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

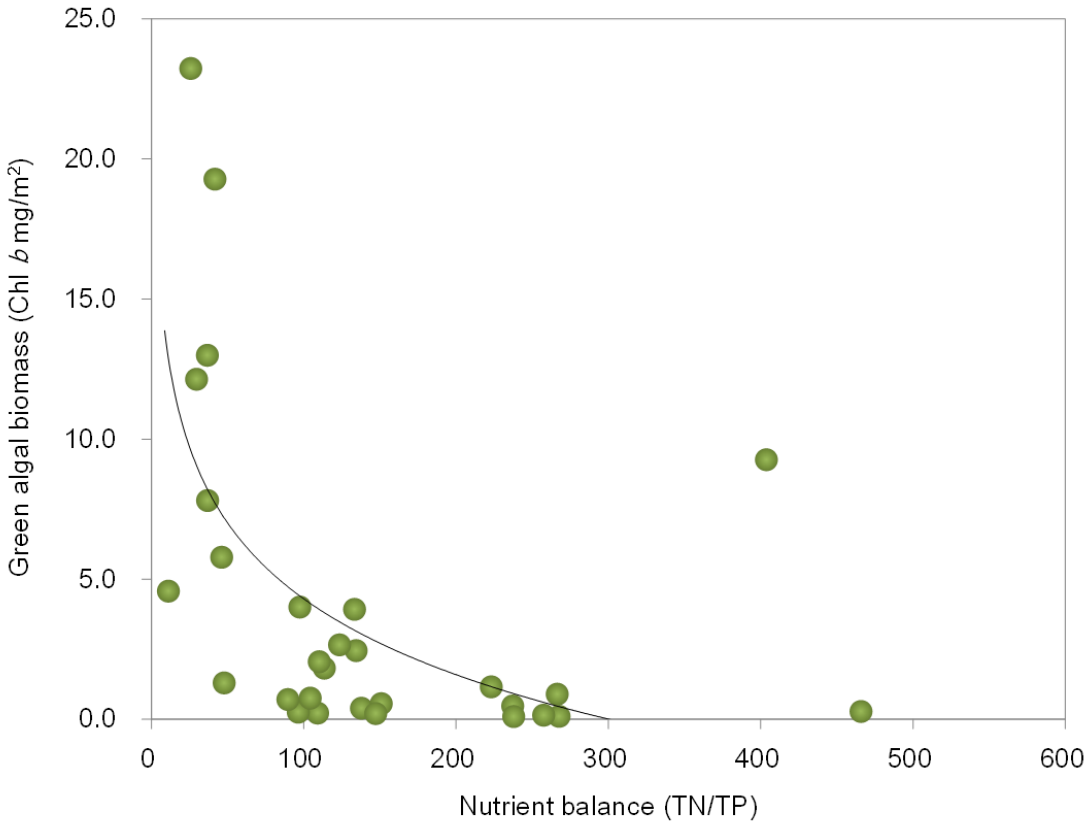
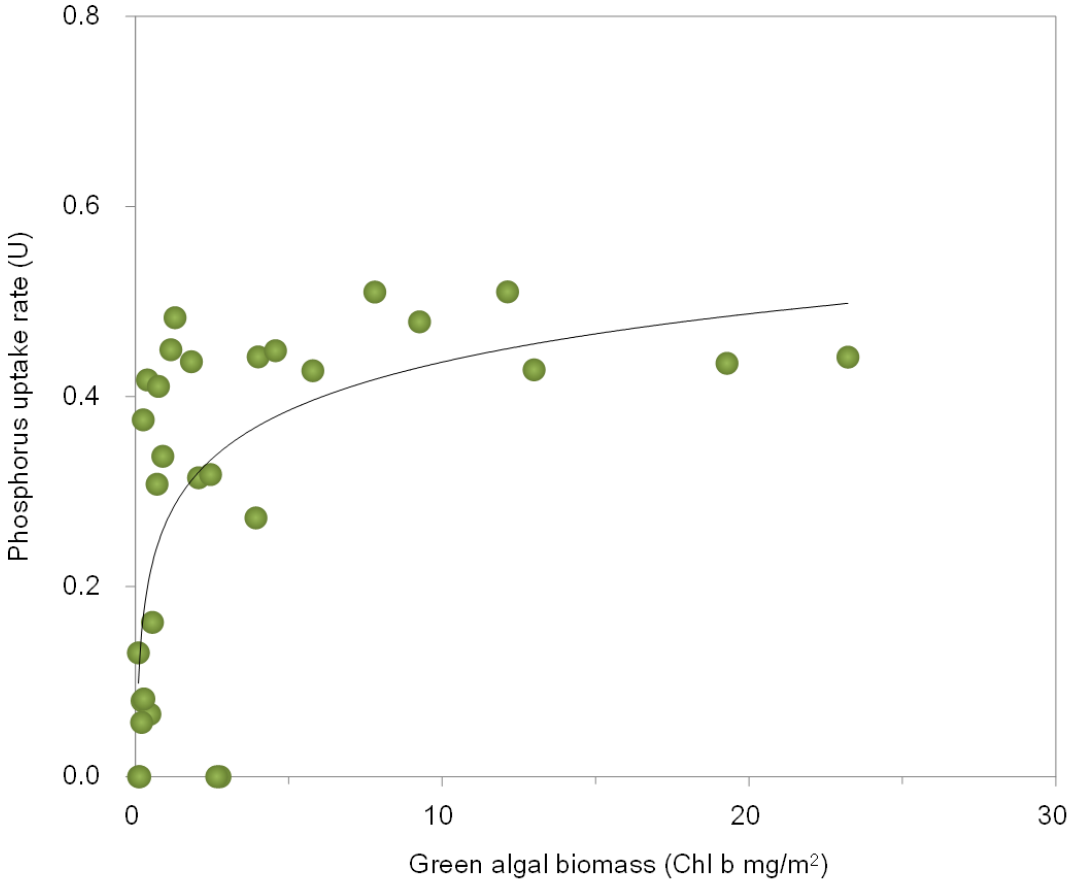


Fig. 2



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

