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

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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.

キーワード：安定同位体、降水、水蒸気起源
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

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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

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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?

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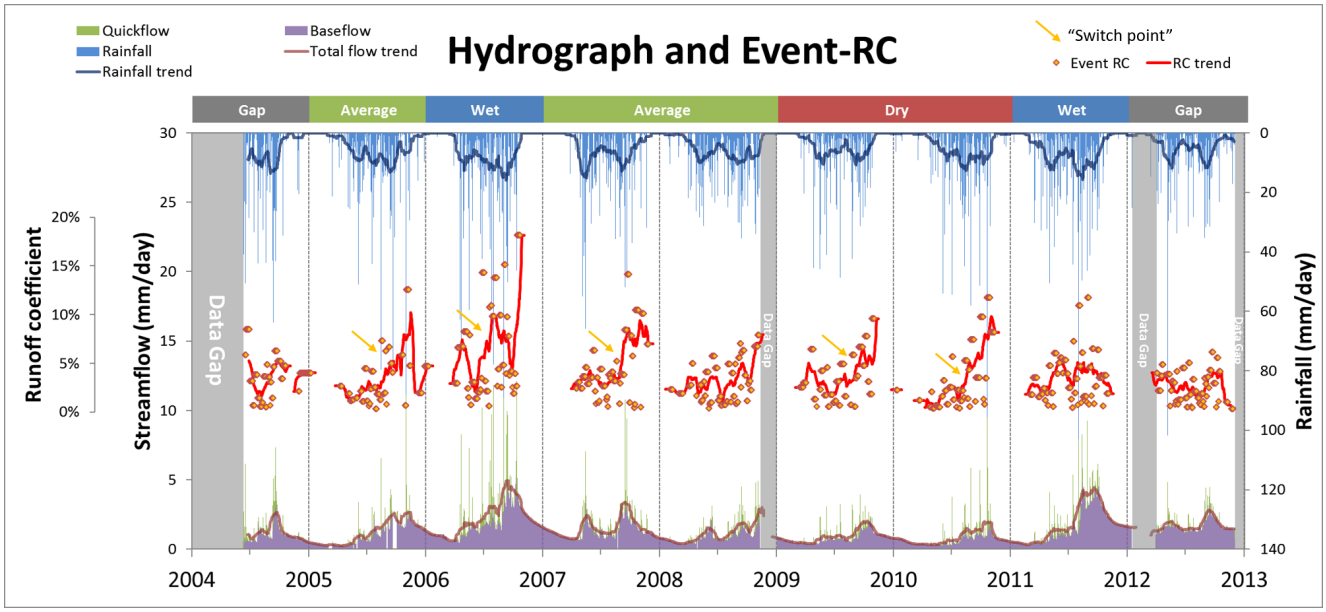
In this study, we examined the dynamics of the rainfall-runoff relationship in Mae Sa watershed, a montane catchment with mixed forest, agriculture, and peri-urban land covers in northern Thailand near the city of Chiang Mai. The Asian monsoon and tropical storms produce highly distinct wet-dry rainfall 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

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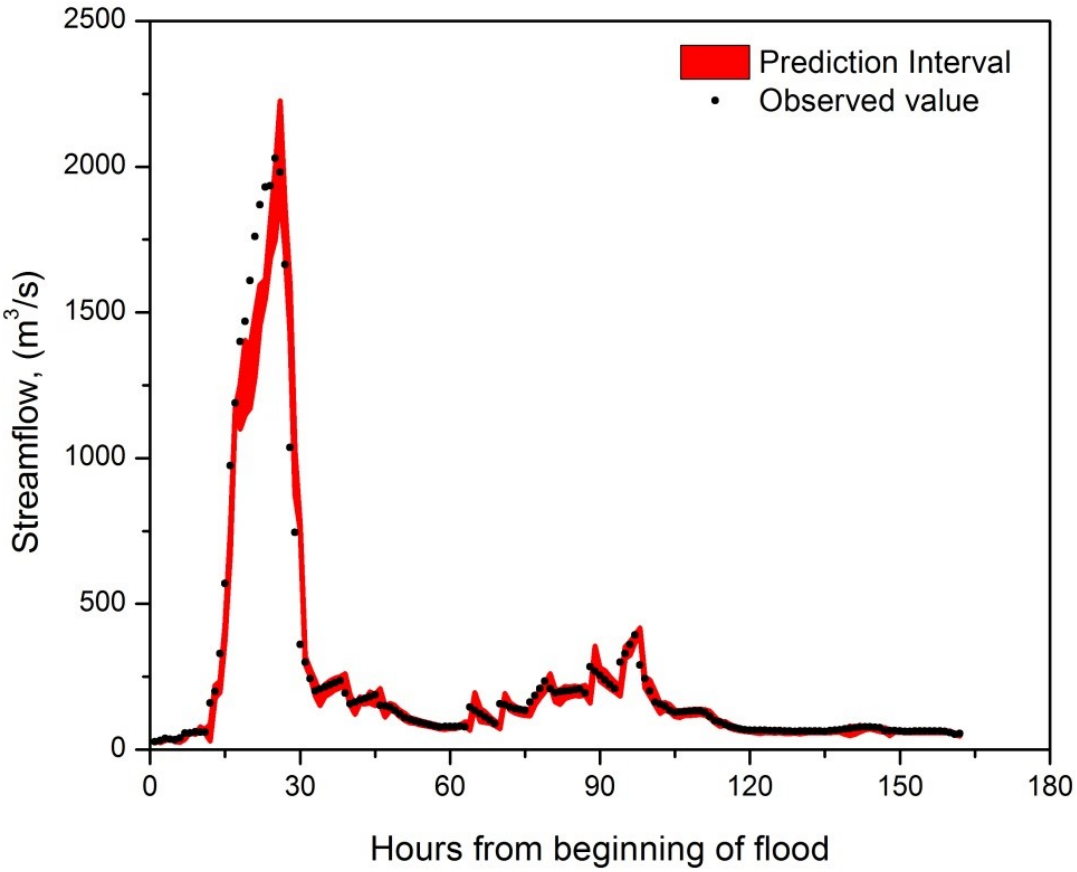
Understanding the complex nature of rainfall-runoff process has opened many folds of modeling technique. It is still a challenging task in hydrologic modeling analyzing the inherent variability or uncertainty besides the improvement in model performance. To date, variety of hydrologic models have been 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

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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

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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

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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

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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

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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

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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

典型的な亜熱帯ダムにおける溶存CH4、CO2、N2Oの季節変化特徴ー中国南部の聯和ダムを例として

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

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世界中に百万を超える数のダムが建設され、人々に様々な便利を与えている。 しかし最近の研究では、亜熱帯及び熱帯ダムは、温室効果ガス（GHGs）の発生源として挙げられている。 溶存GHGsの変化は、ダムからの放出プロセスを制御する為にとでも重要である。 水温躍層の有無に関わらず、N_2O、CO_2、CH_4などの溶存ガスの発生・放出プロセスを理解するために、中国南部の典型的な亜熱帯ダムである聯和ダムを研究対象とした。 現地調査は、2014年9月、2015年1月、2015年6月、2015年9月の四回に分けてそれぞれDCO2（溶存CO2）、DCH4（溶解CH4）、DN2O（溶解N2O）等の溶存ガスを深度別に測定した。

ダムのオペレーターによって水位が25mから30mの間で変化する。水温躍層は夏に形成され、冬には解消する。したがって、夏季の溶存ガスの鉛直分布は冬とは異なる。夏場の水カラムのDO値は8.96mg / Lから0.15mg / Lに減少したが、冬季はほぼ均一的に7.41～8.59mg / Lの範囲であった。夏季には、DCH_4、DCO_2およびDN_2Oの濃度は0.49μg/ Lから795.10μg/ L、0.001mg / Lから1.32mg / Lおよび1.06μg/ Lから3.47μg/ Lの範囲であった。また、冬季のDCH_4、DCO_2、DN_2Oの濃度は、それぞれ0.43μg/ Lから0.85μg/ L、0.81mg / Lから3.50mg / L、0.85μg/ Lから3.09μg/ Lに変化した。全体的に、溶存ガスの鉛直分布は、光合成作用およびそれらに関連する生物地球化学的プロセスによって影響される。光合成は、表層5m水深の層の中の溶存ガスを制御していることが分かった。夏季には、深度が深くなるにつれ利用可能な太陽光が弱くなり、藻類の呼吸や代謝活性によりCO_2濃度が上昇した。そして、ダム底部におけるDCH_4の濃度が最も高い。冬季になると、ダム底部は嫌気的環境から好気的環境へと変化した。.DOがにより補充され、メタンのCO_2への酸化が促進されたからです。

キーワード：ダム、温室効果ガス、溶存ガス、季節変動、水温躍層
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

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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

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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

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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

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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

リン制限環境下でのヨシおよび竹チップを用いた地下水中の硝酸態窒素浄化に関するカラム実験

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

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地下水の硝酸態窒素汚染は世界中で注目されている環境問題の１つである。脱窒反応は脱窒菌と呼ばれる微生物群により硝酸態窒素を窒素ガスへと還元する反応で，自然界では河畔や湿地域が重要な役割を果たしている。地下環境では，脱窒反応における最も多い制限因子は利用可能な有機炭素の不足といわれており，これを植物資材で補った脱窒浄化壁に関する研究が近年行われている。しかしながら，その性能は生物の不可欠な要素であり，生物代謝に重要な役割を果たすリンに大きく依存する。しかし，リン濃度は硝酸態窒素汚染された地下水の場合でも制限されることが多い。

そこで，本研究では脱窒効率に及ぼすリンの影響を調べるため，脱窒資材としてヨシおよび竹チップを用いた室内カラム実験を行った。その結果，流入地下水中のリン酸態リン濃度が0.4mg/Lから0.04mg/Lに低下するとヨシチップ充填カラムのNO_3-N除去率は86.1%から61.6%，竹チップ充填カラムのNO_3-N除去率は73.6%から37.0%に減少した。また，リン酸態リン濃度が低い場合には，竹チップ充填カラムの流出水中で高いNO_2-N濃度が検出された。NO_3-N除去速度の制限因子をリン酸態リン濃度としたMichaelis-Menten型の式を適用した結果，リン酸態リン濃度の半飽和定数はヨシで0.03mg/L，竹で0.09mg/Lが得られ，リン酸態リンがNO_3-N除去速度を制限する重要な因子であることが示された。したがって，流入水のN/P比が100程度であればNO_3-N除去速度は最大速度の半分以上が期待できる。

キーワード：硝酸態窒素、植物チップ、脱窒、リン酸態リン
Keywords: Nitrate nitrogen, Plant chips, Denitrification, Phosphate-P

Assessing the effect of climate change on the hydrology of the Wainganga River basin using VIC model

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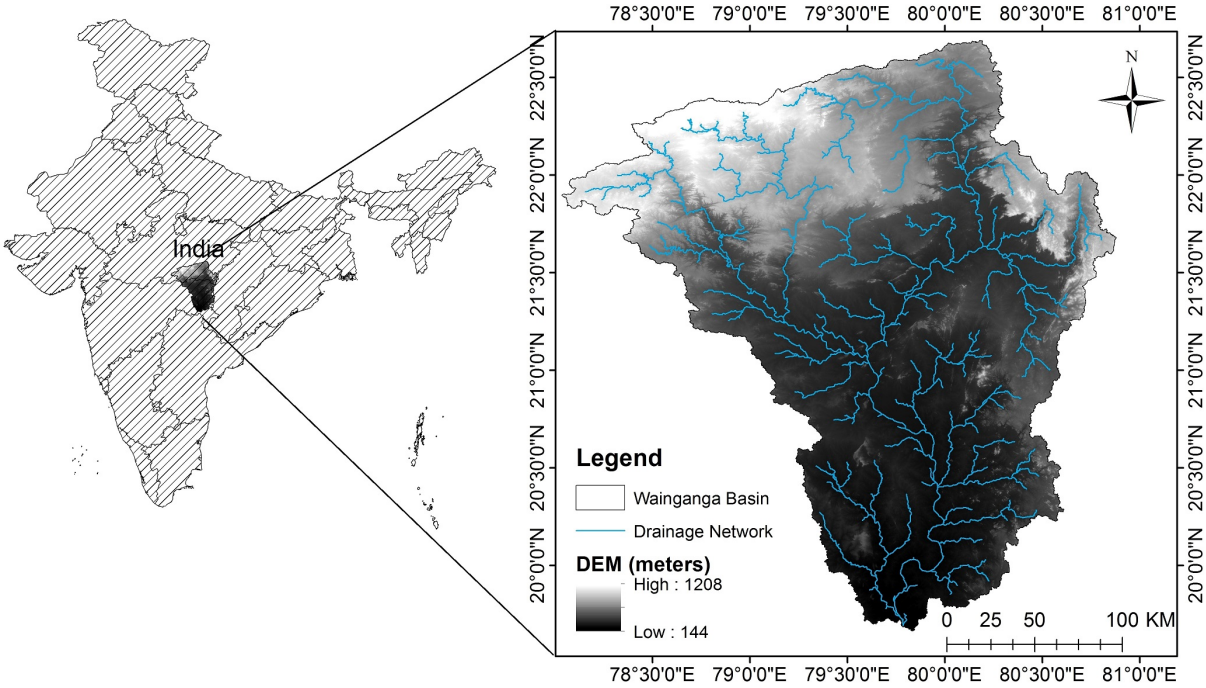
Climate change is one of the most important global environmental challenges, which affects the entire earth system in terms of negative impacts on food production, water supply, health, livelihood, energy, etc. The study aims to assess the long-term impact of on the streamflows in the Wainganga basin at Ashti station for period 1951-2014. The Wainganga basin is the biggest sub-basin of the Godavari and accounts for nearly 1.56% of the total geographic area of India and 16.45% of the total area of the Godavari basin. Wainganga is an agricultural basin with around 51% under cultivation land. Changing climate can have huge impact on the livelihood of the people. Precipitation has decreased by 7.95% in the basin during the study period while temperature have increased by 0.48°C. Variable Infiltration Capacity (VIC) model was used for simulating streamflows. 20 years' durations were selected as calibration (1970-1989) and validation (1990-2009) periods. Daily NSE, COD and RE of 0.85, 0.92 and 2.6% and, 0.84, 0.92, and 1.45% were obtained during calibration and validation of the model respectively. Analysis demonstrates a significant decreasing trend in the basin showing 15.02% decrease in mean annual flows. The decrease is due to decrease in precipitation and increase in losses due to increased temperature. The study contributes to the knowledge and understanding of the climate change impact on the local catchment level.

Keywords: Climate change, hydrological modelling, VIC model, streamflow



Numerical simulation of the climate effect of high-altitude lakes in the Tibetan Plateau

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Lakes regulate the water and heat exchange between the ground and the atmosphere on different temporal and spatial scales. However, studies of the lake effect in the high-altitude Tibetan Plateau (TP) are gradually performed until recently and little attention was paid to modelling of frozen lakes. In this study, we employ the WRF v3.6.1 model to conduct the three groups of long-term simulation experiments of Ngoring Lake basin in the TP (original experiment, experiment with a tuned model, and no-lake experiment). Based on these experiments, we evaluate the effect of model improvement on the simulation in the high-altitude lake basin, and investigate the influence of lake on the regional climate. After the lake depth, the roughness lengths and initial surface temperature are corrected in the model, the simulation of the air temperature is distinctly improved. In the experiment with a tuned model, the simulated H on the lake surface is also clearly improved, especially during the periods of ice melting (from late spring to early summer) and freezing (late fall). However, the H on the lake ice is predominantly negative, which exhibits a relatively large difference from the observation. The improvement of LE is primarily manifested by the rapid increase in the correlation coefficient between the simulations and observations, whereas the improvement in the averaged LE is relatively small. The initial surface temperature improvement shows most prominent effect in the first year, and which distinctly weakens after a freezing period. After the lake becomes the grassland in the model, the daytime temperature clearly increases during the freezing and melting periods, the nocturnal cooling appears in other time, especially from September to October. The annual mean H increases by 6.37 times in the regions of original Ngoring Lake and Gyaring Lake areas, and the LE declines by 56.17%. The sum of H and LE increases from 71.23 W m-2 (with lake) to 84.58 W m-2 (without lake). For the entire simulation region, the sum of H and LE also increases slightly. After the lakes disappear, the air temperature increases significantly over the two lakes from June to September, and a typical abnormal convergence field forms. At the same time, the precipitation clearly increases in the original two lakes and surrounding areas, whereas the precipitation generally decreases in other regions. The pattern of the precipitation increase region is consistent with the inter-annual variation of the convergence field.

Keywords: lake effect, Tibetan Plateau, frozen lake, latent heat flux, precipitation

Meteorological drought change evaluation using comparative standardized precipitation index with d4PDF future and past experiments

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Meteorological drought defines a baseline for the other droughts, such as hydrological, agricultural, and socio-economic droughts. Meteorological drought indices are simply derived using only the meteorological variables, such as precipitation and temperature. The standardized precipitation index (SPI) is used by national meteorological and hydrological services around the world to characterize the meteorological droughts on multiple timescales longer than 1 month. The SPI is computed as follows. The cumulative distribution function (CDF) of the gamma distribution is fitted with the aggregated precipitation dataset at a desired timescale. The fitted CDF is converted to the standardized normal distribution, and the SPI value is computed as the standard score, or Z-score, of the corresponding precipitation. Due to the standardization, the 50th percentile value of precipitation is converted to SPI=0, and the 84.13th and 15.87th percentile values are converted to SPI of +1 and -1, respectively. The SPI values less than -1 are generally treated as the meteorological drought.
The comparative SPI (cSPI) is an extension of the SPI and was developed for meteorological drought assessment under climate change as well as monitoring drought hazards by dividing the input dataset of precipitation into the reference and target datasets. The CDF parameters are estimated with the reference dataset, and the precipitation of the target dataset is converted to the Z-score of the standardized normal distribution related to the CDF using the parameters estimated from the reference dataset. This cSPI approach enables us to estimate the shift of the central condition of the target dataset and the probability changes of dry and wet conditions in the target dataset on the basis of the reference dataset.
The d4PDF (database for Policy Decision-making for Future climate change) consists of three sets of experiments using a general circulation model with 60-km horizontal grid developed by Meteorological Research Institute of Japan: historical climate experiment (100 runs, 60 years from 1951 to 2010), non-warming past experiment (100 runs, 60 years), and +4K future climate experiment (90 runs, 60 years). We compute cSPI of the non-warming past and +4K future climate experiments on the basis of 100 members of the historical climate ensemble experiment, respectively. We demonstrate the changes in the central conditions and in the probabilities of dry and wet conditions with cSPI due to the anthropogenic global warming in future (+4K vs. historical) and past (non-warming vs. historical) climate experiments.

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Keywords: meteorological drought, comparative SPI, anthropogenic impacts, climate change, d4PDF

Evaluating Dynamically and Statistically Downscaled Climate Model for Rainfall Extreme: A Case from Karnali Basin in Western Nepal

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1. Small Earth Nepal

It is well agreed that the climatic extremes events are increasing in last few decades and many scenarios have predicted that those events will increase also in future. There are is an agreement among the climate models on the future increase in temperature, however in case of rainfall, there is a high uncertainty. The global climate models are downscaled either by using the local topography (dynamic) or by establishing a relationship of local weather with the large scale atmospheric phenomenon (statistical). In this paper we attempt to analyze the rainfall extreme events with the dynamically downscaled regional climate models and GCM informed statistically downscaled models for a data scare region of Nepal-Karnali basin. We tested the performances of CORDEX South Asia data and downscaled at the station scale using the SDSM 5.2 (Decision Centric) by providing the GCM informed climate scenarios.

Keywords: Rainfall, Himalayas, Extreme, Models

Evaluation of Uncertainty in Long-term Rainfall-Runoff Forecast for Development of Long-term Prediction Based Water Management System

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1. Hydrometeorological Cooperation Cenetr

The needs for probabilistic long-term forecast is growing more urgent than ever recently with climate change, because of the greater uncertainty in precipitation, the heightened frequency and intensity of natural disasters such as flood and draught, and the increased social demand for stable water supply. Korea Meteorological Administration, a governmental agency, is currently running a long-term forecast using GloSea5, a global seasonal prediction system, but few research has been done on utilization and application of said system in water management. In this study, we focused on Yongdam Dam and Namgang Dam, the most notable multipurpose dams in Korea’ s Geum and Nakdong river watershed, respectively; extracted GloSea5’ s long-term rainfall forecast data (for max. 6 months) for these areas; compared the data with observations and conducted bias correlation on the quantitative differences by the quantile delta mapping (QDM) method; and thereby assessed and measured the accuracy of and the uncertainty in the GloSea5 predictions. In addition, we conducted a long-term runoff analysis taking into account the uncertainty in long-term forecasts, by means of K-DRUM, a distributed rainfall-runoff model generally adopted in dam operations, seeking to establish a long-term plan for dam operation. Our analysis results suggested we could considerably mitigate the quantitative gap between observations and long-term forecasts using the QDM method. The outcome also showed representable patterns comparatively similar to observations. And the result of long-term runoff verification included the observation data within its confidence interval after considering the uncertainty, sufficiently supporting the feasibility of a long-term operation plan for dams. This study concludes it is possible to maintain stable water storages and to plan for water level management by utilizing long-term forecast techniques.

Keywords: GloSea5 Model, Long-term Prediction Forecast, Distributed Rainfall-Runoff Model, Evaluation of Uncertainty

Using HECHMS and WASH123D for operational water stage forecasting of KaoPing River in Taiwan

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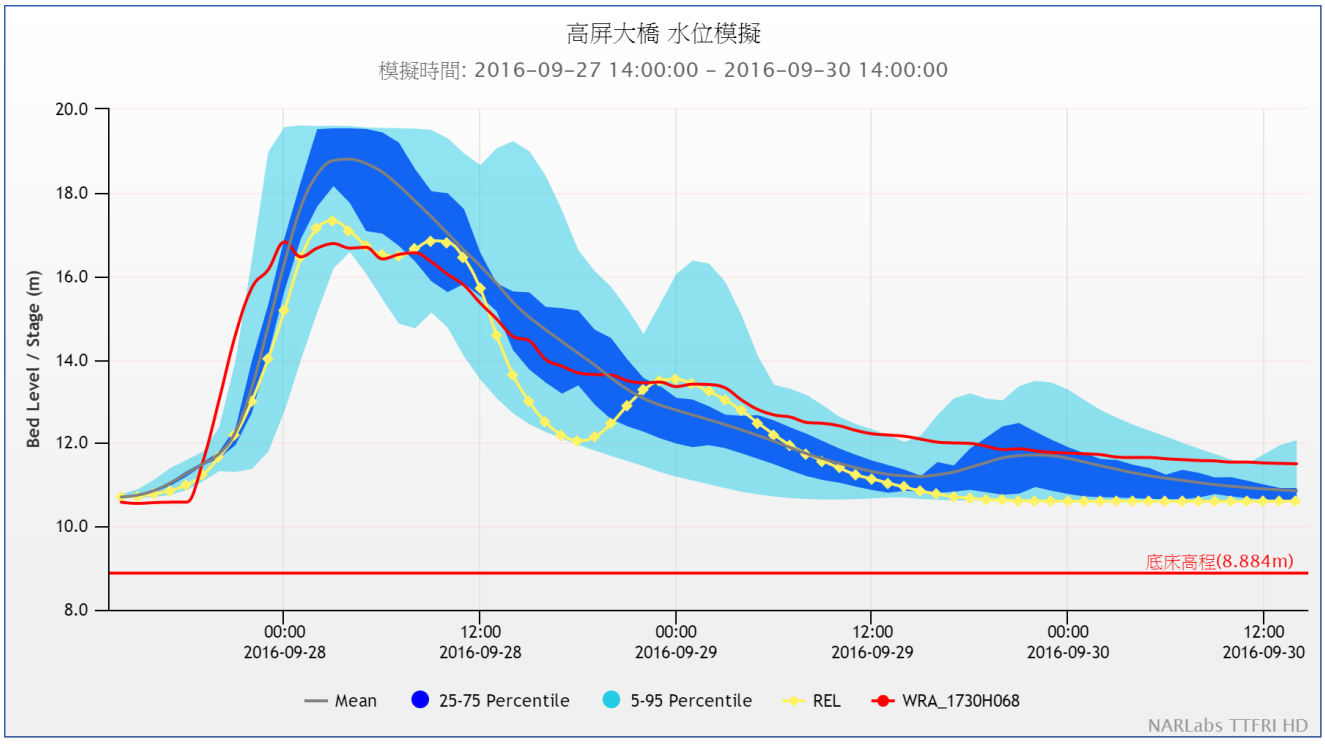
Extreme typhoon rainfall over Taiwan usually causes severe flood damage. Since the impacts of flooding may include social, economic and environmental problems, it is very important to establish a local flood warning system to prevent or mitigate flood disasters.
In 2010, Taiwan Typhoon and Flood Research Institute (TTFRI) started Taiwan Cooperative Precipitation Ensemble Forecast Experiment (TAPEX) that was designed for providing skillful typhoon predictions to related agencies such as CWB, NCHC, SWCB, WRA, and NCDR. To date, TAPEX has included 26 members and is run operationally 4 times a day. In each run, the 72 hours precipitation forecasts are provided.
The purpose of this study is to establish an operational local water stage forecasting system for KaoPing River in Taiwan using HECHMS as a runoff model and WASH123D as a 1D/2D coupling flood model. Precipitation forecasts provided by TAPEX are used in the forecasting system as the input rainfall data. The performance of the developed forecasting system is verified using rain gauge data and observed water stage data. In addition, a web based data monitoring system is constructed for not only collecting real-time observed data, but also displaying the model results compared with observed data.

Keywords: HECHMS, WASH123D, operational, TAPEX



Infrared Sounding Observation of Soil Moisture and Relationship with Skin Temperature

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We have developed a simple, yet effective scheme to derive volumetric soil moisture (VSM) using infrared (IR) land surface emissivity retrieved from satellite measured IR spectral radiance. This novel scheme is applied to a 10-year period of global IR emissivity data retrieved from MetOp-A Infrared Atmospheric Sounding Interferometer (IASI) measurements. The VSM calculated from these IR emissivity data (denoted as IR-VSM) is compared with that routinely retrieved from satellite microwave (MW) multi-sensor measurements (denoted as MW-VSM). Monthly-mean spatially-gridded climatology datasets are then generated to demonstrate VSM spatial variation as well as its seasonal-cycle and inter-annual variability. Positive agreement is shown to exist between IR- and MW-VSM. The relationship between soil moisture and surface skin temperature, as well as the skin temperature diurnal difference (denoted as dTs), were examined globally using the land surface skin temperature (denoted as Ts) retrieved from the same measurements of IASI. We are able to draw the conclusion that both skin temperature and skin temperature diurnal differences follow an inverse relationship with soil moisture.

Keywords: Remote sensing, Infrared, retrieval, soil moisture, skin temperature

Simulating soil moisture dynamics in the overexploited Indo Gangetic alluvium area in Central Punjab, India

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In arid and semiarid areas, accurate estimation of groundwater recharge is essential for sustainable management of water resources. In the Indo-Gangetic alluvial plains of Punjab region, India, groundwater is the main source of irrigation. Insufficient rainfall associated with intensive cultivation in the alluvial plains of this region has resulted in the degradation of groundwater regime both in quality and quantity. In view of moderate to low rainfall in the region, return flow from applied irrigation is likely to be a major source of groundwater recharge. In this study, we estimated the contribution of irrigation return flow on groundwater recharge in paddy fields by modeling water flow in the vadose zone using the HYDRUS-1D software and compared the results with the estimated recharge on a rainfed site by the injection of tritium.

Three representative sites in the alluvial plain were selected, one rainfed site and two fields under rice cultivation. For each site, soil moisture was monitored in situ by vertical neutron probe surveys. The hydraulic properties of the soils at the site were determined using in situ experiments and laboratory measurements. Tritium was injected at selected sites and groundwater recharge was estimated from the depth profile of tritium.

At each site, the 1-dimensional flow model was calibrated using climate, soil hydraulic property, and groundwater levels data, and was validated using the measured soil moisture content. Good agreement was achieved between the HYDRUS-1D simulations and field measurements of moisture content for both rainfed and paddy cultivated sites. Based on the calculated results, unsaturated moisture influx was estimated.

Keywords: Irrigation return flow, Soil moisture dynamics, Modeling

Development and Application of a Distributed Source Pollutant Transport Model Based on BTOPMC

Development and Application of a Distributed Source Pollutant Transport Model Based on BTOPMC

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Agricultural non-point and industrial point sources are contributing nitrogen and phosphorus concentrations in Chinese catchments and these pollutants cause degradation of river water quality for a long distances. To evaluate these impacts, a distributed pollutant transport model was developed on the basis of BTOPMC (Block-Wise Use of TOPMODEL with Muskingum-Cunge Method), a grid-based distributed hydrological model. In this model, the water flow routing process of BTOPMC is the carrier of pollutant transport and these pollutants are washed off with a direct runoff. Pollutant flux for each grid is simulated based on mass balance of pollutants within the grid and pollutant transmission occurs between grids in the direction of the water flow on daily time steps. The model was tested in the study area of the Lu county area situated in the Laixi river basin in the Sichuan province of southwest China. The simulated concentrations of nitrogen and phosphorus are compared with the available monthly data at several water quality stations. These results demonstrate a greater pollutant concentration in the beginning of high flow period indicating the main mechanism of pollution transport. From these preliminary results, we suggest that the distributed pollutant transport model can reflect the characteristics of the pollutant transport and reach the expected target.

キーワード：Pollutant transport、BTOPMC、Distributed hydrological model、Muskingum-Cunge Method、Modeling
Keywords: Pollutant transport, BTOPMC, Distributed hydrological model, Muskingum-Cunge Method, Modeling

印旛沼流域における窒素負荷量の再検討
Reexamination of Nitrogen Loading in Inbanuma Basin

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*Masaki Horie[1], Akira Hama[2], Yoko Fujimura[3], Akihiko Kondoh[4]

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1．はじめに

地球規模の窒素過多・窒素飽和により、人類に与える影響として最も深刻な環境要素の1つに窒素循環が挙げられている[1]。窒素循環の不健全化が引き起こす問題として閉鎖性水域の富栄養化問題があるが、日本では湖沼法のもとで湖沼水質保全計画を策定し、水質改善を図っている。千葉県の印旛沼は指定湖沼の一つであり、過去30年以上にわたり、水質改善の取り組みが行われている．印旛沼湖沼水質保全計画では原単位を使用した発生汚濁負荷量の算定が行われているが、印旛沼への窒素負荷量は土地利用の変化や下水道普及率の上昇に伴い、年々減少傾向にあるとされている．それにも関わらず印旛沼の全窒素濃度は、環境基準を超過したまま下げ止まりの状況が続いている。個々の土地利用、水処理形態に対応する原単位は過去に設定された値が継続して使われてきたが、過去30年間で変化した社会のあり方、調査研究の進展、等を鑑みて原単位を再評価する必要性があると考えられる。これを受けて、藤村(2015)では原単位に関する検討が行われ、一部の項目で新たな値が提案された[2]．そこで本研究では、湖沼水質保全計画で使われている原単位と藤村(2015)による原単位を用いて、印旛沼流域の窒素負荷量分布図を作成し、比較することにより原単位に関する検討を行った。

2．研究手法

印旛沼流域を、行政界と流入河川ごとの集水域で分割した区画ごとに、原単位に2010年の統計データを掛けることで、区画ごとに窒素負荷量を算出した．この統計データは千葉県環境生活部水質保全課から提供していただいた。窒素負荷量は、宅地からの生活系負荷量、家畜からの畜産系負荷量、山林や畑地などの面源汚濁負荷である自然系負荷量、事業場からの事業場系負荷量に分類できる．これらの分類した窒素負荷量を、印旛沼流域水循環健全化会議によって作成された2007年の土地利用図の土地分類ごとに、生活系負荷量は宅地に、畜産系負荷量は畑に、事業場系負荷量は市街地に、自然系負荷量は山林や畑地などの土地分類ごとに割り当てた．その後、流域の負荷量データの精度及び分割後の総メッシュ数を勘案し、250mメッシュに分割することで窒素負荷量分布図を作成した．得られた負荷量の妥当性を検討するために、全窒素濃度の水質測定地点を流出口とする集水域を設定し、その集水域における窒素負荷量と流出口における実測の窒素流出量を比較した．窒素流出量は、千葉県環境生活部水質保全課の観測による全窒素濃度と、印旛沼流域水循環健全化会議の観測による河川の流量から算出した．

3．結果・考察

印旛沼流域の各集水域の窒素負荷量と窒素流出量との相関関係をもとに、回帰モデルを導くと、両者の間に良好な直線関係が示され、集水域における窒素負荷が河川の窒素流出量を増加させていることが示された．湖沼水質保全計画の原単位を使用した場合、回帰直線の傾きは1.40となり、窒素流出量が窒素負荷量を大きく上回ったことから、窒素負荷量を大きく過小評価している可能性がある。一方、藤村(2015)による提案原単位を使用した場合、傾きは1.09となり、窒素負荷量が窒素流出量とほぼ釣り合う結果となった．しかし、現実の流出過程では、脱窒過程により負荷された窒素は減少すると考えられるため、窒素流出量が窒素負荷量を上回ることは考え難く、提案原単位においても窒素負荷量を過小評価している可能性がある。また、本研究で使用した窒素流出量は平水時の観測値から算出したものであり、降雨時のファーストフラッシュによる窒素流出量が考慮されていない。よって、湖沼水質保全計画の原単位はもとより、提案原単位においてもその値は過小評価されている可能性がある。

流域における窒素負荷量を正確に算定することは印旛沼の水質改善のための基本的なアクションである。今後は調査研究を推進することにより、水循環・窒素循環の実態に即した原単位の算定を行う必要がある。最終的には物理性に基づいたプロセス指向の水・物資循環モデルにより定量的な窒素循環の認識が望ましいが、流域の多様性、物理プロセスの複雑さに起因する解決すべき課題が多く残されている。降雨時の窒素流出量の観測、窒素流出量の季節変化に関する検討、等の課題を解決しながらより実態に合った原単位を求めることにより、印旛沼への窒素負荷量の精度を高めていく予定である。

謝辞
千葉県環境生活部水質保全課には貴重な資料の提供を頂いた。また、印旛沼流域圏交流会の方々から貴重なご意見を頂いたことに感謝の意を表します。

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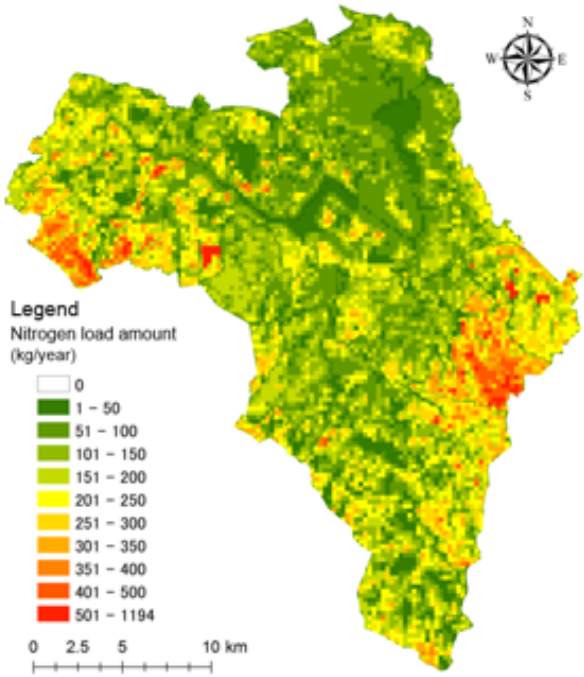
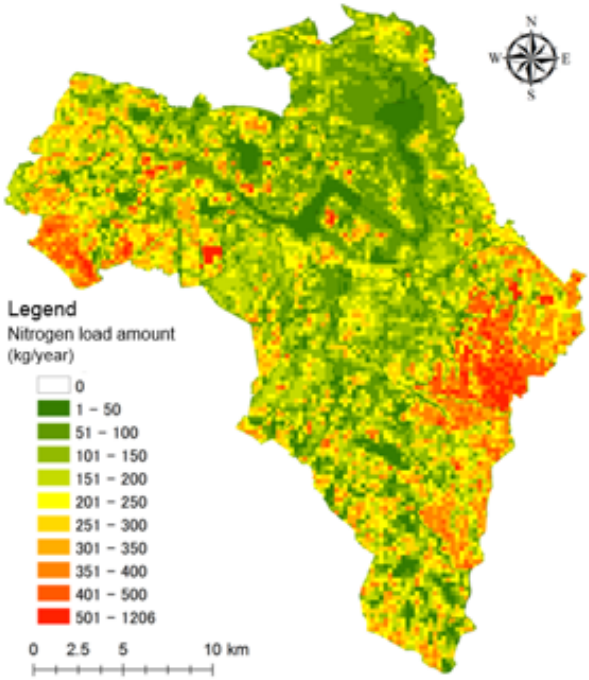
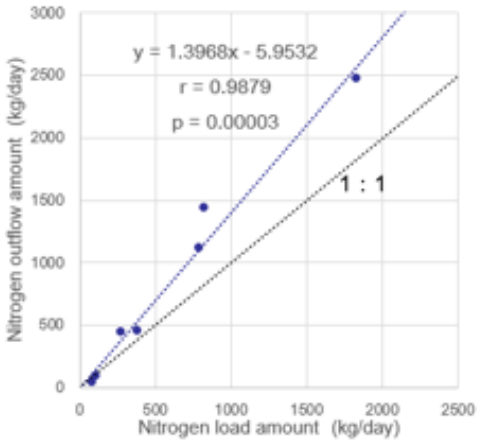
キーワード：窒素循環、原単位、脱窒
Keywords: nitrogen circulation, unit load, denitrification



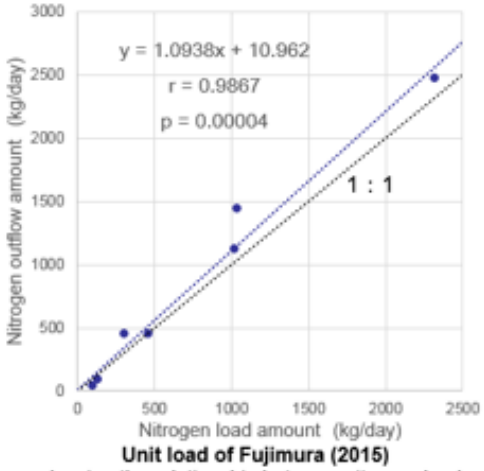
Nitrogen load amount distribution map
～Unit load of Lake Water Quality Conservation Plan～



Nitrogen load amount distribution map
～Unit load of Fujimura (2015)～



Unit load of Lake Water Quality Conservation Plan
Diagram showing the relationship between nitrogen load amount and nitrogen outflow amount



Unit load of Fujimura (2015)
Diagram showing the relationship between nitrogen load amount and nitrogen outflow amount

琵琶湖に生息する魚類の水銀濃度とそのヒト健康リスク評価
Mercury speciation in fish muscles from Lake Biwa and human health risk assessment

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Fish are exposed to metals via both aqueous and dietary routes. Some metals such as mercury (Hg) come mainly from dietary sources, with accumulation from aqueous routes providing a small contribution to the total Hg burden. Many studies have been conducted to understand the Hg accumulation focused on marine fish, however, only a few study has been conducted in fresh water. People who live near lake may also eat fresh water fish as well as marine fish. Therefore, it is important to understand the mercury concentration in fresh water fish as well as marine water fish. In our study, mercury concentration and other metals in fish was measured caught from Lake Biwa, the largest lake in Japan. Result from mercury concentration in fish, we estimated the human health risk caused from fish intake. Sampling was conducted during May 2011 to May 2012 sampling campaign. 82 fish sample, plankton sample, and water sample were sampled in Lake Biwa. Mercury concentration in fish muscle tends to be high as the trophic level going up.

キーワード：水銀、魚、琵琶湖
Keywords: mercury, fish, Lake Biwa

水の微量元素組成による地域特性化の試み
Regional characterization of river and spring waters by trace element signature

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食品の表示偽装が問題視されている近年、その原料産地を科学的に特定する分析技術が求められている。こうした背景から当研究室では、微量元素組成や同位体比を指標とした食品・農作物の産地判別法の開発を進めており、昨年度からは平成20年に環境省が選定した「平成の名水百選1)」の河川水および湧水を対象とした研究を開始した。水は食品の生産工程、および野菜や農作物の栽培において不可欠であることから、水の微量元素情報は産地判別のための重要な指標となる。水は岩石との相互作用で元素が溶出すると考えられ、地質などの地球科学的情報と関連付けた水の地域特性化が期待される。

日本全国40地点（河川16地点、湧水24地点）にて、超純水および10%硝酸で予め洗浄したポリエチレン製容器を用いて現地で採水を行い、3%硝酸を加え約4℃の冷暗所で保存した。孔径0.45 μmメンブランフィルターによるろ過により沈殿物を除去し、分析試料とした。軽元素（Na, Mg, K, Ca, Si）の定量には誘導結合プラズマ発光分析装置（ICP-AES：SPS3520UV）を用いて、その他の微量元素（Li, Al, V, Cr, Mn, Co, Ni, Cu, Zn, Rb, Sr, Ba, 希土類元素：REE）の定量には四重極型誘導結合プラズマ質量分析装置（ICP-MSS：Agilent 7500c）を用いた。定量下限を下回るREEはノビアスキレートを用いた濃縮を行った。分析には、内標準元素として115Inを添加し、検量線法を用いることで、20元素以上の濃度の定量を行った。またICP-MSの分析においては、一部の元素についてコリジョンリアクションセルを用いた干渉除去を行った。

まず検出された各微量元素の由来について考察を行った。Liについては、福島県の荒川、群馬県の神流川源流、山梨県の金峰山・瑞牆山源流で採水された河川水試料で高濃度を示した。この結果は、これらの河川源流では母岩がLiを多く含む花崗岩地質であるためと推察される。なお、他の河川水、湧水試料においては、上流が花崗岩地質ではないところでは、高濃度のLiは検出されなかった。また、富山県の弓の清水は多くのREEを高濃度で含んでいた。弓の清水の付近は堆積岩が広く分布しており、堆積岩中に含まれる燐灰石が風化した際、REEのリン酸塩として溶出した2）と考えられる。長野県のまつもと城下町湧水群は、分析した40試料の中でMg, Ca濃度が最も高かった。Mgは源流である美ヶ原高原の付近に堆積する凝灰岩、Caは石灰岩の影響を受けているとの指摘がある3）。また、高濃度のVが源兵衛川、湧玉池・神田川、十日市場・夏狩湧水群で検出された。いずれも静岡県、山梨県であり、玄武岩地質を反映していると考えられる。

以上より、湧水や河川水中の微量元素組成はその付近の地質を強く反映していることが示唆された。今後は試料の拡充を進め、さらなる地域特性化と食品の起源分析への応用を目指す。

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キーワード：水、微量元素、ICP-MS / AES
Keywords: water, trace element, ICP-MS / AES

伊豆諸島各島における水質と地質の関係性
Relation between water component and geological conditions in Izu Islands

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伊豆諸島を中心に、地質条件が湧水や地下水に与える影響を検討した。玄武岩質火山である伊豆大島、利島、三宅島、八丈島と流紋岩質火山である新島、神津島における湧水や河川水などの水試料全147試料についてICP発光分光分析法、イオンクロマトグラフィーを用いて、各種陽イオン、陰イオンの分析を行った。また、各島83か所における岩石試料の成分分析を蛍光X線分析装置(XRF)を用いて行った。

その結果、海水組成比Mg^{2}/Clと比較して玄武岩質火山地域の湧水・地下水にはMg^{2}の含有が多く、流紋岩質火山地域の湧水・地下水にはMg^{2}の含有が少ない傾向が見られた。

また、Mg^{2}/Ca^{2}を比較した結果、玄武岩質火山地域のほとんどの水試料と岩石組成比の一致が見られたが、大島の筆島付近で採水した水試料については岩石組成比とのずれが見られ、斑晶の多い筆島火山の岩石の風化プロセスとの関係が考えられる。

さらに、海水組成比SO^{2-}/Clと水試料を比較した結果、大島の一部と三宅島の水試料には火山ガス由来と思われるSO^{2-}が多く含まれていた。

キーワード：湧水、地下水、玄武岩質火山、流紋岩質火山、伊豆諸島
Keywords: spring water, groundwater, basaltic volcano, rhyolitic volcano, Izu Islands

離島の水環境に関する比較研究ー長崎県の島嶼を中心にー
A comparative Study on Water Environment of Isolated Islands - Focusing on Islands in Nagasaki Prefecture -

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Ⅰ　はじめに　日本には数多くの島嶼が存在し、その独立した環境のためそれぞれ独特の環境を呈する。その多くが比較的小規模で限られた空間であるため、農業などの人間活動のみならず雨水などの降下物の影響が大きく反映される傾向にある。しかし、対馬・壱岐・五島列島に関するものは比較的少ない。本研究では、それぞれの島の陸水や雨水の水質の特性を比較しながら水環境の現状を明らかにすることを目的とする。

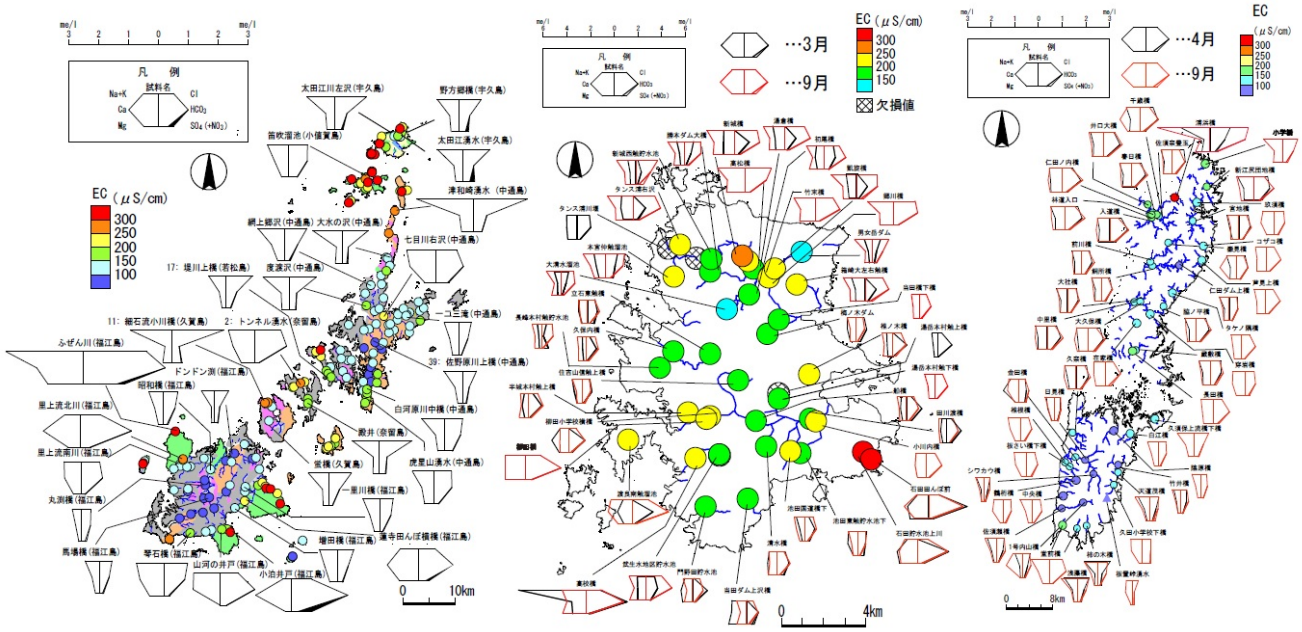
Ⅱ　対象地域　壱岐島は九州北部の玄界灘に位置する面積136.69km²で、地形がなだらかで島の各地に多くの溜池が分布する。対馬は面積約708 km²で壱岐島と比べ標高が高く約89%を山地が占め、大部分が堆積岩で表土も薄く岩石が露出する。五島列島は長崎港から西100kmに位置し総面積約690 km²で、北東から南西に80kmに渡り約140の島々が連なり、地形が変化に富み各島ごとに大きく地質条件が異なる。

Ⅲ　研究方法　2014～2016年の春季と秋季に水文観測を行った。現地で気温、水温、EC、pH、RpHを測定し、サンプルを持ち帰りTOCの測定、イオンクロマトグラフィーによる主要溶存成分の分析を行った。雨水についても毎月採取したサンプルを同様に分析した。

Ⅳ　結果・考察　ほぼ全ての島の陸水には海塩の影響が見られ、壱岐島では海塩よりも地質による寄与が大きく、対馬では上島と下島で水質組成が異なり、下島は風送塩の影響が顕著で、五島列島では地質や土地利用の影響が大きく、壱岐島や対馬と比較して硝酸が多く検出された。

Ⅴ　おわりに　今後は小流域での解析を進めてゆくほか、より各島における陸水の特徴を明確にしたい。

キーワード：壱岐島、対馬、五島列島、雨水、水環境
Keywords: Iki Island, Tsushima Island, Goto archipelago, rainwater, water environment



日本の活火山周辺の水環境　ー御嶽山・浅間山・箱根山を中心にー
A comparative study of the water environment around active volcano in Japan - mainly Mt.Ontake, Mt.Asama and Mt.Hakone

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Ⅰ　はじめに　日本列島には数多くの活火山が存在しているが、その形成要因や山体を構成する成分などは火山によって異なる。また、火山活動の影響で、火山周辺の河川や湧水の水質にも変化が表れることが予想される。そこで、2014年から活動が盛んになった御嶽山、浅間山、箱根山、の３つの火山地域において継続的な水質調査を行った結果を報告する。

Ⅱ　研究方法　御嶽山では2014年から、浅間山と箱根山は2015年から、それぞれ継続調査をしている。現地調査項目はAT,WT,pH,RpH,EC等である。現地では採水も行ない、持ち帰ったサンプルは、研究室にてTOC,主要溶存成分の分析などを行なっている。

Ⅲ　結果と考察

1．pHの比較　pHを比較すると、御嶽山、箱根山では、山体から流れ出る河川の中に酸性を示すものがある一方、浅間山ではアルカリ性を示す河川が多く存在する。

2．電気伝導度の比較　電気伝導度(EC)は、御嶽山の周辺河川で全体的に値が小さく、浅間山、箱根山の周辺河川で全体的に値が大きい傾向が見られた。特に、箱根山には3000μS/cmを超える河川が存在する。

3．溶存成分の比較　３地域とも、EC値の小さい地点は$Ca\text{-}(HCO_3)_2$型の水質組成を示す傾向が見られるが、値が大きい地点では地域によって組成に差が見られ、御嶽山では$Ca\text{-}SO_4$型の水質が多い。箱根山は温泉地ということもあり、$Ca\text{-}SO_4$型のほか、Na-Cl型やCa-Cl型の水質組成も見られる。浅間山は、他の地域と比べて、Mg^{2+}の比率が高い地点が多い傾向にあり、$Mg\text{-}(HCO_3)_2$型や$Mg\text{-}SO_4$型の水質組成が見られる。

Ⅳ　おわりに　活火山地域の水質の特性がある程度見えてきた。今後は条件を絞りつつ東北地方や九州地方にある火山地域についても調査を進め、さらに特性を明確にしたい。

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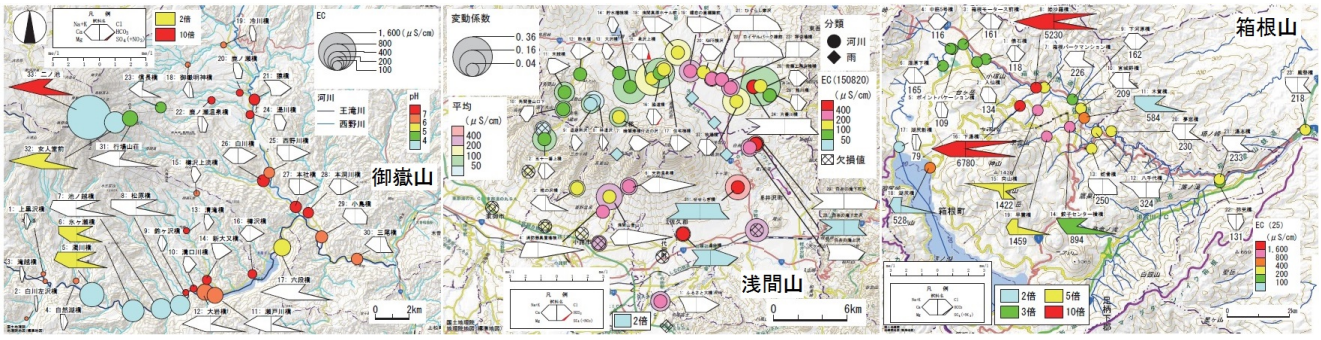
キーワード：活火山、噴火、水質、溶存成分、地質
Keywords: Active Volcano, Eruption, Water quality, Dissolved component, Geology



別府温泉の流動経路と微動アレイ探査によるS速度分布との関係
The relationship between flow path of Beppu Onsen and S velocity distribution by microtremor array survey.

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別府温泉では、大沢ほか(1994)及び、大沢・由佐(1996）により、別府温泉南部地域並びに北部地域における温泉水の流動経路が明らかにされている。これらの流動経路は、泉質ごとに3～4種類に区分され、立体的に重なり合いながら、分岐や変曲が見られる。

これらの流動経路と地質構造との関係を明らかにするため、半径0.6m～350mの微動アレイ探査を105地点で実施し、S波速度の三次元分布を明らかにした。

その結果、南部地域においては、標高-300mにある透水性が低い基盤とみられるS波速度の速い領域にNa-Cl型の温泉流路が遮られ、それらの両側に回り込んでいることが明らかとなった。

一方、北部地域では、Ca-Mg-HCO3型の流路が、標高-100～-200mにおける透水性が低いS波速度の高い領域にぶつかって北方に変曲していた。そして、標高-400～-600mでは、透水性が比較的高いS波速度が中程度の領域部分を、Na-Cl型の温泉が通過して東方に流下していた。

キーワード：別府、微動探査、温泉流動経路
Keywords: Beppu, microtremor array survey, Flow path of Beppu Onsen

Preliminary paleomagnetic results from the manganese wad deposit at the Niimi hot springs, Hokkaido.

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Paleomagnetic results are reported for the manganese wad deposit at the Niimi hot springs, Hokkaido, Japan. The hot spring is located at the foot of Mt. Shyakunage in the active Niseko volcanic area. The area is covered by Quaternary pyroclastics erupted from Mt. Syakunage. The manganese wad deposit was formed from the hot spring water by biomineralization processes. The hot spring’ s water emerges from a local spa that closed in March 2016 and forms two small waterfalls. Paleomagnetic analysis was done on 144 manganese wad specimens that were collected from a wall surface next to one waterfall. The wad was about ~65 cm in thickness and oriented specimens were collected with 7 cc non-magnetic plastic cube at 14 levels between ~5.5 cm and ~62 cm in thickness. Alternating field step demagnetization appears to isolate either one or two stable characteristic remanent magnetization (ChRM) components. The lower coercivity component shows clustered ChRM directions at each sampling level and likely retains paleosecular variation. Conversely, the higher coercivity component shows scattered directions. When the observed ChRM directions are compared with the paleosecular variation records for Japan, the duration of the manganese wad deposition appears to have lasted at least 600 years. In other words, the regional hydrothermal system has been active for at least 600 years.

キーワード：古地磁気学、マンガン土、熱水流体
Keywords: Paleomagnetism, Manganese wad, Hydrothermal fluid

