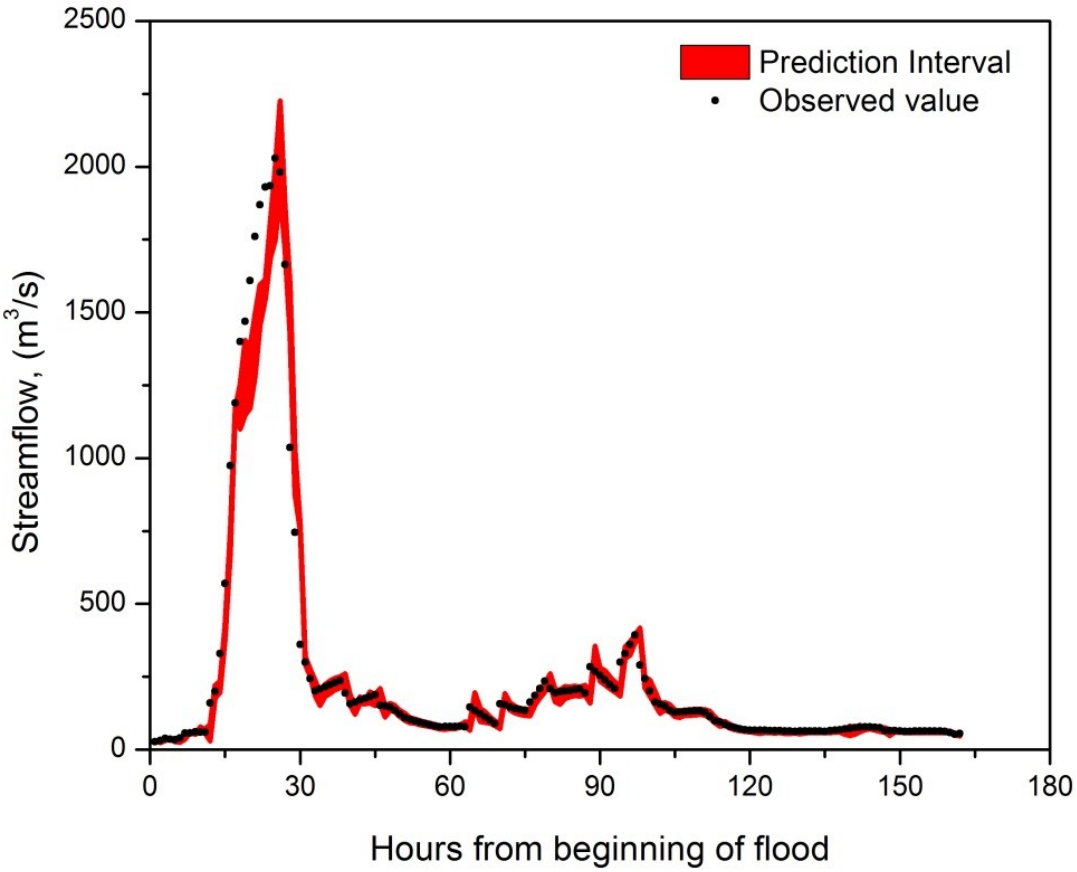
*Kasiviswanathan Kasiapillai Sudalaimuthu[1], Sudheer KP[2], Adebayo J Adeloye[1]

1. Institute for Infrastructure and Environment, Heriot-Watt University, Edinburgh EH14 4AS, UK , 2. Department of Civil Engineering, Indian Institute of Technology Madras, Chennai 600036, India

Understanding the complex nature of rainfall-runoff process has opened many folds of modeling technique. It is still a challenging task in hydrologic modeling analyzing the inherent variability or uncertainty besides the improvement in model performance. To date, variety of hydrologic models have been developed which are mainly classified into physics based or data driven based approaches. The advantage of using physics based models represents the physical processes responsible for generating the flow. However, it often requires more information of catchment, and expertise of modeler. In addition, any changes in the catchment may alter the performance of the model because of the sensitivity of model parameters. Alternatively, the data driven models have produced reasonable estimate of streamflow forecasting compared to physics based models. The main advantage lies learning the underlined processes from historically measured data without explicit information of the system to be modeled. Though the data driven models might not include the physical processes in its computation, the accurate estimation of flood is mainly required, which encourages the application of these models. Over the last two decades, various types of data driven based flood forecast/rainfall-runoff models have been reported, in which Radial Basis Function Artificial Neural Network (RBFANN) model has been recognized as a promising tool while approximating the non-linear hydrologic processes. However, the point estimation of RBFANN sometimes lacks in explaining the underline variability or uncertainty associated with modeling, which reduces the reliability of the models. Hence the main focus of the present paper is to carry out the uncertainty analysis of RBFANN. The RBFANN has a parameter called spread, which needs to be determined carefully, since it identifies appropriate model parameters of ANN (i.e. weights and biases). In general, the RBFANN uses a default constant spread value (named as Static RBFANN in this study) which leads to a point prediction of model output. However any improper selection of spread value might lead to over and/or poor generalization of ANN models. In this paper, a multi-objective optimization method is proposed for estimating the upper and lower values of spread (named as Stochastic RBFANN), which in turn train two sets of weights and biases for forecasting the upper and lower bounds of model output in the form of prediction interval (PI). The proposed modeling approach is demonstrated through streamflow forecasting using the hourly rainfall and runoff data collected from Kolar river basin, India. The comparison between Static and Stochastic RBFANN models indicates that the performance of these models is similar. However, the Stochastic RBFANN modeling approach produces prediction interval that indicate the level of uncertainty. The multi-objective optimization function comprised of two indices such as percentage of coverage (POC) and average width (AW), which are generally used to evaluate the model prediction uncertainty was formulated. The prediction interval (Fig.1) for various flow domains resulted in different magnitude of prediction uncertainty. The high flow series contained only 7 percentage of observation in the prediction interval compared to low (77%) and medium flow (79%) in the model validation. As uncertainty can be directly related to the reliability, the information from the prediction interval is necessary for the careful identification of model output, in specific to the decision making on the flood forecast. Overall, the quantification of prediction uncertainty in RBFANN provides valuable information, which clearly illustrates the strong and weak points while forecasting the streamflow.

Fig. 1 Prediction interval corresponding to upper and lower bound values of spread

Keywords: Artificial neural network, Prediction interval, Radial basis function, Streamflow forecast, Uncertainty



Seasonal variation of major ions and trace element distribution in streams draining the mineralized Lom Basin, East Cameroon

*Mumbfu Ernestine Mimba[1,2], Takeshi Ohba[1], Salomon César Nguemhe Fils[2], Mengnjo Jude Wirmvem[1], Festus Tongwa Aka[2]

1. Department of Chemistry, School of Science, Tokai University, 2. Institute of Geological and Mining Research

Surface water and boreholes comprise the major source of water supply for domestic and small scale mining operations in the Lom Basin. Streamwater chemistry of the mineralized basin was investigated for the first time in order to show the seasonal variation in major ion distribution patterns and identify the origin and geochemical behaviour of some trace elements. A total of 81 water samples collected from lower order streams during the dry and wet seasons, were analysed for major ion and trace element contents. Results revealed that all the measured physico-chemical parameters varied narrowly between the dry and wet seasons. Concentrations of Cl^- showed no fluctuations throughout the sampling seasons due to its conservative nature and limited potential sources. Nitrate levels decreased in the wet period owing to dilution by surface runoff. Dissolved SO_4^{2-} concentrations were low for both seasons indicating the dissolution of low sulphide minerals associated with gold deposits. The concentration of the major ions Ca^{2+}, Mg^{2+}, Na^+, K^+ and HCO_3^- slightly increased during the wet season as they are flushed from soils during precipitation. As a whole, the seasonal regime of stream water chemistry is controlled by the following processes: a) contribution of major cations and HCO_3^- from chemical weathering supplied by ground water flow during the dry season. b) leaching of salts from surface soil layers during rain events and c) dilution by surface runoff during the wet season. Streamwater is characterised by low acidity and trace metal loadings reflecting low sulphide solubility and the likely buffering capacity of silicate minerals. In this strongly lateritic environment, the weathering of vein gold mineralisation results in sulphide oxidation and the entrapment of a significant portion of released trace metals in ferruginous oxide phases. Despite the past and active small-scale mining operations, the streams have not been impacted. Bearing in mind that legal standards for water chemistry evaluation are yet to be fixed in Cameroon, our findings may assist policy makers to set guidelines, especially in mineralised areas.

Keywords: seasonal variation, major ions, trace metals, Lom Basin, Cameroon

Geochemical evolution of deep groundwater in Cretaceous aquifer of the Southern Gobi, Mongolia

*Batdemberel BAYANZUL[1], Kengo NAKAMURA[1], Isao MACHIDA[2], Takeshi KOMAI[1]

1. Graduate school of Environmental Studies, Tohoku University, 2. Groundwater research group, Advanced Industrial Science and Technology

In the Southern Gobi Region, water use by the mining industry, which is one of the important industries in Mongolia, depends on groundwater. The area is characterized by a dry climate. Although the average air temperature is around 7.5˚C, the lowest temperature in the winter reaches -34˚C, and the highest temperature in the summer reaches up to +43˚C at Khanbogd soum. The total annual precipitation is approximately 85 mm, of which 90% falls as rain during the summer seasons and the remaining 10% as snow.

The Gunii khooloi aquifer is the most important water resource for Oyu Tolgoi Mine. The aquifer consists of Cretaceous sediments which comprise up to 150 m thick unconsolidated brown sands and gravels with minor interbedded units of clay and conglomerate. Recently, there has been growing concerns about droughts which might affect the groundwater recharge. However, despite this, extensive groundwater study in the Gobi region has yet to be carried out.

Our field survey took place in September 2016. Shallow and deep groundwater, springs and rain water were collected at a total of 70 points. Groundwater samples were taken from production and monitoring boreholes using existing pumping, portable mini pump or hand bailer. Temperature, pH, EC and alkalinity were measured at the field. Analysis of the water samples for major ions, hydrogen and oxygen stable isotopes, as well as tritium (8 samples) is underway at the laboratory in Tohoku University or AIST. Here, we will present the chemical and isotopic properties of water samples, and will introduce our future plan.

Keywords: Gunii khooloi aquifer, Groundwater recharge, Groundwater origin

Metal pollution assessment of subsurface profile in saline water affected area of Bengal Delta

*SUSHMITA HOSSAIN[1,2], Asma Akter[4], Shirin Akter[2], Yeasmin Nahar Jolly[2], Bilkis Ara Begum[2], Takashi Ishiyama[3], Shoichi Hachinohe[3], Aziz Hasan[4], Kazi Matin Ahmed[4]

1. Graduate school of Science and Engineering, Saitama University, Japan, 2. Chemistry Division,Atomic Energy Centre,Bangladesh Atomic Energy Commission,Bangladesh , 3. Research Institute,Center for Environmental Science in Saitama,Japan, 4. Department of Geology,University of Dhaka,Bangladesh

Groundwater of southern part of Bengal Delta is severely affected by saline water along with heavy metals and trace elements e.g., Arsenic (As), Iron (Fe), Manganese (Mn), Copper (Cu) and Zinc (Zn) etc. Groundwater management in this area needs detail risk assessment of metal pollution and potential mobility of metal from sediment to groundwater. Sediment plays major role to transfer metals to groundwater under different environmental conditions. Determination of total heavy metal content in surface soil, sediment of aquitard and aquifer is necessary to understand overall risk of mobility and to take initiative for groundwater management. Recently Managed Aquifer Recharge (MAR) has been introduced to improve the groundwater quality of near coastal area of Bengal Delta. In this study, total 18 soil, channel fill deposit aquifer and overbank deposit aquitard sediment samples of two MAR boring locations had been collected up to depth of 100 ft at 10 to 20 ft interval. Total content of As, Cu, Zn, Fe and Mn were determined using XRF (X-Ray Fluorescence) spectrometer. In aquifer sediment, total As, Cu, Zn, Mn and Fe content ranges from total As, Cu, Zn, Mn and Fe content ranges from 10.5-15.8 mg/kg, 29.7-38.7 mg/kg, 36.3-44.8 mg/kg, 257.6-487.8 mg/kg and 2.1-2.7 % respectively. Metal content in aquitard is variable at different depth. Metal pollution assessment has been carried out using some pollution indices like Geo accumulation index (Igeo), Contamination Factor (Cf), Pollution Load Index (PLI), Elemental Contamination Index (ECI) etc. Based on comparing the natural abundances and results of different indices, it is found that both location is moderate to highly contaminated with As, Mn and Fe whereas not contaminated with Cu and Zn. However, metal like As has strong affinity with iron manganese oxyhydroxide, therefore further speciation analysis will give precise information for potential mobility of metals.

Keywords: Heavy metal, Pollution Index

Groundwater modeling studies to understand hydrogeological conditions and to develop a groundwater management strategy in parts of Dewas District, Central India

*Devdutt Vijay Upasani[1], Himanshu Kulkarni[2]

1. Department of Geology, Fergusson College, Pune-411004, India, 2. Advanced Center for Water Resources Development and Management (ACWADAM), Pune-411021, India

The high dependency of India on its agrarian economy has caused overexploitation of aquifers in many parts of the country. The need of the hour is to develop a sustainable groundwater management strategy, which is not only based on social makeup of an area but also considers the hydrogeological variables in the region.
Groundwater models are computer models of groundwater flow systems and are used to simulate and predict aquifer conditions. Groundwater modeling was undertaken in a part of the *Central Drylands* of India as a part of this study. BGSPT-PTSIM program package by Barker (1989) was used specifically to simulate time-drawdown behaviour for a specified set of parameters.
The radius of influence as an effect of the pumping was modelled for different shallow aquifers in the area of approximately 600 km^2, based on their Transmissivity and Storativity values. Numerous simulation runs were conducted with various data sets. The modelling considered estimates of aquifer properties like Transmissivity and Storativity and also the rates of pumping (Q) that were recorded during pumping tests as well as on the basis of observations made during the inventory of wells from time to time during the research work.
The behaviour of the water levels in the area was understood and further from these simulations, the safe distance between wells was calculated. Safe distance between wells implies the spacing between wells which will not lead to an accelerated dewatering of the aquifers, in general. The last set of simulations was created using the actual well distances in the different areas and the cone of influence of the wells, pumping for a complete pumping season i.e. about 100 days. These simulations indicate that, in the current situation, there are areas where the aquifers are free from major well-interference, due to fewer numbers of wells and because of the aquifer characteristics. However, there are a few aquifers where the higher number of wells actually causes the cones of depression of the pumping wells to interfere with each other causing a quicker dewatering of the aquifers, leading to over-abstraction and unsustainable pumping conditions.
This study is one of the first studies in the country where hydrogeological analyses and groundwater modeling data was used to develop a groundwater management strategy in the region.

Keywords: Groundwater modeling, BGSPT-PTSIM, radius of influence, dewatering of aquifers, groundwater management strategy

Learning about future applications of tritium-tracer in Japanese river waters from the Hokkaido headwater catchments

*Maksym Gusyev[1], Uwe Morgenstern[2], Michael K. Stewart[3], Yoshio Tokunaga[1]

1. International Centre for Water Hazard Risk Management, Public Works Research Institute, Tsukuba, Japan, 2. GNS Science, Lower Hutt, New Zealand, 3. Aquifer Dynamics & GNS Science, PO Box 30368, Lower Hutt, New Zealand

Tritium-tracer in river water can provide useful information about surface water –groundwater dynamics in Japan as demonstrated at 12 headwater catchments of Hokkaido Island with altitudes between 22 and 831 m above sea level and catchment areas between 14 and 377 km^2. For these catchments, we collected 16 water samples at baseflows in June, July, and October 2014 and one river water sample on February 2016 near the south of Sapporo. These water samples were analysed for tritium as well as stable isotopes at the GNS Science low-level tritium laboratory in New Zealand. Measured tritium concentrations were between 4.07 (±0.07) TU and 5.29 (±0.09) TU in June, 5.06 (±0.09) TU in July, and between 3.75 (± 0.07) TU and 4.85 (±0.07) TU in October. In the south of Sapporo, the neighboring river catchments clustered in similar hydrogeological settings of Quaternary lava as well as Tertiary propylite formations had similar tritium values suggesting that they drain the same groundwater watershed system: 4.114 (± 0.062) TU (Takinosawa) and 4.184 (±0.063) TU (Otarunai), and 3.825 (±0.07) TU (Izariirisawa), 3.926 (± 0.061) TU (Honryujyoryu). On February 2016, the Otarunai river water sample collected at winter baseflow had 3.838 (±0.061) TU indicating similar tritium concentrations at subsurface water of the Izariirisawa and Honryujyoryu catchments. For these headwater catchments, we found unique mean transit times (MTTs) using the exponential(70%)-piston flow(30%) model (E70%PM) LPM and very low MTT aggregation errors with the long-term tritium record of Tokyo precipitation scaled for Hokkaido groundwater recharge using wine data. This result suggests that their low tritium concentrations are not ambiguous anymore for the MTT interpretation. However, nine river samples from six other catchments produced up to three possible MTT values with E70%PM due to the interference by the tritium from the atmospheric hydrogen bomb testing 5–6 decades ago. We show that tritium in Japanese groundwater will reach natural levels in a decade, when one tritium measurement will be sufficient to estimate a robust MTT, while using a series of tritium measurements over the next few years with 3 year intervals will enable us to determine the correct MTT without ambiguity in this period. Unique MTTs obtained from tritium-tracer allow us to improve numerical models and to estimate groundwater storage volumes for sustainable water resources management.

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Keywords: river water sampling, tritium isotope, lumped parameter model (LPM), mean transit time (MTT)

Effect of Roughness Lengths on Surface Energy and the Planetary Boundary Layer Height over High-altitude Ngoring Lake

*Zhaoguo Li[1]

1. Key Laboratory of Land Surface Process and Climate Change in Cold and Arid Regions, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences

The high-altitude lakes in the Tibetan Plateau (TP) have a unique roughness length distributions and atmospheric boundary layer variation characteristics. However, how different types of roughness lengths affect the lake surface energy exchange and the planetary boundary layer height (PBLH) remains unclear in the TP lakes. In this study, a tuned Weather Research and Forecasting (WRF) model version 3.6.1 was used to investigate the responses of the freeze-up date, turbulent flux, meteorological variables, and PBLH to surface roughness variations in the Ngoring Lake. Of all meteorological variables, the lake surface temperature responded to roughness length variations most sensitively, increasing roughness lengths can put the lake freeze-up date forward. The effect of momentum roughness length on wind speed was significantly affected by the fetch length. An increase in the roughness length for heat can increase the nightly PBLH during most months, especially in the central lake area in autumn. The primary factors that contribute to sensible heat flux (H) and latent heat flux (LE) were the roughness lengths for heat and momentum, respectively. Although the momentum roughness length also had an important effect on the sensible heat flux, there was no obvious correlation between H and the PBLH.

Keywords: Lake ice , Lake temperature, Roughness length, Turbulent flux , Tibetan Plateau

Seasonal changes of dissolved CH_4, CO_2 and N_2O in a subtropical reservoir, Guangdong, China

*Yang Zhenglun[1], Xing Li[2], Changyuan Tang[1], Han Zhang[1]

1. Graduate School of Horticulture, Chiba University, Japan, 2. School of environmental science and engineering, Sun Yat-sen University, China

Million dams have been built around the world to providing many services for people. However, recent shallow subtropical and tropical reservoirs have been argued as a source of the greenhouse gases (GHGs). The changes of dissolved GHGs is key to control their emissions processes from the reservoirs. In order to understand the generation and release process of dissolved gases such as N2O, CO2 and CH4 in the period with and without thermocline, the Lianhe Reservoir, a typical subtropical reservoir in southern China has been chosen. The field surveys have been conducted to measure DCO_2 (dissolved CO_2), DCH_4 (dissolved CH_4), DN_2O (dissolved N_2O) in September 2014, January 2015, June 2015 and September 2015.

The depths of reservoir changed from 25m to 30m depending on the operation for water supply. The thermocline forms in summer and disappears in winter. Accordingly, the vertical profiles of dissolved gases in summer were different from winter. DO value in the water column decreased with depth from 8.96mg/L to 0.15mg/L in summer, but was almost uniformly ranging from 7.41 to 8.59 mg/L in winter. In summer, concentrations of DCH_4, DCO_2 and DN_2O ranged from 0.49 μg/L to 795.10 μg/L, less than 0.001 mg/L to 1.32 mg/L and 1.06 μg/l to 3.47 μg/l, respectively. Also, concentrations of DCH_4, DCO_2 and DN_2O in winter changed from 0.43 μg/L to 0.85 μg/L, 0.81 mg/L to 3.50 mg/L and 0.85 μg/l to 3.09 μg/l, respectively. As a whole, the vertical distributions dissolved gases are affected by photosynthesis and associated biogeochemical processes. It was found that photosynthetic dominated the dissolved gasses in the top 5m think layer in the reservoir. Available sunlight becomes weaker with increase of depth, CO_2 concentration increased because respiration and metabolic activities of algae and DCH_4 concentration was highest in the bottom in summer. In the winter, the deep part of the reservoir changed from anaerobic environment to aerobic environment because DO was replenished in the overturn period, enhancing oxidation of methane to CO_2.

Keywords: Reservoirthermocline, Greenhouse gas, Dissolved gas, Seasonal variation, Thermocline

Effect of spatial resolution of rainfall on runoff modeling in urbanized basins: A case study of the Tsurumi river basin, Japan

*Shakti P.C.[1], Tsuyoshi Nakatani[1], Ryohei Misumi[1], Koyuru Iwanami[1], Kohin Hirano[1], Masayuki Maki[2]

1. Storm, Flood and Landslide Research Division, National Research Institute for Earth Science and Disaster Resilience (NIED), Tsukuba, Japan, 2. Kagoshima University, Kagoshima, Japan

The use of accurate information in rainfall-runoff models regarding the spatial variations of rainfall is essential for monitoring river discharge, and may help to improve our understanding of water balances. Spatial variations in the amount of precipitation are monitored using limited rain gauge networks with the help of various interpolation techniques which have been used in rainfall-runoff modeling in many cases. Limited and interpolated rain gauge data can introduce large uncertainties into predictions made by hydrological models. In recent years, different type of spatial and temporal resolution of radar estimated rainfall data has been considered in the hydrological computation. Several studies agree that use of high-resolution rainfall data to the hydrological model may offer more realistic output, but there is not a clear guideline about the optimum scale of spatial and temporal resolution for the radar rainfall data. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) established an X-band polarimetric radar network (XRAIN), which uses an operational data processing system developed by the National Research Institute for Earth Science and Disaster Resilience (NIED). XRAIN is composed of X-band MP (multi-parameter) radars, and has spatial and temporal resolutions of 250-m and 1-min, respectively. This product is one of the best high-resolution radar rainfall systems in the world, considered as an input to the Hydrologic Engineering Center’ s Hydrologic Modeling System (HEC-HMS) model to simulate runoff. The model was set up for the Tsurumi river basin (≈117 km^2) and it is located close to the Yokohama city of Japan. In this study, we selected some extreme rainfall events to simulate runoff separately. Different spatial resolution of rainfall data were generated from XRAIN radar rainfall for each event and applied into the model. Simulated runoff of each event was analyzed and compared each other separately and few remarks are drawn on using different spatial resolution of rainfall to the hydrological model for small urbanized basin.

Keywords: Hydrology, Weather radar, Spatial distribution of rainfall, Hydrological model, Urbanized basin, Runoff

Monitoring wetland inundation dynamics from space using a fully automated multi-sensor mapping approach

*Ben DeVries[1], Wenli Huang[1], Chengquan Huang[1], Megan Lang[2], John W. Jones[3], Irena Creed[4], Mark Carroll[5,6]

1. University of Maryland, College Park, MD, USA, 2. US Fish and Wildlife Service, National Wetlands Inventory, Falls Church, VA, USA, 3. US Geological Survey, Eastern Geographic Science Center, Reston, VA, USA, 4. Department of Biology, University of Western Ontario, London, ON, Canada, 5. Biospheric Sciences Lab, NASA Goddard Space Flight Center, Greenbelt, MD, USA, 6. Science Systems and Applications, Inc., Lanham, MD, USA

Surface water inundation drives myriad important wetland functions, including water storage, carbon sequestration, nutrient removal, and biodiversity. Reliable information on wetland inundation dynamics is often lacking, leading to large uncertainties when studying these functions. A number of regional to global-scale surface water products have been released in recent years using a variety of satellite data sources. However, their utility is limited due to their relatively coarse spatial and temporal resolution. The fusion of optical and synthetic aperture radar (SAR) data streams has been put forward as a way to enhance temporal resolution and leverage the inherent benefits of these two disparate data types. Harmonized methods are needed to achieve enhanced temporal resolution through the generation of consistent wetland inundation estimates. Here, we present novel algorithms for the automated mapping of inundation, making use of optical (Landsat and Sentinel-2) and SAR (Sentinel-1) data streams. Using a combination of static thresholds, spatial aggregation, inundation probability from time series imagery and random forest classifiers, these algorithms are shown to be efficient in deriving inundated surfaces from optical and SAR imagery without the use of externally derived training data. While both algorithms are highly scalable in both space and time, several key limitations will need to be addressed before generating regional dynamic inundation products, including: insufficient frequency of satellite overpasses; commission errors from dark surfaces in optical imagery; and challenges in quantifying sub-pixel inundated extent from SAR imagery, which is necessary to ensure consistency between data streams. Addressing these issues will allow for the generation of near-daily estimates of wetland inundation at the continental to global scale, representing a significant step forward in understanding wetland ecosystems in support of relevant policies and management strategies.

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Government.

Keywords: Landsat, Sentinel, inundation, surface water, wetlands

Numerical Simulations of Vertical Water Redistribution in Sand using COMSOL and HYDRUS Software

*Abhishek Abhishek[1], Luwen Zhuang[2], S. Majid Hassanizadeh[2]

1. Indian Institute of Technology Roorkee, India, 2. Utrecht University, The Netherlands

Moisture redistribution process in porous media has a wide range of practical applications in petroleum industry, agriculture engineering, hydrology and carbon/CO_2 sequestration. Recently, a vertical water redistribution experiment was designed. A thin column with dimensions of 50 (height) by 1.2 cm (inner diameter) was employed. Five water tensiometers were mounted along the column at a distance of 1, 13, 25, 37 and 49 cm from the top. Two air tensiometers were mounted at 15 and 35 cm from the top to measure air pressure. Initially, the column was packed with saturated medium sand. The bottom of the column was open to the air to drain the sand gradually under gravity. Once the equilibrium had reached, the column was reversed to let moisture in the sand redistribute. During free drainage and redistribution processes, saturation was measured by gamma transmission method, and water and air pressure were measured by tensiometers. Numerical simulations were used to estimate saturation distribution over the whole column and the duration of experiments.
In this work, we used both 1D and 2D models using Richards equation to simulate this vertical redistribution process. Both COMSOL and HYDRUS-1D were used to solve 1D model, while COMSOL was employed to solve 2D model. In 1D simulations, equilibrium time is found to increase linearly during free drainage process, as the length of the column increases. It is 1.4 d for the length of 50 cm, which is employed in experiments. In 2D simulations, water saturation profiles are non-uniform along the width of the domain at earlier time steps, while become almost uniform when it reaches equilibrium. By comparison, the average saturation distribution along the column in 2D simulations considering different values of width is exactly the same as the one in 1D simulations. The simulated results are to be compared with experimental results.

Keywords: Water redistribution, Richards' equation, Tensiometers, Numerical Simulation

Sulfonamides degradation and microbial responses in Riverbank Filtration(RBF) system: a laboratory column study

*Ying Bai[1,2,3], Xiaohong Ruan[1,2], Jingwei Wu[2], Jan Peter van der Hoek[3]

1. Key Laboratory of Surfacial Geochemistry, Administration of Education, Nanjing University, China, 2. School of Earth Sciences and Engineering, Nanjing University, China, 3. Delft university of Technology, Department of Water Management, 1, 2628 CN Delft, The Netherlands

Contamination of drinking water sources by pharmaceutical activated compounds is emerging recently in the urban water cycle, which is an important issue related to human health, ecological effects (Benner et al. 2013). Antibiotic resistance genes (ARGs) are also increasingly regarded as emerging environmental contaminant.
the other hand, bank filtration has long been recognized as an effective and sustainable technique for pathogenic microbes and organic micro pollutants removal around the world (Tufenkji, Ryan and Elimelech 2002). River bank area which is characterized by gradients in light, temperature, redox potential, pH, oxygen, and carbon source, controls the intensity of biodegradation. It is frequently reported that the most significant biochemical changes related to microbial activity occurs in the early stages of bank infiltration process (Kedziorek, Geoffriau and Bourg 2008, Zhang et al. 2015, Ma et al. 2015).
The changing redox conditions in natural groundwater system would enhance a change in microbial activity, which is the main incentive of biodegradation intensity (Richter et al. 2009). In the biodegradation process of antibiotics in the environment, redox condition as long as carbon source supply controls the microbial activity, and are the main factors controlling the intensity (García-Galán et al. 2008). Benno et al. proved that sulfamethoxazole was more effectively degraded under aerobic than under anoxic conditions and the availability of DOC fosters SMX removal (Baumgarten et al. 2011). Raffaella et al. noticed an increasing degradation rate of p-TSA in groundwater due to the microbial adaption to the change of redox condition (anoxic to oxic) (Meffe et al. 2012). Doreen et al. also found out p-TSA and o-TSA were redox-sensitive compounds and preferably degraded in the presence of O2(Richter et al. 2009). Jette et al. studied direct metabolism of three sulfonamides (sulfanilamide (SAA), sulfadimethoxine (SDT), and sulfapyridine (SPY)) through enzymatic catalysis by the fungal laccase from Trametes versicolor in soil. So it is imperative that we improve understanding of the processes and environmental factors that govern the fate of sulfonamides in the riverbank filtration process (Mohatt et al. 2011).
In this paper, two independent RBF soil column pilots (3 columns and 7 columns) were constructed and five sulfonamides including Sulfapyridine, Sulfadiazine, Sulfamethoxazole, Sulfamethazine and Sulfaquinoxaline were selected as the target antibiotics. The object of this research include: 1) contrasting the attenuation dynamic and migration behavior of sulfonamides in monitored RBF system under different redox condition and retention time, 2) examining microbial community structure dynamic in porous aquifer media and its effect on sulfonamides removal rate, 3) investigating sulfonamides resistance gene (sul1, sul2) abundance and accumulation mechanisms during riverbank filtration and the risk posted on drinking water safety. By analyzing the different attenuation behavior of sulfonamides in two pilot systems, and the microbial responses to this environment pressure, we can further deduce the effect of hydrological retention time, redox condition and microbial activity and community structure had on sulfonamides degradation during MAR process.

Keywords: River bank filtration, Antibiotics, Antibiotics resistance genes

Column experiments for nitrate attenuation in groundwater using reed and bamboo chips in phosphorus restrictions environment

*Shunichi Satake[1], Changyuan Tang[1]

1. Graduate School of Horticulture, Chiba University

Nitrate pollution of groundwater is one of the environmental issues in the world. Wetland and riparian zone play a very important role on removing nitrate from groundwater through denitrification where denitrifying bacteria reduce nitrate to nitrogen gas. In past decades, such natural attenuation has been enhanced in a low cost by using wood chips as the carbon sources available for denitrifying bacteria. However, its performance depends on largely on phosphorous that is an indispensable element of organisms and plays an important role in biological metabolism. Phosphorous concentration is often limited in groundwater even those polluted by nitrate under the natural condition.
In order to study the effect of phosphorous on denitrification efficiency, column experiments have been conducted by using reed or bamboo chips as denitrification materials. It was found that the NO_3-N removal efficiencies decreased from 86.1% to 61.6% for reed and from 73.6% to 37.0% for bamboo when the phosphate-P concentration of influents declined from 0.4 mg/L to 0.04 mg/L. In addition, NO_2-N concentration was detected high in the effluent from the column filled with bamboo chips when the phosphate-P concentration was low. NO_3-N removal rate was estimated by the Michaelis-Menten equation. The half-saturation constant for phosphate-P concentration was 0.03 mg/L for reed and 0.09 mg/L for bamboo, indicating that phosphorous is the key to control NO_3-N removal rate. Therefore, the NO_3-N removal rate in groundwater with plant chips can be expected high when N/P ratio is around 100.

Keywords: Nitrate nitrogen, Plant chips, Denitrification, Phosphate-P

