Runoff and erosion processes in a forested river catchment

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Behaviors of rainwater in the forest soil layer and its associated erosion processes were explored in the forested Oikamanai River catchment, Hokkaido, by setting a 4CH soil moisture profiler (10 - 40 cm depth) and five tensiometers (10 –50 cm depth) in the rainfall season of 2015. Water budget of the soil layer were estimated for some rainfall events in forest. As a result, a rainfall of total 58.0 mm in forest produced saturated throughflow in the tephra layer (Tarumae 1667 Ta-b) at 30 - 40 cm depth, which exhibited the high potentiality for eroding sand and mud grains.

Keywords: forest slope, tephra layer, saturated throughflow

Spatial distribution in sediment yield within watershed: fingerprinting source of suspended sediment from mountain to coast

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Information of source and runoff process of suspended sediment is crucial for better sediment management at not only the watershed scale but also the "source to sink" system from mountain to coast. To understand the dynamics of water and suspended sediment at the watershed scale, we conducted the hydrological observation, fingerprinting source of suspended sediment using natural radionuclides as tracers, and GIS analysis in the Mukawa River (1270 km^2) and the Saru River (1350 km^2), Hokkaido, northern Japan. From the results of fingerprinting, dominant source areas discriminated by lithology could be found to be different among the suspended sediment, dam deposit and coastal sediment. Suspended sediment, composed of silt and clay size particles, was found to originate mainly from sedimentary rock and metamorphic rock, which are lying in the mid- to down-stream area within the watersheds. Meanwhile coastal sediment, composed of fine sand, was found to be originated from plutonic rock and melange matrix of accretionary complex, which are lying in the upstream area. Susupended sediment yield for 4 years (2011-2014) was also quantitatively evaluated by hydrological observation and fingerprinting technique, showing the positive correlation with landslide density along the stream side, but not with shallow landslide scars mainly occurred by the catastrophic typhoon event in August 2003. These results were supported by field survey and exposure weathering test, indicating that the lithology underlying the watershed was dominant factor controlling recent suspended sediment yield.

Keywords: suspended sediment, landslide, watershed scale

Relationship between sediment production and beach formation in Japan

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Beach is an important space for disaster reduction, nearshore ecosystems, and leisure activities. However, interception of sediment transport due to rapid development of infrastructures caused beach erosion throughout Japan after 1950s. This study compares the sediment production with the beach width and its change after 1950s, and analyzes the effect of those development.

Keywords: Precipitation intensity, Sediment transport, Beach erosion

Water quality monitoring with high temporal resolution in a forested catchment and optimization of loading and solute concentration model

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Introduction

This study discusses on the long-term water quality monitoring with high temporal resolution in a forested small catchment using flow injection potentiometry and the multi-objective optimization of a conceptual hydrological model for simulating streamflow, loading and solute concentration.

Study Catchment, Water Quality and Hydrological Data

Study area is the forested experimental catchment of 12.14 ha located in Gojo city, Nara prefecture, Japan. Precipitation data were observed by tipping bucket rain gauge and streamflow data were observed by V-notch weir and water gauge at outlet of the catchment. Moreover, an in situ flow injection potentiometry (FIP) system to monitor the stream water quality (potassium, sodium and chloride) every 15 minutes for two weeks was developed and applied to the catchment (Tada et al., 2006). The precipitation and stream flow data every 10 minutes and daily potential evapotranspiration from May, 2007 through April, 2011 and sodium concentration data every 10 minutes estimated by liner interpolation from June, 2009 through April, 2011 were used to calibrate the loading model and solute concentration model.

Loading and Solute Concentration Model and its Optimization

The Long- and Short-Term Runoff Model (LSTRM, Kadoya and Nagai, 1988) composed of three storage tanks was used for streamflow simulation. The LSTRM has 14 parameters including 3 initial storage depths. The LSTRM combined four LQ equations of power type was used for simulating sodium loading and the LSTRM combined four CQ equations of power type was used for simulating sodium concentration. The four LQ equations (CQ equations) have 8 parameters and total number of parameters to be calibrated is 22. In this study, the 22 parameters were estimated by the following three steps based on the compromise programming (Yu, 1973; Zeleny, 1973; Tanakamaru and Fujihara, 2006). The minimization of Root Mean Square Error (RMSE) using SCE-UA method (Duan et al., 1992) was applied in each step. Step 1: Firstly 14 parameters of the LSTRM were estimated by streamflow data and secondly 8 parameters of LQ (CQ) equations were estimated by sodium loading data (sodium concentration data). Step 2: 22 parameters were estimated by using only sodium loading data (sodium concentration data). Step 3: Firstly, the objective space composed of horizontal axis of streamflow RMSE and vertical axis of loading RMSE (concentration RMSE) were set and the ideal point were plotted by RMSE values in step 1 and step 2. Secondly, the compromise solution is determined by minimizing the weighted Euclidian distance between the ideal point and a search point in the objective space.

Results

The Model-1, Model-2 and Model-3 were obtained in step 1, 2 and 3, respectively. The results of sodium loading simulation are summarized as follows: (1) Model-1 showed the smallest RMSE of streamflow and the largest RMSE of sodium loading in three models. (2) Model-2 showed the largest RMSE of streamflow and the smallest RMSE of sodium loading. (3) Model-3 showed the streamflow RMSE close to Model-1's error and the loading RMSE close to Model-2's error. The Model-3 optimized by the compromise programming can be evaluated the best by the comprehensive assessment of simulated streamflow and sodium loading. The overall results of sodium concentration simulation were similar. The time series of streamflow, sodium loading and sodium concentration estimated by Model-3 showed

good agreement with observed ones.

Keywords: water quality monitoring, flow injection potentiometry, loading and solute concentration model, Long- and Short-Term Runoff Model, multi-objective optimization, compromise programming

Variation of nitrite reductase gene *nirS* in denitrification process

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This study explores the use of microbial community analysis to evaluate the processes involved in nitrate attenuation in groundwater. Real-Time PCR (Polymerase chain reaction) is used to quantify nitrite reducing genes (nirS). It is suggest that the new method for detecting denitrification activity by comparing the gene dosage that has been detected by Real-Time PCR and the value of the nitrate $\delta^{15}N$ and $\delta^{18}O$ is effective.This study focuses on a variation of the nitrite reductase gene (nirS) that has been detected by Real-Time PCR through at the denitrification process by the column experiment.
Acrylic column which was used in the experiment is height 70cm, an inner diameter of 7cm. The bottom of the column was packed with crushed Ryukyu limestone, the upper was filled with soil. The analysis items, in addition to the DNA copy number of *nirS*, was selected inorganic nitrogen (NO_3^-, NO_2^-, NH_4^+), Total Organic Carbon (TOC), Inorganic Carbon (IC) and the nitrate $\delta^{15}N$ and $\delta^{18}O$.
As a results of the column experiment, oxidative environment had been maintained at the column packed with Ryukyu limestone. On the other hand, the formation of the reducing environment had been confirmed at the column packed with soil.
The variation characteristics of the nitrite reductase gene *nirS* in the denitrification process was understand by column experiment. In addition, a differences as the index of denitrification between *nirS* and the nitrate $\delta^{15}N$ and $\delta^{18}O$ was revealed.

Keywords: Denitrification , Nitrite reducing genes (nirS), Real Time-PCR

Feasibility Study for Tracing of Source Area of the Groundwater NO_3-N Pollution in Basin Using CFCs of River Water and Groundwater

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Chlorofluorocarbons CFC-12, CFC-11, CFC-113, which are primarily of anthropogenic origin, are often used to young groundwater dating. However, CFCs concentrations are extremely over record (EOR) in 40 % in sampling points of the well waters in Matsumoto basin as well as in other agricultural basin. The concentration of CFCs in EOR is also likely to increase with NO_3-N. Supposing CFCs with NO_3-N enrich along groundwater flow path, the source area of NO_3-N pollution can be identified by tracing the relationship between CFCs, NO_3-N and the location. In order to identify the source of NO_3-N in agricultural basin, we carried out feasibility study using CFCs. We measured the CFCs and SF_6 concentrations of river water at 19 points of three rivers, groundwater at 21 wells and air at 19 points along rivers in the Matsumoto basin. The CFCs' concentrations of river waters exponentially increase with distance and elapsed time in the direction from upstream to downstream up to air values of CFCs' concentrations, being close to average atmospheric CFCs' concentrations of north hemisphere. It is natural that the gradual increases of CFCs concentrations in rivers with distance and elapsed time reflects the process of gaining equilibrium between water and air. Moreover, CFCs' concentrations of river water at beginning point of mountain stream will correspond to the CFCs of spring, in our understanding. The NO_3-N of river waters decreases with distance and elapsed time in the direction from upstream, surrounding vegetable fields, to downstream, indicating dilution due to river water. On the contrary, the CFCs' concentrations of groundwater increase with NO_3-N from upstream, surrounding vegetable fields, to downstream along groundwater flow path, suggests CFCs with NO_3-N enrich in the groundwater. The relationship between CFCs and NO_3-N of river water and groundwater along groundwater flow paths is plotted around a same line, indicating that the source area of NO_3-N pollution of groundwater is identified to be vegetable fields.

Keywords: groundwater, Chlorofluorocarbons, nitric acid, groundwater pollution

Dynamics of sewage-derived nitrogen in the coastal area of a mega city

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Water pollution by human activities has been improved by sewage systems in the big cities. However, increase of sewage-derived material load during rainfall events and groundwater inflow to sewage pipes are recognized as new problems in recent years.
In the present study, we aimed to examine the dynamics of sewage-derived nitrogen in the coastal area of Osaka bay.

Accurate and precise quantification of atmospheric nitrate in streams draining land of various uses by using triple oxygen isotopes as tracers

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^{17}O anomalies were used to quantify the influence of changes in land use and population density between each catchment area on the fate of atmospheric nitrate by determining the areal distribution and seasonal variation in stable isotopic compositions including the ^{17}O anomalies ($\Delta^{17}O$) of nitrate for more than 30 streams within the same watershed. Nitrate in each inflow stream showed small annual average $\Delta^{17}O$ values ranging from +0.5‰ to +3.1‰, which corresponds to the mixing ratios of unprocessed atmospheric nitrate to total nitrate from 1.8 ±0.3% to 11.8 ±1.8%, with 5.1 ±0.5% as the average of all inflow streams. Although the annual average $\Delta^{17}O$ values tended to be smaller in accordance with the increase in annual average nitrate concentration from 12.7 to 106.2 μmol L^{-1}, the absolute concentrations of unprocessed atmospheric nitrate in the streams were almost stable at 2.3 ±1.1 μmol L^{-1} irrespective of the changes in population density and land use in each catchment area. We conclude that changes in population density and land use between each catchment area had little impact on the concentration of atmospheric nitrate. Thus, the total nitrate concentration originated primarily from additional contribution of remineralized nitrate from both natural sources, having values of +4.4 ±1.8‰ and −2.3 ±0.9‰ for $\delta^{15}N$ and $\delta^{18}O$, respectively, and anthropogenic sources having values of +9.2 ±1.3‰ and −2.2 ±1.1‰ for $\delta^{15}N$ and $\delta^{18}O$, respectively. In addition, both the uniform absolute concentration of atmospheric nitrate and the low and uniform $\delta^{18}O$ values of the remineralized portion of nitrate in the streams imply that in-stream removal of nitrate through assimilation or denitrification had small impact on the concentrations and stable isotopic compositions of nitrate in the streams, except for a few streams in summer having catchments of urban/suburban land uses. Additional measurements of the $\Delta^{17}O$ values of nitrate together with $\delta^{15}N$ and $\delta^{18}O$ enabled us to exclude the contribution of unprocessed atmospheric nitrate from the determined $\delta^{15}N$ and $\delta^{18}O$ values of total nitrate and to use the corrected $\delta^{15}N$ and $\delta^{18}O$ values to evaluate the source and behaviour of the remineralized portion of nitrate in each stream.

Landscape stoichiometry and biological nutrient recycling in the watershed ecosystem

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1. Introduction
Nutrient resources have provided us with economic prosperity and human welfare, whereas overexploitation of these resources poses a threat to disturbance of natural biogeochemical cycles of macronutrients, such as nitrogen and phosphorus. Such nutrient imbalances currently cause eutrophication, which in turn lead to drastic changes in community composition and biomass in the watershed ecosystems. Because of its scarcity relative to other macronutrients and its biological requirement, phosphorus plays a key role in controlling aquatic ecosystem processes. Here we will take a new approach, landscape stoichiometry, which links ecological stoichiometry with landscape ecology in order to understand dynamical interactions between nutrients and biological communities in the watershed ecosystems under human disturbances.
2. Materials & Methods
We conducted the synoptic research in the whole catchment of Yasu River, which is the largest tributary of the Lake Biwa Watershed. We set 59 monitoring sites at streams, which vary in terms of the land use patter in their catchment areas as well as stream size ranging from 1^{st} to 5^{th} order. For all of these sites, we measured total phosphorous (TP) and nitrogen (TN) concentrations and physical characteristics. We also collected GIS data in this catchment. We used a modified method for spatially referenced regressions of contaminant transport on watershed attributes (SPARROW), according to Smith et al. (1997). We estimated three variables of nutrient spiraling metrics for phosphorous (i.e., U: areal uptake which is the microbial uptake rate of phosphorous per unit stream area, v_f: uptake velocity as an index of phosphorous removal efficiency in streams, S_w: uptake length defined as the average distance taken for a phosphorous atom to be biologically turned over during the upstream-downstream movement), incorporating the above environmental and GIS data into the model.
At 30 out of 59 monitoring sites, we also collected epilithic algae from the river beds to measure their chlorophyll *a*, *b*, *c* concentrations as an index of the whole algal, green algal and diatom biomasses, respectively. We examined how much and which land uses load phosphorous into the streams, using the nutrient spiral metrics. We also examined how the resultant nutrient imbalance alter algal communities and their ability for phosphorous recycling.
3. Results
In the catchment of Yasu River, the TP concentration was higher in areas dominated by residential and agricultural land uses. Based on the nutrient spiral metrics, we estimated its non-point source loading (mol/km^2*day) from residential and agricultural areas as 1.34 and 0.26, respectively. The nutrient imbalance (TN/TP) due to the phosphorous loadings was the primary factor to determine the green algal biomass.
Our model showed that the U was higher in residential and agricultural areas and lower in forest areas. This trend was the same as the v_f. The S_w increased toward the downstream, in which most of phosphorous cannot be taken up by microbes. The U was significantly correlated with the green algal biomass.

4. Discussion
The nutrient spiral metrics revealed that residential and agricultural land uses are the main source of phosphorous pollution, which caused spatial variation in nutrient imbalances on the watershed scale. As previously reported, green algae can linearly respond to the phosphate availability, often dominating in the algal communities under eutrophication. Based on the landscape stoichiometry, we demonstrated that human land uses cause the nutrient imbalances, which can alter algal community composition and thus their ecosystem functioning, especially phosphorous recycling.

Keywords: Nutrient cycling, Nutrient imbalance, Nutrient spiral metrics, Ecosystem function, Phosphorous loading, Epilithic algae

Fig. 1

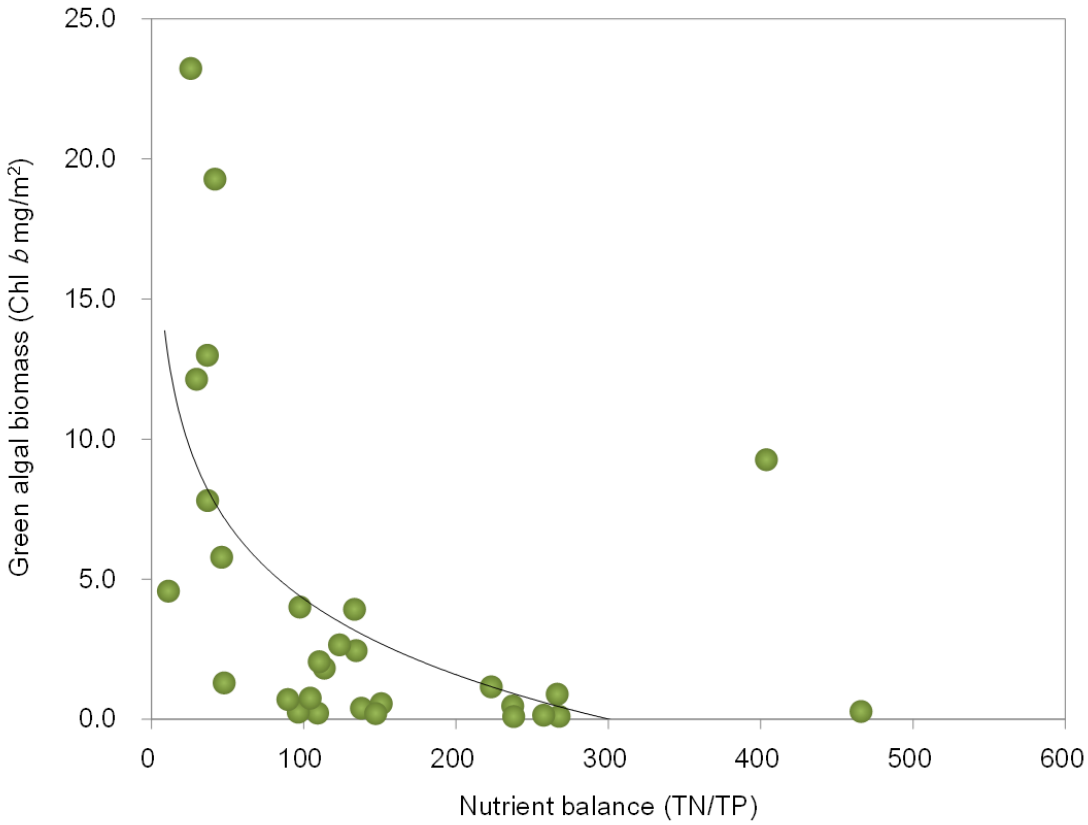
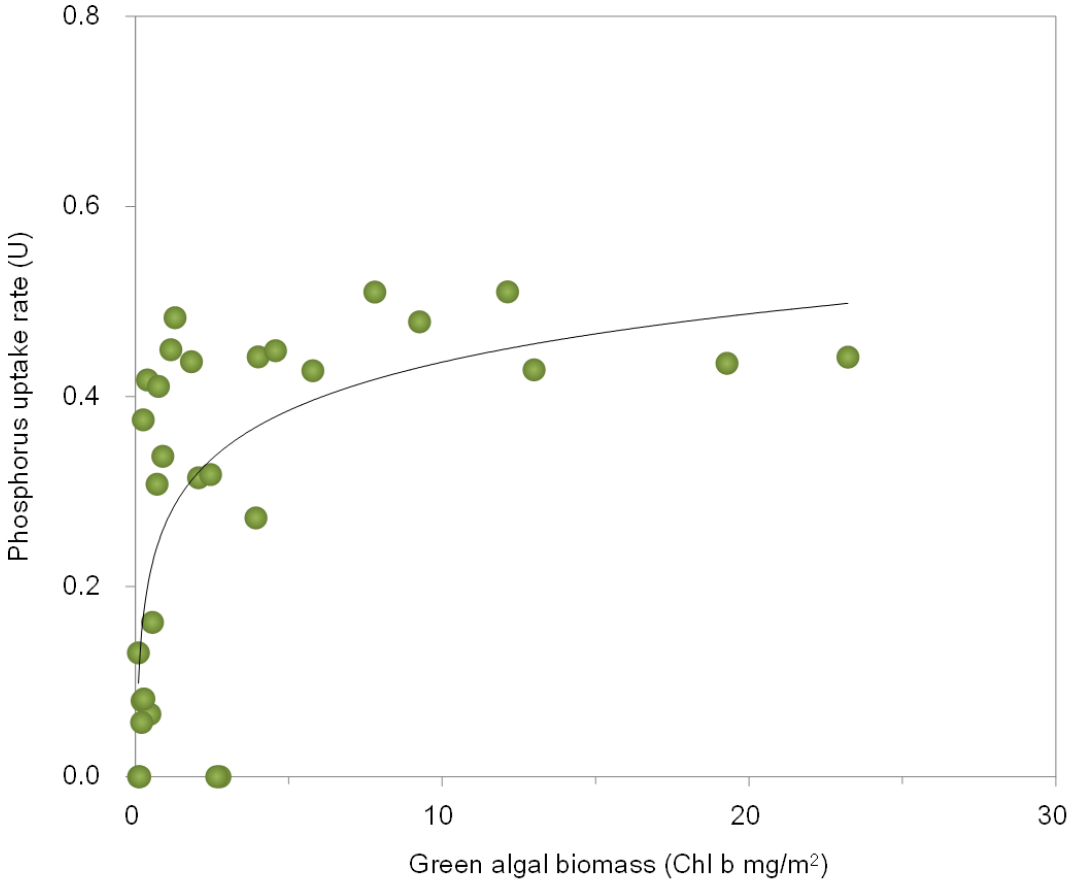


Fig. 2



Physiological responses in phytoplankton under nutrient-limited epilimnion in north basin of Lake Biwa

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In north basin of Lake Biwa, phytoplankton production has been shown to suffer from phosphorus limitation throughout the year, especially in the stagnation period every year. In this study, we determined physiological responses in phytoplankton under such P-limited environment using dilution-nutrients-enrichment experiments.
The experiments were conducted at 5 times from 14 June to 4 December 2013 at St. 3 (60 m depth) in north basin of Lake Biwa. Lake waters for the experiments were collected from 5-m depth with a Schindler trap and then filtered with a 200-μm-mesh net for eliminating meso-zooplankton. Another waters for measuring chlorophyll a (chl. a), nutrients and sestonic C, N, P were collected from 8 depth layers between 0 and 50 m. Simultaneously, vertical profiles of water temperature and photon flux density were determined with a CTD profiler. A part of the water collected was filtered with a capsule filter set (pore size, 0.45 μm), and then made 5 diluted lake waters with mixing to remaining non-filtered lake water. Three treatments for the experiments, adding NH_4Cl (20 μM) as +N treatment, KH_2PO_4 (2μM) as +P treatment and both as +NP treatment were prepared with control at all 5 dilution levels. All of the experimental bottles were incubated at in situ temperature and light conditions for 48 hours with a shaking incubator. Apparent growth rates (μ_{net}) were calculated using an initial and final concentrations of chl. *a* (chl_0, chl_t) at each experimental bottle with the following equation, $\mu_{net} = \ln (chl_t/chl_0)/48$. Grazing coefficient (g) was calculated using the μ_{net} for +NP treatment from the following equation, $\mu_{net} = \mu_{mean} - g\ x$, where μ_{mean} is potential growth rate without grazing by micro-zooplankton at each dilution, and x is dilution rate. Then, μ_{mean} for +N and +P treatments was calculated from the g obtained. Assuming that phytoplankton could use three nutrient sources, μ_{mean} could be calculated from the following equation, $\mu_{mean}(x) = \ln (1 + Kr\ x + Ki + Ke/x)/48$, where Kr, Ki, and Ke were growth coefficients for recycling nutrients, internal nutrient stock and external dissolved nutrients, respectively. Each growth coefficients were estimated with a stepwise multiple regression analysis. Lake water was strongly stratified from June to September, started vertically mixing at October, and then the mixing layer was deepened after that. NO_3-N concentrations were depressed from July to September, while recovered at October. PO_4-P conc. were always below the detection limit in the epilimnion. Seasonal changes of sestonic C:P and N:P ratios implied that phosphorus limitation for phytoplankton growth was likely in June to July, but relaxed after September. Dilution-nutrient-addition experiments showed that phytoplankton was exposed phosphorus limitation for its growth throughout the study period. Multiple regression analysis indicated that phytoplankton used internal and recycling phosphorus for growth in June to September, and that it used just internal one in October and December. Whereas, for nitrogen, it used recycling one for growth in June to September with lower ratios comparing to those of phosphorus, and internal one in October and December. These results suggested that recycling phosphorus from micro-zooplankton grazing supported phytoplankton growth under phosphorus-limited epilimnion in Lake Biwa. Phytoplankton used internal sources in both phosphorus and nitrogen for its growth in October and December. During this period, phytoplankton could stock nutrients recovering from the deeper layer due to deepening the mixing layer and then grow using the stock one.

Keywords: phosphorus limitation, phytoplankton production, recycling nutrients, micro-zooplankton grazing, Lake Biwa

Chromatographic determination of trace orthophosphate in water of North basin of Lake Biwa

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Introduction: Phosphorus is essential nutrient for primary production in waters and often acts as limiting factor in many lakes in Japan. Orthophosphate is thought to be the main chemical form of phosphorous directly available to organisms in water. For the determination of soluble reactive phosphorous (SRP) in water, spectrophotometry of reduced form of phosphomolybdate is widely used. However, there are some problems concerning interference of other oxoanions (arsenate (As(V)), and silicate) forming similar molybdenum blue complexes. Moreover, other phosphorus compounds such as polyphosphates and organic phosphates in natural water are hydrolyzed during the analytical process and release orthophosphate, which causes overestimation of orthophosphate in water. Although detection limit of this method can be improved at some tens of nmol/L to 1 nmol/L levels by using liquid waveguide capillary cell (LWCC) [1], the problems on interference of various compounds and CDOMs (especially in humic waters) were not solved [2].
Ion chromatographic determination has advantage to separate orthophosphate from other interfering compounds in natural waters. As detection limit of the method was not so enough in conventional analytical condition, we investigated both decrease in background conductivity and increase in injection volume to enhance detection limit below 1 nmol/L [3]. This method was applied to measure orthophosphate in waters of phosphorous limiting freshwater lake (Lake Biwa, Japan: mesotrophic). Obtained results of orthophosphate concentration was compared with those obtained by conventional molybdenum blue method (SRP).
Materials and Methods: Lake waters were sampled from April to October in 2015 at the north basin of Lake Biwa (35° 22' N, 135° 06' E, max. depth 90m). Waters were collected by X-Niskin sampler (Teflon coated, 5L) on the research ship Hassaka (The Univ. of Shiga Pref.). Samples were filtered with Acropak-200 capsule filter (0.8/0.2 micro meter pore size) onboard and stored in a cool dark container below 10 degree in Celsius. Orthophosphate concentration was measured by suppressed ion chromatography. Dionex AS-23A analytical column (250mm in length) was applied with electrochemical suppressor in electric suppression mode (external mode: supplying pure water as regenerant of suppressor membrane). Injection of high volume sample (5 mL) enhanced detection limit of orthophosphate to 1 nmol/L or less (blank peak hight < 0.2 nmol/L). SRP was measured according to the method JIS K0102 using ascorbic acid as reducing reagent. Micro glass cells of 50 mm path length (approximate volume: 3 mL), or LWCC (light path length 1000 mm) was used.
Results and discussion: Determined value of orthophosphate dynamically varied from 0.8 to 466 nmol/L. Eplimnetic water usually showed very low orthophosphate concentration in the range 0.8 to 8.8 nmol/l (0 to 40 m in sampling depth). From 50 m or 60 m to the bottom, orthophosphate concentration steeply increased regardless of the sampling dates.
SRP values were only obtained in the samples having concentrations higher than 68 nmol/L because of low sensitivity by 50mm cell. LWCC was also applied for SRP determination but enough performance was not obtained because of high blank absorption probably caused by contamination of reagents by phosphate impurity. By comparing the concentrations of SRP in hypolimnetic waters with those of orthophosphate by this ion chromatographic method, we found that orthophosphate content increased with the depth and almost matched with SRP values in the depth close to the lake bottom. This trend became more prominent according to the succession of the season from spring to autumn.
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(2012) Limnol. Oceanogr Methods 10, 568-580. [3] Maruo, Ishimaru, Obata et al (2016) Limnology 17, 7-12.

Keywords: Trace orthophosphate, Chromatography, Lake Biwa

Evaluation of inflowing nutrients from groundwater on nutrient input in Lake Biwa

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There are few studies on nutrient fluxes from groundwater into a lake. To evaluate nutrient cycling in a lake more in detail, however, it is necessarily to investigate inflowing nutrients from groundwater into the lake.
1) We measured groundwater levels at the two sites (depth, 1 and 2 m) constructed in southern (Yasu) and western coasts (Takashima) in northern part of Lake Biwa in 2015. 2) Radon radioisotope (^{222}Rn) concentrations were measured with a RAD7 at 500 m interval along the shoreline of the southern and western coasts, and surface water samples were coincidently collected. Oxygen stable isotope ratio (δ^{18}O), Chloride anion and nutrients (nitrogen, phosphorus, and silicon) concentrations were measured in the laboratory in order to evaluate inflow of the groundwater into the lake. 3) Those dissolved materials were also measured from the groundwater samples were collected in ca. 20 wells situated along the shore of the lake as well as those in river waters. In the eastern coast (Hikone), artesian groundwater was also collected because of aquiclude at 10m deep under the ground. 4) Lake waters at the surface, middle and bottom layers and interstitial waters in the bottom sediments were collected for measuring ^{222}Rn concentrations.
At the both sites of Yasu and Takashima, high pressures of groundwater indicated flow of the water to the lake under the ground. Spatial distributions in ^{222}Rn, Cl^{-1} and nutrient concentrations with those inδ^{18}O along the coasts also indicated discharges of groundwater into the lake. High concentrations of dissolved phosphorus phosphate (> 0.1ppm) were detected from several wells out of 15 ones investigated. Finally, ^{222}Rn concentrations were higher in the site of 20m deep than those in the littoral sites, suggesting higher possibility of groundwater discharges into the lake. This implies inflow of the artesian groundwater from the deep lake floor that has never known previously.

Keywords: Lake Biwa, Lake groundwater discharge, nutrient, confined groundwater

Experimental laboratory observation of freshwater lens under gaining river conditions

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Buoyant freshwater lenses may result from fluvial processes in saline aquifers common to arid and semi-arid regions. Freshwater lens is the precious freshwater resource in the riverine ecosystem, and revealing its occurrence mechanism is very important for the management of freshwater lens. Riverine lenses formed here under losing river conditions are conceivably unambiguous, and moreover recent mathematical analysis also indicates that a lens may persist under gaining conditions.In this study, we performed physical sand tank modelling of a riverine freshwater lens with gaining conditions. The experimental procedure is analogous to a steady-state unconfined head-controlled physical seawater intrusion model except that the saltwater is mobile ensuring that both density and hydraulic forces act towards the river at all times. A continuously flushing in-tank freshwater reservoir was implemented to ensure density contrast between fresh river water and saline groundwater remained consistent throughout each experiment.The experiment was replicated three times using different head gradients in each case. Results are presented as photographs of the sand tank lens at steady-state. Predictions made by the analytical solution for lens interface, surface extent and maximum thickness are compared with those observed in the photographs. Each experiment successfully reproduced the lens predicted by the analytical solution, notwithstanding the limitations of steady-state sharp-interface solutions. The results of this experiment constitute the first physical evidence of this lens type.

Keywords: arid and semi-arid regions, gaining river, freshwater lens, saline aquifer, sand tank modeling

Material cycles in Kojima Lake -From oxidation-reduction in the sediment to fish

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Kojima Lake is an artificially-made lake located at south part of Okayama Prefecture. The water quality has been deteriorated since 1959 when the lake was isolated by setting the closing levee at the mouth, which was constructed as part of land reclamation. Although the water quality has been gradually improved by several measures such as equipment of sewage treatment plants, fish production is still decreasing largely.
There are several numerical studies on material cycles of the lower pelagic ecosystem of the lake. Therefore, in the present study, we tried to expand the numerical study to the oxidation-reduction processes occurring in and around the bottom sediments at the sluice of the lake and also to the higher trophic level.
We conducted field observations at 5 stations both on water quality and sediment quality 4 times in 2014. Nutrient concentrations and dissolved metal concentrations were determined for water samples including sediment interstitial water. As for the sediment quality, water content, ignition loss, acid volatile sulfide concentration, and phosphorus content were also measured. Furthermore, water temperature, underwater fluorescence, turbidity, pH, and dissolved oxygen concentration were monitored at the central lake station.
A numerical model was constructed using a software, STELLA (isee systems, ver. 10.0.4), and the outputs were verified with the collected data and other published data. In the model, the lake area was divided into 2 sub areas because of the different of conditions in terms of sediment quality; the sediment is quite anoxic near the sluice due to seawater intrusion from out of the sluice which may derive sulfate reduction. Crusian carp, the dominant species in the fishery statistics, was incorporated in the model as 2 compartments, large fishing size group and small non-fishing size group. The calculation was made with a time step of 1/64 days and initial values obtained in the field observations and published data.
Seasonal variations of dissolved inorganic phosphorus (DIP), dissolved organic phosphorus (DOP) concentrations and others were well reproduced by the numerical model. Out of the total DIP loads to the water column in the central part, 60% was estimated as those supplied by the decomposition of organic matter in the water column. On the hand, 30% was from sediment decomposition in the sluice area. About 90% of total DIP loads was estimated to be consumed by phytoplankton. The primary production and decomposition of the produced organic matter are the main path in the system.
In the sensitivity analyses by increasing and decreasing of riverine phosphorus load, DIP load at 80% or less of the present level drastically decreased the small non-fishing size crusian carp biomass. It was understood that the nutrient load from the river is quite important to maintain the productivity of the ecosystem whereas the riverine load is only 15%.

Keywords: Brackish water, levee, oxidation-reduction, fish

Distribution of phosphorus carbon nitrogen and biogenic silica in sediment from Kojima Bay, Seto Inland Sea.

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River mouth estuaries receives large quantities of terrestrial derived nutrients via rivers and it is an important pathway for which transported to the sea. It has significant alternations on sediment accumulated nutrient and recycled nutrient has bought impact on local nutrient balance and eutrophication events. In central Japan from 1960s, coastal land reclamation has increased the terrestrial nutrient discharge from reclaimed agriculture farmland, meanwhile, the artificial dam lake has increased the nutrient retention which may have changed the nutrient pattern in this area. Our objective is to clarify the nutrient distribution along the river mouth area from central Seto Inland Sea area, clarify the possible impacts on nutrient accumulation and recirculation from artificial dam construction.
Two cores were taken by piston sampler and 27 surface sediment samples were also collected from Kojima Bay and connected artificial Lake, samples were analyzed for nitrogen carbon phosphorus and biogenic silica. ^{137}Cs and ^{210}Pb activity were determined for sediment dating and calculation of sediment accumulation rate. Surface sediment shows higher level of nitrogen and carbon accumulated in brackish bay and high level of phosphorus in the lake. In both cores, carbon and nitrogen contents decreased with depth, suggests the decomposition and released to the overlying water. N:P molar ratio shows 4 times higher in Bay than the connected lake. This suggests large nitrogen and organic matter resources supplied from several main rivers, and the phosphorus is accumulated less efficiency than nitrogen and carbon in the brackish bay. core profiles shows phosphorus contents increased after 1950s, with two peaks at 1970s and 2000s, indicates the hypereutrophic event in 1970s and accumulation of recycled P in the surface oxide sediment. Nitrogen phosphorus and carbon shows significant different between two cores, in core from brackish Bay, N:P ratios increased from 12:1 at surface to 16:1 at around 20 cm, then gradually decreased to around 5:1, suggests that over time proportionately more phosphorus than nitrogen is released and transported out of sediments, hypereutrophic events in 1970s (21cm) increased nitrogen discharge and still remains a peak in the core record. On the other hand, core from artificial lake shows relatively low N:P ratio from 3:1 at surface increased to 8:1 at 60cm, suggests the phosphorus is more mobile than nitrogen in these sediment. The biogenic silica shows a low content level before 1950s at 40cm and comparably higher level at from 1950s to 1990s. After 1990s. The biogenic silica content shows a decreasing trend and remains at low level until 2009. This may infers that before the dam of Kojima lake is enclosed, The higher river flow before the dam constructed may have a dilution effect on the Bsi retention in this area because the sediment Bsi is mainly reflected the history of water soluble silica content and the aquatic primary productivity of phytoplankton(such as diatom). The terrestrial resources and the water flow affect the retention of biogenic silica in sediment. After the dam enclosed, the water environment became stable and it is easier for the biogenic stabilization. The heavy nutrient inflow and eutrophication during 1970s leads to a boom of plankton, which may leads to a higher production of diatoms. It may result in the higher biogenic silica content in sediment during that time. After 1990s with the consumption of silica in the lake, decreased water soluble silica content decreased the production of diatoms and resources of biogenic silica. This may leads to the lower level of biogenic silica after 1990s.

Keywords: Sediment, Phosphorus, Carbon, Nitorgen, Biogenic Silica, Kojima Bay

Study on transport of particulate organic matter from river to ocean using carbon isotopes

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Global riverine discharge of organic matter to the ocean represents a substantial source of dissolved terrestrial matter and organic carbon particulates. The inputs and fates of terrestrially derived organic carbon discharged to the coastal ocean is still not fully constrained. To resolve the present situation, many scientists have been investigated using a variety of geochemical approaches such as delta^{13}C, C/N ratio and lignin biomarker analyses. Radiocarbon abundances have become an additional indicator of terrestrial versus marine sources because nuclear weapons testing in the 1950s and 1960s injected large quantities of ^{14}C into the atmosphere. This study reports the fate of riverine particulate organic matter (POM) in watershed with forest, paddy field and wetland at eight river systems in Japan by using simultaneous use of capitaldelta^{14}C and delta^{13}C.
We selected two rivers in wetland, Bekanbeushi and Kushiro Rivers, and six rivers in forest and paddy field such as the Ishikari, Saru and Teshio Rivers in northern part of Japan, Kuzuryu River in the central part and the Chikugo River in Kyushu Island in Japan. Suspended particles were concentrated with a single-flow continuous-flow centrifuge from 60-100 l of river waters. Organic carbon contents were determined using a elemental analyzer. Prior to analysis for the riverine suspended solids, carbonates were removed by adding 0.1 M HCl solution. ^{14}C measurements were performed by accelerator mass spectrometry at the Japan Atomic Energy Agency and the National Institute for Environmental Studies in Japan. The capitaldelta^{14}C is defined as the deviation in parts per thousand from the modern standard. delta^{13}C values were determined for sub-samples of the CO_2 gas generated during graphite production, using an isotope ratio mass spectrometer.
The paired capitaldelta^{14}C vs. delta^{13}C distributions vary with the river systems and divided into three groups. Riverine POM in wetland has lower in delta^{13}C and higher in ^{14}C rather than those of rivers in forest and fluvial plain. This indicates higher contribution of younger organic matter at the wetland river systems. The riverine POM has different ranges of delta^{13}C and capitaldelta^{14}C among the rivers running through forest area. The Teshio River samples are plotted in higher delta ^{13}C and capitaldelta^{14}C than those of other rivers. The Tokachi River has larger variations of delta ^{13}C and capitaldelta^{14}C values. On the other hand, the Ishikari and Saru Rivers are almost plotted in similar distribution area except for the spring snow melt sample of the Saru. The capitaldelta^{14} C values of Saru River are -296‰ to -247‰ for the summer and -720‰ for the spring samples. The similar result was observed for the spring samples of Tokachi and Bekanbeushi Rivers. The riverine POM with older age shows the presence of fossil organic matter such as bitumens or kerogen, and/or the entrainment of terrigenous organic matter of long residence times within the drainage basin. The Kuzuryu River system shows different distribution at the Kuzuryu and its brech river, Hino River. Consequently, the land-use type in the river watershed is related to the sources as well as the transport and sedimentation processes of POM.

Keywords: POM, radiocarbon, coastal sediment, AMS

Analysis of the river plume dynamics in Osaka Bay: a new estimation of sea surface salinity using ocean color satellite images.

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The riverine, low saline water, river plume, from the rivers into the coastal seas contains a large amount of the terrestrial organic matters to provide the nutrients in the environments of marine ecosystems and fishery grounds. However, the riverine water can often induce the harmful algae bloom such as red tide. Therefore, information of sea surface salinity (SSS) as an index of the low saline water draws increasing attention for not only researchers but also fishers from point of view of water environment conservation in semi-enclosed seas and fishery grounds. In date, not only SST maps but also SSS maps can be derived by satellites owing to development of the observational sensors and platforms. However, the resolutions of the conventional SSS maps are too coarse to estimate the SSS in the coastal seas with the large observational errors. Therefore, the technique to estimate the SSS in the coastal seas using satellites has been unestablished yet. The SSS has been known to highly correlate with the terrigenous, coloring dissolved organic material (CDOM) since the river plume in the coastal seas contains the CDOM discharged from the land. Using this relationship between SSS and CDOM, this study estimate the SSS in the coastal seas based on the CDOM map derived from the hourly products of the satellite observation to analyze the dynamics of riverine plume.
We used the hourly ocean color satellite images with the horizontal resolution of 500 m derived from the COMS/GOCI products to investigate the SSS dynamics in Osaka Bay because a large terrestrial runoff from Yodo River forms the distinguished river plume in the bay. The in-situ observations and water samplings using R/Vs were conducted in the flood seasons during the period from August through November to derive salinity and CDOM data in the sea surface. Further, we corrected the SSS data from regular observations conducted by several research institutes and automated observational stations to establish the estimation method of the SSS map from the CDOM map. The CDOM maps can be derived from the GOCI products. As a sample of the results, we show the dynamics of the river plume in Osaka Bay from a temporal sequence of the SSS maps in July to September, 2015, corresponding to the flood events induced by the typhoon approaches.

Keywords: ocean color satellite images, coloring dissolved organic material, sea surface salinity, river plume

Element fluxes through a small forested watershed at Hokuriku district

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In recent years, the concerns about the effects of atmospheric deposition on forest ecosystems, particularly on areas along the Sea of Japan, have been growing. On-site monitoring throughout the year is difficult in most of these areas because of heavy snow. Therefore, the dynamics and budgets of elements within forest ecosystems throughout a year remain to be elucidated. We began monitoring the cycles of major and minor elements in a small forested watershed at the Tedori River basin, Ishikawa Prefecture, Japan, in 2013. This study aimed to reveal the element dynamics and input-output budgets within a forested watershed in a heavy snowy region and understand the contribution of transboundary air pollution to the quantity of atmospheric deposition. The second aim was to compare atmospheric nitrogen (N) deposition in this mountain area to that of forests surrounding the Tokyo metropolitan area. The study site receives high rainfall throughout the year (2870-3350 mm $year^{-1}$). There were seasonal fluctuations in the influx of atmospheric deposition, particularly during winter when the quantities of most elements increased. Atmospheric N deposition from rainfall and snowfall was 23 kg ha^{-1} $year^{-1}$. N input quantity was similar or more than that reported in N-saturated forested areas of the Kanto district. Conversely, the output concentrations of most dissolved elements in stream water did not show clear seasonal fluctuations. Stream water nitrate concentration was stable and low.

Temporal changes in stream water chemistry during forest thinning and logging road construction

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Forest use and management are known to affect stream water chemistry. Research has demonstrated that NO_3^- concentrations tend to increase in streams after clear cutting, but it is still unclear how forest thinning operations affect stream chemistry. We have been monitoring stream water chemistry in an experimental watershed, and continued to collect data while the area was subjected to forest thinning operations and logging road construction in 2013. Our objective was to investigate the short-term effects of thinning operations on stream water chemistry in this experimental watershed.
Forest thinning operations included building logging roads beside streams. Japanese cedar (*cryptomeria japonica*) had been planted in this area. They were thinned using machinery: two planting lines per seven lines were logged. During thinning operations, slash was spread over stream channels. After the thinning was completed, the slash was used to cover the cut slopes of the logging roads.
During the thinning operations, we observed increased soil sediment in stream channels, and the concentrations of K^+, Ca^+, and DOC increased remarkably in streams. In contrast, NO_3^- concentrations decreased to almost undetectable levels. We also observed a thin layer of gel on the stream bed, which was likely a biofilm produced by aquatic microorganisms.
After the thinning operations were completed, K^+, Ca^+, DOC, and NO_3^- concentrations returned to pre-thinning levels. The increased concentrations of K^+, Ca^+, and DOC in stream water were likely to have been leached from the slash or the soil sediment. Additionally, the reduced NO_3^- concentrations were probably caused by an increase in aquatic microorganisms, which used the increased K^+, Ca^+, and DOC as nutrients.

Keywords: forest, stream chemistry, thinning

Quantitative relationship between sediment storage in dam reservoir and coastal erosion as the basis of future sediment management and planning

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Toward comprehensive sediment management and planning in future, the present study investigated quantitative relationship between sediment storage in upstream dam reservoirs and downstream coastal erosion as the basis of future sediment management and planning. Firstly, we mapped sediment storage in 966 dam reservoirs in Japan, where we employed total sediment volume stored since their constructions. Secondly, we estimated volumetric coastal erosion of the 71 Japanese coastal zones between 1903 and 1991. Thirdly, we calculated total sediment storage in dam reservoirs located in the upstream area of a coastal zone for all the coastal zones. And finally, we plotted total sediment storage in upstream dam reservoirs and downstream coastal erosion to find positive and significant correlation between them.
Based on the result that upstream dam sediment storage certainly increase downstream coastal erosion, we then explored a simple methodology to estimate dam sediment storage in future based on the relationship between hourly precipitation intensity and hourly sediment inflow to dam reservoir estimated by water inflow to dam reservoir and its turbidity. We found remarkable correlation between precipitation intensity and sediment inflow; hence we expect that future sediment inflow to upstream dam reservoirs and downstream coastal erosion could be estimated if hourly precipitation, water inflow and its turbidity are continuously monitored in the watershed of dam reservoirs.

Keywords: Dam reservoir, Coastal erosion, Future prediction, Sediment, River flow quantity, Turbidity

The feature of the suspended solid movement on an irrigation pond in the Abukuma Mountains

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In the present study, the movement of the suspended solids is examined for an irrigation pond that located in the nuclear disaster hit area after 2011.3.11. The characteristics were examined based on the site investigation on a pond located in the Abukuma Mountains, Fukushima prefecture. We will report the characteristics of mass balance of suspended solids.

Keywords: irrigation pond, suspended solids

Estimation of material flux from an abandoned agricultural watershed in coastal area of Seto Inland Sea, western Japan

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The objective of this study is to evaluate the impact of abandoned rice paddy on water and sediment yields in Tanijiri River catchment using SWAT model. The target catchment (2.6km^2) is located on a hilly and mountainous area near central Fukuyama City, Hiroshima Prefecture Japan. The rice paddy were distributed along bottom of valleys and uplands were distributed on hills although those has already abandoned according to land use map established on 2006. Calibration and validation processes were conducted using the observed data which were measured since 2007 because the data is limited only recent years except meteorological data. Then the impact was evaluated comparison of different land use map that are before and after abandonment of rice paddy. Changing hydrological processes due to abandonment was also validated using published papers and the observed data of field experiment that were conducted lysimeters that are filled with several rice paddy soils. As the result, the water and sediment yields were changed depends on elapsed years after abandonment. Especially, it is suggested that categories of former rice paddy; wet or dried rice paddy. Changing physical properties of the soils and intrusion of woody plants are suggested as sensitive factors as well.

Keywords: Material transport, Abandoned agricultural-forestry, Soil and Water Assessment Tool

Applying SWAT model to estimate effects to mitigate nutrient losses by improved fertilization in Ibaraki, Japan

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The aim of this study is to apply SWAT model to estimate water, sediment(SS), and nutrient movements of the rice paddy watershed (Sakura River basin, Ibaraki, Japan). The river is one of tributaries of Lake Kasumigaura, which is the second largest lake in Japan and whose water is used for domestic, agricultural and industrial purposes in spite of insufficient water purity. The area of the basin is 335 km^2, of which 29% is used as paddy fields and 20% as upland fields. The paddy fields are irrigated by Kasumigaura Canal. For modelling the basin characteristics, digital data including DEM (10m mesh by MLIT, Japan), land use data (100m mesh by MLIT), and soil map data (100m mesh by NIAES) were used. Besides, meteorological data at 3 stations, Soil-Profile Physical Properties Data set (“Solphy-J” by NIAES), irrigation water supplying data (Kasumigaura Canal O & M Office), and a general crop calendar were also used. The amount of domestic discharge was determined in proportion to the urban area of each sub-basin on the hypothesis that people live evenly in urban areas. The domestic discharge was assumed to have been added directly into the stream, because the saturation level of sewage was low in the upper area of the observation station located in the lower reach of the river in the watershed. Water, sediment (SS), Org-N, NO_3-N, Org-P, and Min-P were added constantly into the stream from every sub-basin in proportion to the calculated population of the sub-basin. The surface runoff was estimated with “Daily Rain/CN/Daily Route” method. For calibration and validation of the model, daily stream water flow data, and SS, TN, TP, NO_3-N, and Ortho-P data was measured a few times a month at the station. For model run, 3 years (2000-2002) was assigned to the warm-up, 3 years (2003-2005) to the calibration, and the following 3 years (2006-2008) to the validation. By adjusting several parameters, relatively good estimations were attained for daily stream water flow and daily SS (R^2>0.6, NSE (Nash-Sutcliffe efficiency coefficient)>0.6). Certain levels of correlation were gained for nutrients (Organic-N, Organic P, NO_3-N) with R^2 from 0.3 to 0.8 and NSE from 0.1 to 0.4. By introducing improved fertilization; smaller and more frequent fertilization, NO_3 discharge decreased by 20 %.

Keywords: SWAT model, nutrient discharge, improved fertilization

Water reuse and Spatial distributionof Nutrient in drought risk area, Marugame plain

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Global warming causes climate change in recent years and Japan is no exception. Risk of water shortages is increasing around the West Japan. The annual precipitation in Seto Inland Sea climate area is from 1000 to 1600 mm. Especially, the Kagawa prefecture receives only about 1082 mm of precipitation per a year. This value is the loweat in that area. The people have formed agricultural zone where they do original custom of water use (agriculture ponds and shallow groundwater)for decreasing drought risk. But groundwater contaminated with nitrate nitrogen matters in agricultural zone in Japan. The cause is mainly chemical fertilizer or compost and barnyard manure. In Kagawa prefecture, shallow groundwater is repeatedly used for agriculture. So, nutrient is condensed in shallow groundwater. But, Kagawa prefecture has many agriculture ponds in Japan and nutrient is consumed in agriculture ponds.
However, it doesn't reveal how is spatial distribution of nutrient in Surface water-groundwater chain system area. So, We confirmed spatial distribution of nutrient and water stable isotope ratio and revealed the effect of too much water use to water environment in this study area, Marugame plain.
The result indicates Kanakura-river in Marugame plain is affected by depuration
Shallow groundwater results show groundwater in upstream area contaminates with nitrate nitrogen by fertilizer, but groundwater in downstream area decrease nitrate nitrogen concentration by denitrification.
Agriculture ponds water's oxygen isotope ratio and chloride ion concentration
increase from upstream area to downstream area in Marugame plain. This result indicates that agricultural water eveporate. Nutrient balance considering eveporation in pounds show that supply of nutrient is higher than consumption of that in agriculture pounds in upstream area, but agriculture pounds in downstream area show opposite results. It can be said that purificating function of agriculture pounds is valid and the system which controls nutrient flowing to Seto Inland sea.

Keywords: Nutrient, Spatial distribution, drought risk

Study of the water environment evaluation method using aquatic organisms

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In order to evaluate the desirable water environment, it’s necessary to have the perspective of various water environmental factors in addition to water quality like Biochemical Oxygen Demand (BOD). For example, there are water quantity, aquatic organisms and the waterside environment. We can know the soundness of water environment by investigating aquatic organisms, because aquatic organisms are affected by various factors of water environment. Ministry of the Environment is considering the method that can be evaluated for water environment soundness using an average score per taxon (ASPT) of benthos in river. This method is called "Biological Monitoring Working Party System in Japanese version". The method has different advantage from the indicator of water quality like BOD. Civilians can understand more easily whether water environment is good, and have friendly feeling to the waterside. In order to improve the advantage of the method, it needs to set reference values of ASPT. In this study, we examined the setting of the reference values of ASTP based on BOD by analyzing the correlation between BOD and ASPT. As the results, we suggested that it’s more possible for ASTP to set reference values in middle basin of river than in lower basin.

Estimation of water quality improvement function of an abandoned meadow adjacent to mire area

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Konsen region, eastern Hokkaido, is one of the largest dairy farming area in Japan. In dairy farming basins, nutrients loading often cause eutrophication at downstream mires and lakes. Negative impacts of eutrophication have been concern for biodiversity and fisheries. On the other hand, recently, meadows which are not suitable for cultivation have become evident due to their poor drainage and wet condition especially in the margins of mires and rivers. Thus, reduction of pollution loads and effective utilization of abandoned meadows are important issues for dairy farming basins of eastern Hokkaido. Focusing on the nutrients retention processes in wetlands, we are considering about the role of abandoned meadows as buffer zone with water quality improvement function. In this study, we examined the nutrients dynamics in an abandoned meadow based on the observation of nitrogen and phosphorous concentrations in groundwater and surface water and the hydrological condition.

We investigated at an abandoned meadow in Tsurui Village, Akan District, which was located upstream of Kushiro-shitsugen National Park. We set a plot of approximately 100 m×175 m surrounded by open drainage ditches. The field was abandoned and covered by weeds including hygrophyte except for some areas where grass were cultivated during low water table period. We surveyed the ground elevation of 68 points in the plot. We comparted the plot into 28 cells of each 25 m×25 m. A well and three piezometers (30, 80, and 130 cm depths) were installed at the center of each cell. Water table was manually measured in the wells and piezometers in August and October of 2015. In addition, water level was automatically recorded from August to November at a continuously waterlogged point in the plot and drainage ditches on the north and south sides of the plot. Hydraulic conductivities were measured using piezometers at four points in the plot. Groundwater was sampled at each piezometer in August and October. Total nitrogen, total phosphorous, and ionic nitrogen and phosphorous were analyzed after filtration.

The ground surface in the plot gently down from the north to the south with an approximately 1/200 gradient. And the ground surface slightly down along the east and west drainage ditches. Continuous water level measurement in the plot showed about 52 cm change during investigation period. Almost the entire plot was considered to be flooded for the highest water level. Lower area on the east and west sides of the plot was continuously flooded and water depth reached a maximum of 64 cm at the lowest point. These indicated the study plot had similar hydrology with flood wetlands and groundwater level varied spatially according to the variation of ground surface. Similarly to the ground surface, groundwater level in October lowered from the north to the south and from the center to the east and west sides of the plot. Hydraulic conductivity represented the order of 10^{-8} -10^{-5} m s^{-1}, which was lower than those of peat in Kushiro Mire. Lower permeability of shallower layer implied the effects of tread pressure with farming vehicles. Because hard soil layer interrupts rain infiltration, surface water runoff would be likely to occur. Groundwater showed high nutrients concentration locally in the plot. The highest concentration of nitrogen was appeared at 30 cm depth in the center of the plot. The concentration decreased with depth and the peak moved toward the east drainage ditch. This implies nitrogen moved from some nutrients sources near the surface ground to the drainage ditch by advection and diffusion. Spatial distribution of nitrogen concentration was similar between August and October, though the concentration slightly

decreased across the plot. Therefore nitrogen export might occur throughout the investigation period. We plan to estimate nutrients retention in the abandoned meadow by the calculation of nutrients fluxes in the plot.

Keywords: Hydraulic conductivity, Nutrient, Peatland, Spatial distribution, Water level change, Waterlogging

Transportation mechanism of trace elements from river to the inside of paddy rice in river water system

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Some toxic and nutrient trace elements are often transported to paddy field through irrigation from river water. The transportation mechanism of toxic trace elements in a local river water system is important for sustainable, environmental conservation and for risk reduction. In order to clarify the mechanism for transportation and deposition of toxic trace elements from river water to paddy rice, we analyze the concentration of trace and major elements in two river waters, paddy field waters, and paddy rice, root, shoot, leaf, and grain, separately, in headwaters, which is in volcanic rock areas near Mt. Asama and Mt. Yatsugatake in Saku, Nagano. The number of sampling are at 15 points in waters of river and of paddy field, and 2 points in paddy rice in each Asama area and Yatsugatake area.
From the correlation between major elements and toxic trace elements, it is inferred that Fe-colloid works as an attracter due to sorption to trace elements in a river. In paddy field, some trace elements are likely to precipitate with Fe-colloid, and other trace elements in water-soluble state can infiltrate into soil. The following conclusions are obtained: 1) The toxic trace elements in river waters are with compatible major attracter elements; (a) Fe-colloid for (Cr, Cu, Ga, La, Zn, Cs, U) and (Ti, Al, Mn) in Mt. Yatsugatake area, (b) Fe-colloid for (Cr, Cu, Zn) and (Al) in Mt. Asama area, 2) (a) No attractor for (Se, Rb, Sr) in river water in Mt. Yatsugatake area, (b) No attractor for (Se, V, Ga, Ge, Sr, Y, Cs, Ba, La, U) and (Mn, Ti) in river water in Mt. Asama area. And 3) (As, Cd, Mn, Ni, Sb, Sr, Zn) are transported with Fe from root to shoot in paddy rice, while (As, Co, Mn, Sr, Zn) are transported with Fe from shoot to grain in paddy rice, and (Sr, Zn) are transported with Fe from shoot to leaf in paddy rice. Especially, we conclude that As is transported with Fe from root to grain through root in paddy rice.
From the described above, it is modeled that first, Fe-colloid works as an attractor of trace elements, transporting them to paddy fields, second, Fe works as a transporter of trace elements from root to shoot, however, from shoot to leaf, and from shoot to grain, some trace elements are transported and deposited in separating from Fe.

Keywords: toxic trace element, rice, river, colloid, Mt. Yatsugatake, Mt. Asama

Evaluation of the source and bioavailability of particulate phosphorus in Yasu River by using sequential extraction methods

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It is well known that primary production in Lake Biwa is limited by phosphorus, and that means phosphorus load into Lake Biwa influence on its environment. In general, it is considered that algae in lake use PO_4-P as a phosphorus nutrient, however, it has been revealed that a part of particulate phosphorus (PP) also might be used as nutrient in recent study. It has been reported that the load of PP discharged through river increases during ploughing and irrigating the fields or rainfall event, and most of the annual phosphorus load discharged through river is PP. However, there are a few studies that clarify the sources and bioavailability of fraction of PP discharged through river in Japan. The purpose of this study is to estimate sources of bioavailable fractions of PP discharged through Yasu river into Lake Biwa.
River water samples were collected from 5 sites in Yasu river once or twice a week from April 2015 to May 2015. Drainage from paddy fields were collected from Koka city, where locates in middle part of Yasu river watershed once a month between May and July. Furthermore, river water samples after rainfall event were collected from 10 rivers flowing into Lake Biwa on September 2015. After sampling, we separated several fractions of PP from suspended solids by sequential extraction methods (1M ammonium chloride, 0.11M bicarbonate dithionite, 1M NaOH, 0.5M HCl extraction) in water sample. In this method, PO_4-P is extracted from the particle fraction with high bioavailability in sequence. PO_4-P extracted from the particle fraction was determined by the molybdenum-blue method.

Keywords: particulate phosphorus, sequential extraction, bioavailability, Lake Biwa

Currents and nutrient environment in Lake Biwa

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Lake Biwa is the largest lake in Japan has experienced eutrophication and warming of water temperature through the past few decades. Because of rapid urbanization and industrialization in the lake and river basin, the water quality began deteriorating during the 1960’s and 1970’s, then eutrophication was accelerated. In the present study, we aimed to examine and overview the currents and nutrient environment in Lake Biwa based on the previous research.

The evaluation of the 100 best natural water sources in Hesisei period by trace elements and application for the origin estimation of foods

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Recently, fraudulent claiming of origin and safety control of foods have become a social problem in Japan, there is a growing need for a traceability of food's origin and manufacturing process. We have previously developed estimation methods for origin of grains, vegetables and beverages using inorganic chemical composition and isotope ratios. In the present study, we newly focused on Japanese natural water, especially water designated as "the best 100 natural water sources in Heisei period". The water is an essential resource having commitment in our life with wide range of application. Using trace elements solved in the water as a tracer, we examined regional characterization of waters with a view to application for origin estimation of foods.
Natural water samples were collected from 20 points (5 rivers 15 springs) over Japan using a previously-cleaned polyethylene container and have been stored in a cold dark place (~4℃). Deposits in water samples were removed by a filtration using a membrane filter (pore size 0.45 μm) prior to the analysis. While light elements (Na, Mg, K, Ca, Si) were analyzed by an inductively coupled plasma emission spectrometer (SPS3520UV), other trace elements were analyzed using a quadrupole inductively coupled plasma mass spectrometer (Agilent 7500c). ^{115}In was added to each water samples as an internal standard element, concentrations of more than 20 elements solved in the waters were quantified by a calibration method.
At first we considered possible sources of trace elements in water samples detected by our analyses. Concentrations of Li was characteristically high in river water samples from the Saitama and Yamanashi Prefectures. This is because the riverhead of these rivers runs over a granite layer containing Li. On the other hand, high concentration of V is characteristic in water samples from the Yamanashi and Shizuoka Prefectures. The *Natsukari Spring* in the Yamanashi Prefecture and the *Wakudama Pond* in the Shizuoka Prefecture are spring waters in the region consist of V-rich basalt rock. Similarly, the *Genbei River* is a river belonging to the *Sagami Riverine* system in which basalt rocks are widely distributed. Concentrations of Li and V of other water samples were not so high because geology of upper stream and waterbearing stratum of these waters are not granitic or basaltic. In the case of Cu, waters sampled from the Saitama and Gunma Prefectures showed high concentration. The *Tokura Spring a*nd the *Hotaka Spring* in the Gunma Prefecture are located around the *Ashio Copper Mine* known as mineral poison. Similarly, there is the *Chichibu Mine* with a skarn deposit near the *Bisyamon Spring* and the *Bukousan Spring* in the Saitama Prefecture. We could find good agreement between distributions of these three elements of water samples and concentrations in river sediments reported as the Geochemical Map by AIST. It is thus expected that these trace elements will be useful parameters for regional characterization of the natural water. Concentrated Al, Mn, Zn and rare earth elements were detected from a water sampled from the *Detsubo Spring* in the Akita Prefecture. The pH value of this water was 4.4, although averages of spring waters and river waters analyzed in this study are 7.2 and 7.8, respectively. Previous studies pointed out that the pH value of the spring water and the groundwater could decrease with an increase in organic acids by microbial activity under the specific environment such as a swamp. As the result, Al and rare earth elements would dissolve into the water from soil under the acid condition.
In conclusion, it was revealed that trace element composition of the spring and river waters obviously reflects their geological background.In the future, we aim to region characterization with a goal of application for the origin estimation of foods.

Keywords: water

Behavior of Arsenic in the Red River, Northern Vietnam

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The samples were collected from main channel and branches of Red River in Vietnam territory in rainy season (2013.7.26 - 8.4) and dry season (2014.4.10 - 21); river water (Rainy season: 29, Dry season: 45), and sediment (Rainy season: 4, Dry season: 18).

Ranges of total arsenic concentration of the main channel waters were 1.4-9.1 μg/L in the rainy season, 2.2-92.9 μg/L in the dry season. Arsenic concentrations were the maximum at the uppermost sampling point, close to border with China; 9.1 μg/L and 33.9 μg/L respectively. The value of the dry season was 3 times higher than the WHO standard (10 μg/L). Arsenic concentration decreased toward downstream, and was not exceeding the WHO standard in the all river water from the channel in the Red River Delta. Range of arsenic concentration of branches were 0.2-1.6 μg/L, 0.3-4.5 μg/L in the rainy and dry season respectively, and is lower than those of main channel. The main channel water was diluted by the inflow from the branches.

In the Red River, dissolved arsenic was more abundant than the absorbed one onto suspended particle. The dissolved phase of 50% was the lowest in the uppermost water. The rate of dissolved As increased toward downstream. The range of arsenic concentration in the rainy season is lower than in the dry season. It is suggested that arsenic concentration was diluted by abundant runoff derived from basement flow into the branches.

Arsenic concentration of 5 sediment samples collected from the main channel was 30.0-33.6 mg/kg and 2 samples gave 21.1 and 55.6 mg/kg. Unlike river water, arsenic concentration did not decrease toward downstream. There is no difference in arsenic concentration between the uppermost sediments from Lao Cai (30.0 mg/kg) and around that from the river mouth (31.6 mg/kg). Arsenic concentration of sediments from branches were lower than those from the main channel, and 2.8 mg/kg at the maximum.

Insoluble and oxidizable forms of arsenic was accounted for approximately 80%. The insoluble arsenic decreased toward downstream, while the oxidizable arsenic increased.

Arsenic and lead concentrations of sediments showed good positive correlation (R^2=0.92), suggesting the same origin. The lead isotope ratios were analyzed to estimate source materials. Lead isotope ratios of sediments (n=6) were $^{206}Pb/^{204}Pb$=18.572-18.766, $^{207}Pb/^{204}Pb$=15.727-15.739, suspended matters (rainy season:n=14, dry season:n=1) were $^{206}Pb/^{204}Pb$=18.516-18.667, $^{207}Pb/^{204}Pb$=15.701-15.737 in rainy season and $^{206}Pb/^{204}Pb$=17.611, $^{207}Pb/^{204}Pb$=15.586 in dry season. Relation between $^{206}Pb/^{204}Pb$ and $^{207}Pb/^{204}Pb$ showed that the most parts of lead in sediments and suspended maters had the similar origin. However, the correlation of sediments showed an positive inclination, on the other hand, that of suspended maters in rainy season showed negative inclination. This suggests that the suspended maters contained the lead from another source supplied from the branches to the single source of sediments in the main channel. The lead isotope ratio of sediments was different from those of ore minerals including lead (galena, sphalerite, pyrite) collected Yunnan where source area of Red River. Thus, these ores can not be source of arsenic and lead of Red River water.

Arsenic concentration of river water was in μg/L order, while those of the river bed sediments were in mg/kg order. Therefore, the most of arsenic is transported by the clastic particles, derived in the upstream China.

Keywords: Red River, Arsenic, Lead

Evaluation of river water-groundwater interaction and its effect to nutrient variation in Asahi River, Okayama prefecture

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Recent researches have shown the evidence of interactions between river water and groundwater-these interactions have affected the nutrient distribution and dynamics during the discharging. Our objective is to identify the river/groundwater interactions and estimate the nutrient variations along the river Asahi. Research field is located in the River Asahi of Okayama prefecture, western Japan. River water samples were collected from 50 sites along the River Asahi. Stable isotope of Radon (^{222}Rn) and nutrient concentration were analyzed in Hiroshima University. Seasonal variations of data were arranged in this research (February, June, and November, 2015)
Seasonal variations data shows radon(^{222}Rn)concentration was highest in summer(June, 2015), suggesting the high percentage of groundwater contribution in summer. It probably because large quantities of irrigation decreased the river water level in summer, groundwater discharge to river water increased than in other seasons. On the other hand, radon tends to increase release ability with temperature increasing.
The spatial pattern of Radon(^{222}Rn) distribution decreased from upstream to downstream in all seasons.
The results of nutrient showing that dissolved silica concentrations increased from February to November, suggesting the groundwater discharge increased from February to November. However, phosphorus concentrations were highest in June. Nitrogen concentration didn't show any variations throughout the research seasons.
In the last, we calculated and evaluated the nutrient contribution from river water/groundwater interaction processes in Asahi River based on the above data. Silica variations were mainly controlled by groundwater contributions. The ratio of silica supplied by groundwater was up to 60%. However, phosphorus variations were controlled by river water (surface water and tributaries). The ratio of phosphorus supplied by river water was up to 90%. Nitrogen variations were controlled by groundwater, as the disturbance of denitrification and biological turbulence, nitrogen concentration was lower than the estimated values. In nutrient cycle processes, nitrogen is considered to be supplied mostly from human activities however our results suggest another important nutrient pathway thorough water circulation. In Asahi River, nitrogen is dominant from groundwater, and river/groundwater interactions purify the nitrogen concentration.
In future, we will increase the research area from main stream to tributaries, in order to better evaluate the effect of river/groundwater interaction on nutrient dynamic.

Keywords: 222Rn, river water/groundwater interaction, nutrients

The migration of nitrate and possible impacts on groundwater of Ikuchi Island, Japan

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Nitrogen is one of major elements for crops, which directly affects the production of agricultural. However, excessive application of nitrogen fertilizers can lead to a variety of environmental issues. Therefore, it's important to investigate the mechanisms and magnitude of nitrogen migration.
Ikuchi Island located in Seto Inland Sea, is one of the most famous orange and lemon production areas in Japan. Orange and lemon groves cover 42% of this island. To maintain and improve the yields, much fertilizer (~2400 kg ha^{-1} $year^{-1}$) is applied during a whole year and nitrate contamination in this island was very serious (Onodera, et al., 2007). In order to evaluate the spatial and temporal variations of NO_3-N in soil water, several observation wells with different depth (10cm, 30cm, 50cm, 70cm) were installed in one square meter of space of one orchard in Ikuchi Island. 1000ppm of KNO_3-NO_3 and NaCl-Cl mixtures were shed on the surface of this one square meter of space in August 20^{th}, 2015. After that, water samples were collected from these wells every two weeks and analyzed for NO_3-N, Cl.
The results showed that the highest concentrations of NO_3-N in 10cm and 30cm, 50cm and 70cm were occurred in August 30th, 2015, the second water sampling time and September 15th, 2015, the third water sampling time, respectively. In addition, the peak value of concentrations of NO_3-N decreased with the increase of soil depths except 10cm. This may attributed to the fact that the interval time between the first and second water sampling was 10 days, the peak value of NO_3-N may have passed before we took water samples. From the relationship between the C_N/C_{Cl} (the ratio of concentration of NO_3-N and NaCl-Cl) and time, we found that the value of C_N/C_{Cl} from 10 cm to 30cm decreased very rapidly. Moreover, it's easier to collect water from 30cm than other depths, which may imply that place near to 30cm may be the most humid locations. Therefore, denitrification may take place in the depth from 10 to 30cm, resulting in the decline of NO_3-N concentration. The migration rates of NO_3-N in soil water were estimated to be about 3.0cm/day and 2.5 cm/day in the depth from 0cm to 30cm and 30cm to70cm. The groundwater level is about one meter in this area, NO_3^- would migrate into groundwater about 24 days later after 1000 ppm nitrate fertilizer was applied.

Keywords: Nitrogen, migration , Ikuchi Island, denitrification

Assessment of the spatial distribution of submarine groundwater and associated nutrients discharge along the Ikuchi Island coastline, Seto Inland Sea, Japan

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Ikuchi Island located in the central Seto Inland Sea, is an example of a classic oceanic island with no large rivers, high shoreline-to-land area ratio and steep topography. Due to small annual precipitation (1100mm) with large inter-annual variation, the island faces a risk of water shortage, especially in dry seasons. As an alternative water resource, submarine groundwater discharge (SGD) could potentially substitute as a water supply for irrigation. Estimation of SGD along the coastline is therefore crucial to develop a sustainable water management plan for people living in the island. What's more, Onodera et al. (2007) found that nitrate contamination of groundwater in Ikuchi Island was very serious, thus, the spatial distribution of SGD and associated nutrient fluxes along the shoreline of Ikuchi Island may also be important for reducing the occurrence of eutrophication in Seto Inland Sea.
To analyze the spatial distribution of SGD and associated nutrients, we performed a continuous ^{222}Rn and conductivity (EC) monitoring survey on a boat along the shoreline during December 22th, 2015. The total SGD flux was estimated to be 8.60×10^{6} m^{3} yr^{-1} based on the ^{222}Rn mass balance, which was in reasonable agreement with results obtained from the Darcy's law ($8.53\times10^{6}m^{3}$ yr^{-1}) and water balance calculation (8.55×10^{6} m^{3} yr^{-1}). A strong pattern in the spatial distribution of SGD was observed, with the highest values (>2.5 cm d^{-1}) located along the western part of the island due to the steepest topography and much lower population. The results from a nutrient analysis of the groundwater indicated that the associated nutrient fluxes loading through the SGD pathway were 109.6×10^{6}, 2.980×10^{6}, and 439.8×10^{6} g yr^{-1} for DIN, DIP and DSi, respectively, which were comparable to or even higher than the levels observed in the local streams. Therefore, adequate attention should be paid to the importance of SGD as one source of nutrients during the eutrophication controls process in this area.

Keywords: Submarine groundwater discharge (SGD), Radon, Nutrients , Ikuchi Island

Properties of water quality and groundwater flow in Okayama plain

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Coastal alluvial plains have typical properties of formation, sedimentation, hydrogeology, and water use etc. For example, groundwater recharge from a main river mainly occurs at the upstream area of the plain. But seawater intrusion occurs at the coastal area in case of over groundwater abstraction with less management. For coastal groundwater managements and sustainability, it is important to understand the vulnerability of them and confirm the risk stage, using tracer methods. Our objective is to confirm the groundwater flow and water quality characteristics of Okayama plain. We analyzed chemical composition and oxygen and hydrogen isotopic ratios of water collected at the observation sites.
Inorganic ion components of the groundwater indicated the transition from a river type to a marine type from the upstream area of the plain to the coastal line. The detail types are from Ca-HCO_3 type, Na-HCO_3 type, to Na-Cl type. In addition, hydrogen and oxygen isotope at the mid-stream site of the plain show different values from a river and sea water. This means different groundwater flow system with different recharge area.

Last 10,000 years variation of biogeochemical process in enclosed bay of a western Japan

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Some enclosed seas have a eutrophication issue, most of causes is due to anthropogenic supplies such as agriculture or human waste. But it is necessary to consider the background value or geological stock of nutrient in coastal regions. We aimed to confirm the geological stock and supply variation of the phosphorus in an alluvial plain for 10,000 years. Our research area is located on Okayama Alluvial Plain, western Japan. We drilled and collected the boring core of 6m to 19m at 4 sites. The each core was carried out the dating at the 2 depths, using 14C and volcanic ash. The core at the site of the mountain foot has sandy sediment, whereas another three cores at the coastal side has thick Holocene clay layer. The high phosphorus contents were found at the Holocene clay deposited in around 6,000 to 8,000 years ago under the sea level rising. These periods had rapid warming trend after the Last Glacial period, the increase of rainfall was also suggested. The increase of rainfall would cause the increase of sediment yield. The organic matters in soil are accumulated more in a headwater areas under the cooler climate because of the low decomposition rate, as compared with warmer climate. Based on the results and general present aspects, such high phosphorus content in the sediment is suggested that the organic matters including the phosphorus accumulated in the Last Glacial Period were eroded in headwaters and supplied to the coastal regions with the enclosed sea during the period from around 6,000 to 8,000 years ago with the warming and humid trend. After that, the organic phosphorus had been gradually decomposed, mineralized and released to the groundwater and sea. Such type of background phosphorus would also control the eutrophication and ecosystem environment in the enclosed sea.

Keywords: nutrient, enclosed bay, warming, last 10,000 years

Heat budget of hydrothermal ponds and its relation to geothermal flux in a neighboring deep lake: Kuttara Volcano, Hokkaido, Japan

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In order to know the geothermal activity of Kuttara Volcano, Hokkaido, Japan, heat budget of internal hydrothermal ponds is estimated and its geothermal influence on the neighboring deep Lake Kuttara (148 m depth in maximum) is explored. The major hydrothermal area in the geothermal region of Noboribetsu town consists of three hydrothermal ponds, Oh-yunuma (water surface area, 1.61×10^4 m^2), Okunoyu (9.0×10^2 m^2) and Taisho-Jigoku (2.6×10^2 m^2), and a small bubbling pond (4.1 m^2), where the bubbling of hot water continuously occurs. Heat budget of Oh-yunuma, Okunoyu and the small bubbling pond in 2013 –2015 showed mean geothermal flux at 2.8, 22.0 and 32.0 kW m^{-2}, respectively. It was found out that the neighboring Lake Kuttara increases both water temperature, T (℃), and electric conductivity, EC_{25} (mS/m), at 25 ℃ near the bottom at the deepest point (148 m) in thermally stratified periods of 2013 - 2015. The linear relationship between T and EC_{25} suggests that geothermal water leaks to the bottom. The geothermal flux at the bottom was calculated at a range of 0.50 - 9.3 W m^{-2} with mean of 2.9 W m^{-2}. With respect to the interannual geothermal-flux variations, a comparison between Okunoyu and Kuttara indicates that Kuttara responses to the geothermal variation of Okunoyu with a time lag of 5 months on average. Supposing a hydrothermal reservoir at ca. 100 m below the lake bottom, the time lag is explained by the Darcy law between the reservoir and lake bottom.

Keywords: hydrothermal flow system, geothermal heat flux, volcanic activity

