Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AHW30-01 Room:202 Time:May 22 14:15-14:30

Nutrient transport and surface water-groundwater interaction in the tidal river of a coastal megacity in Japan

Shin-ichi Onodera[1*], Mitsuyo Saito[2], Yuta Shimizu[1], Masashi Yoshikawa[1], Koki Onishi[1]

[1]Integrated Sciences, Hiroshima University, [2]Ehime University

In coastal megacities, sever groundwater depression and water pollution occurred. These impacts affected to river environment change. Especially, the river mouth area has been deposited the polluted matters. These areas have characteristics of water level fluctuation which causes river water-groundwater interaction and the associated change in dynamics of nutrients. However, these effects on the nutrient transport in tidal reaches and nutrient load to the sea have not been fully evaluated in previous studies. Therefore, we aimed to clarify the characteristics of the nutrient transport with the river water-groundwater interaction in the tidal river of Osaka metropolitan city. We conducted the field survey from the river mouth to the 7km upstream area of Yamato River, which has a length of 68km and a watershed area of 1070 km2. Spatial variations in radon (222Rn) concentrations and the difference of hydraulic potential between river waters and the pore waters suggest that the groundwater discharges to the river channel in the upstream area. In contrast, the river water recharged into the groundwater near the river mouth area. It may be caused by the lowering of groundwater level associated with the excess abstraction of groundwater in the urban area. The result also implies the seawater intrusion would accelerate the salinization of groundwater. The spatial and temporal variations in nutrient concentrations indicate that nitrate-nitrogen (NO3-N) concentrations changed temporally and it negative correlated with dissolved organic nitrogen (DON) concentrations. Inorganic phosphorous (PO4-P) concentrations showed the increasing trend with the increase of the river water level. Based on the mass balance, nutrient reproduction from the river bed was suggested in tidal reach. That was estimated to be 10 % of total nitrogen and 3% of phosphorus loads from the upstream.

Keywords: nutrient transport, surface-groundwater interaction, megacity, radon

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Effect of variation in the nutrient supply from terrestrial area on the coastal seaweed cultivation in the Hiuchi-Nada

Mitsuyo Saito[1*], Shin-ichi Onodera[2], Genki Hidaka[3], Minoru Tokumasu[4], Koki Onishi[2], Yuta Shimizu[2]

[1]JSPS PD, Ehime Univ., [2]Grad. School of Hiroshima Univ., [3]Hiroshima Univ., [4]Saijo city

Bad harvest of the seaweed (nori) is one of the recent severe problems in the Seto Inland Sea. In order to evaluate the factors influence on the seaweed cultivation, relation between the variation of the nutrient supply from terrestrial area and seaweed yield was examined for the last 40 years in the coastal area of Hiuchi-Nada in Seto Inland Sea. We also examined the effect of nutrient supply by submarine groundwater discharge.

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AHW30-03 Room:202 Time:May 22 14:45-15:00

Fluvial transport of nutrients along the river-to-ocean continuum in the Fuji River watershed

Iwata Tomoya[1*], Hayato AOYAMA[2]

[1]University of Yamanashi, [2]Hokkaido University

Riverine transports of nitrogen and phosphorus from watersheds can be an important flux that impacts the integrity of downstream and coastal ecosystems. Therefore, numerous nutrient-transport models have been developed to predict the nitrogen and phosphorus flux from lands to the oceans, but these models have paid rather less attention to the nutrient uptake from water column by stream communities. Recent empirical studies have increasingly identified that aquatic communities in river networks uptake and/or mineralize the large amount of river-borne material leaking from terrestrial ecosystems. However, the uptake rates of nitrogen and phosphorus by aquatic communities in the entire area of a river network from headwater streams to downstream rivers to estuary has remained unknown, especially in mountainous watersheds with high relief, such as watersheds in Japan. We developed the nutrient transport models that explicitly incorporate stream ecosystem metabolism in order to understand the roles of stream ecosystem function (i.e., nutrient uptake) in controlling the nitrogen and phosphorus flux to the coastal ecosystems.

We performed a field sampling campaign covering the whole area of the Fuji River watershed, central Japan, during September and October in 2010. In each of 107 study streams/rivers, we measured stream discharge, total nitrogen (TN) and total phosphorus (TP) concentrations, as well as other physico-chemical attributes. We then developed the modified version of spatially referenced process-based model (SPARROW) to predict the observed flux of nitrogen and phosphorus in the entire area of the Fuji river networks. The models describe phosphorus and nitrogen yields from watershed sources, terrestrial processes during their transports from the sources to rivers, and aquatic processes during their fluvial transports from upstream to downstream rivers. In the models, we formulate the aquatic processes as kinetic equations of stream metabolism, which depends on water temperature, photosynthetically active radiation, and/or substrate concentration.

The best predictive models revealed that rice paddies and orchards yielded the largest amount of TN and TP among the various landscape types, with the specific discharges both accounting for 46% and 66% of nitrogen and phosphorus exports from the watershed, respectively. Moreover, landuse affected the nutrient uptake by stream communities; the estimates of areal uptake rates were significantly higher in agricultural and urban streams than forested streams. However, our model also revealed that although stream metabolism was accelerated in highly impacted streams, the estimates of uptake velocity (vf) of nitrogen and phosphorus atoms from the water column were greatly decreased, implying the decrease of nutrient removal efficiency in these stream ecosystems.

The areal uptake rates were summed to calculate the basin metabolism of nitrogen and phosphorus in this river network. Those estimates showed that stream ecosystem can uptake the large amount of nitrogen (25t/d) and phosphorus (0.3 t/d), both contributing the 78% of nitrogen and 44% of phosphorus yields from the watershed sources. These results showed that the Fuji river network controls the nitrogen and phosphorus delivery to the coastal ecosystems. We argue that the management actions that do not consider the maintenance of stream ecosystem function may be insufficient for the controls of nutrient transports along the land–to-river-to-ocean continuum.

Keywords: Drainage networks, spiral metrics, nutrients, basin metabolism

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AHW30-04 Room:202 Time:May 22 15:00-15:15

Estimation of phosphorus budget in coastal lake using mass balance model and sediment core profile data

Guangzhe Jin[1*], Shin-ichi Onodera[1], Yuta Shimizu[1], Mitsuyo Saito[2], Atsuko Amano[3]

[1]Hiroshima University, Japan, Graduate School of Integrated Arts and Science, Japan, [2]Ehime University, Japan, Center for Marine Environmental Studies, [3]Institute of geology and Geoinformation Geological Survey of Japan ,AIST

In order to understand the processes of phosphorus retention and export in a eutrophic coastal artificial lake in western Japan, we estimated the phosphorus budget by the sediment nutrient data and a mass balance model approach from 1980 to 2008. The phosphorus flux from inflowing rivers is highest in summer period from June to August which contributes the 43% of annual average P input and is lowest at 9% in winter period from December to February. The phosphorus retentions determined by mass balance calculations were lower than those calculated from sediment total phosphorus concentrations and sediment accumulation rates. The mass balance results show around 400 tons of phosphorus was trapped in the lake from 1980 to 2008. Meanwhile the sediment core data shows the accumulation is about 3 times higher than that. It suggests that phosphorus release from sediment which was affected by the sever lake eutrophication in the 1970s contributed to the recent phosphorus cycle in the lake. The mass balance results suggest the phosphorus is trapped in the lake in all seasons except winter. The dominant period is in spring from March to May, which contributes an average of 57% of the annual average trapped phosphorus. The annual phosphorus trapped in lake calculated by the mass balance model has been decreasing from around 15 g m-2 year-1 in 1980 to around 0 in 2008. This result shows the decreasing trend of the nutrient flux into the lake, especially after the 1990s. However, core profile result shows a slightly increasing trend with variations up to 6 g m-2 year-1 in 2008. These different trends suggested the recovery of hyper eutrophication and high level of phosphorus recycle in lake is still continuing.

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AHW30-05 Room:202 Time:May 22 15:15-15:30

Effect of climate change on flood events as major driver of nutrient transportation in a suburban watershed

Yuta Shimizu[1*], Shin-ichi Onodera[1]

[1]Graduate School of Integrated Arts and Sciences, Hiroshima Univ.

This research aims to confirm the effect of climate change on flood events as a major driver of nutrient discharge. It was confirmed that small-scale flood events have decreased and extreme flood event has increased in western Japan. This trend leads that study catchment has advanced to polarization which has relatively low flows in base flow period and high flows in flood events. Accordingly, the capability of nutrient transportation during base flow condition has decreased. While amount of nutrient has accumulated inside of the catchment during drought period, large amount of nutrient will be transported in first flood event. It is like the first flush phenomenon on urban hydrology. It was confirmed that the mean N:P ratio of the catchment has been increased in recent decade. Although changes of human activities might be one of the reasons, it was suggested hydrologic changes also affected.

Keywords: nutrient transport, climate change, flood, drought, SWAT model

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AHW30-06 Room:202 Time:May 22 15:30-15:45

Factor analysis and classification of dissolved iron concentrations of Japanese rivers

Takeo Onishi[1*], Kaori Sakuma[2], Ken Hiramatsu[1], Shinichi Nishimura[1], Muneoki Yoh[3], Atsushi Masaki[3]

[1]Faculty of Applied Biological Sciences, Gifu University, [2]Midac Co. Ltd., [3]Graduate School of Agriculture, Tokyo University of Agriculture and Technology

Recent studies showed that dissolved iron transported through rivers may be an important source of iron in oceans. In cold and sub-cold regions, it has been found that wetlands which form reductive condition and accumulate un-decomposed organic materials are the main source of dissolved iron. However, it is unknown whether these findings can be applicable to watersheds in temperate regions such as Japan. Thus, in our study, we conducted statistical analysis to extract main factors governing dissolved iron concentrations of 408 points in Japanese 45 Rivers ranked as primary rivers and to classify them into several groups. We executed multiple regression analysis using climate conditions (annual precipitation and annual average temperature), topographical conditions (slope), geological types (5 categories), soil types (12 categories), and landcover types (10 categories) as explanatory variables of dissolved iron concentrations. The minimum parameter set providing the best fitted regression line was selected according to AIC values. In addition, for the classification of rivers, combined use of principal component analysis and cluster analysis was applied.

Result of multiple regression analysis reveals that while soil types such as gley soil, peat soil, and grayish lowland soils have a positive effect on dissolved iron concentration, landcover types such as building and golf course, soil type such as brownish lowland soil, and annual average temperature have a negative effects. Through multiple regression analysis, we succeeded to extract factors consistent with previous studies. Moreover, temperature and golf course are newly extracted but reasonable factors. By using extracted factors, we attempted to classify rivers into several groups and construct dissolved iron production curves. We need validation of obtained curves through applying them to regions with various geographical conditions.

Keywords: dissolved iron, landuse change, multivariate statistics

Japan Geoscience Union Meeting 2013
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AHW30-07 Room:202 Time:May 22 16:15-16:30

Geochemical characteristics of groundwater and its flow system in Miyagi Prefecture

Harue Masuda[1*], Ayaka Matsuyama[1], Kohei Yoshimoto[1], Shigeshi Fuchida[1], Kaoru Watanabe[1], Katsuki Okabayashi[1], Yusuke Katsuki[1], Fumie Chikaoka[1], Shinji Nakaya[2], Shuto Aoki[2], Phan Hoang Minh Ha[2], Tsuyoshi Shintani[2], Ryo Hirasawa[2], Reo Ikawa[3], Atsunao Marui[3], Teruyuki Maruoka[4]

[1]Osaka City University, [2]Shinshu University, [3]AIST, [4]Tsukuba University

Major and minor element chemistry, stable isotopes (H, O, S), and radiogenic Cs (134 and 137) were analyzed for of ca. 200 groundwaters and 30 river waters taken from Miyagi Prefecture from the March to November 2012 to evaluate the groundwater quality at present and draw groundwater flow system in and around Sendai Plain, which was surrounded by high mountains in the northern and western end and facing to the Pacific Ocean at the east. Sendai Plain can be divided into northern and southern plains by Matsushima hill, and two large rivers run in the basins of each plain; Kitakami and Naruse rivers in the northern plain, and Natori and Abukuma rivers in the southern plain.

Groundwater chemistry is different in between the northern and southern plains. In the northern plain, diluted Na-Cl type shallow groundwater (spring water and groundwater from $<$10 m depth) and riverwater are found in the high mountainous and hilly areas, indicating that the groundwaters of this area are not chemically immature and residence time would be short to react with the soils and sediments to dissolve the salts. Dilute Ca-HCO3 type shallow groundwaters are found in the plain basin as results of evolution of the water chemistry. In the southern plain, Ca-HCO3 type water appears in the high mountain area, and Ca and HCO3 concentrations become higher in the hill and inland basins. The groundwaters in the southern plain seem to be more mature than those in the northern plain. Along the coast, where Tsunami covered the ground in the 11th, March, 2011, seawater contaminated into the shallow Ca-HCO3 type groundwaters. The highest Cl concentration was 14000 mg/L, however, most of the seawater contaminated groundwaters contained ˜500 mg/L Cl. S isotope of sulfate ions also suggests the contamination of seawater. Deep groundwater ($>$10 m depth) occasionally gives Na-HCO3 type chemistry. Also, high Na-Cl type chemistry occurs in the deep groundwaters in Sendai of the southern Plain and Ishinomaki in the northern plain. Those would be results of salinization due to excess use or fossil seawater. Thus, the groundwater aquifers $>$10 m depth from the surface are commonly at stagnant condition in the studied area.

Hydrogen and oxygen isotopes of groundwater become smaller from east to west along NS direction, parallel to the coast and mountains, in the southern plain, however, such a variation is not prominent for the groundwaters in the northern plain. The isotope ratios of groundwater change corresponding to the sampling sites but not depths, indicating small catchments of the deep groundwater in the studied area.

Contamination of toxic elements such as As is found from shallow and deep groundwaters. Some of them are presumed to originate the oxidation of As-bearing pyrite in the Neogene aquifer sediments. As contaminated groundwater can be found in the groundwaters from Tsunami affected area, although the relationship of seawater and/or sediments carried by Tsunami to As contamination is not clear at present.

Radiogenic Cs was not detected from the all samples analyzed here, thus, the accident at Fukushima Daiichi nuclear power plant would not cause contamination of radionuclides in the studied groundwater at present.

Keywords: groundwater contamination, aquifer, Tsunami, radiogenic Cs, O, H, S stable isotopes, As

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AHW30-08 Room:202 Time:May 22 16:30-16:45

Traceability of SF6 and CFCs for Groundwater Flow in Matsumoto Basin, Japan

Shinji Nakaya[1*], Hideto Aoki[1]

[1]Shinshu University

Chlorofluorocarbons CFC-12, CFC-11, CFC-113 and sulfur hexafluoride SF6 are primarily of anthropogenic origin, while SF6 also occurs naturally. Groundwater dating by CFC-12, CFC-11, CFC-113 and SF6 is carried out in Matsumoto basin, central Japan, consisting of Quaternary sediments, in complex land use. CFCs and SF6 concentrations are extremely over record (EOR) in 40 % and 10 % in sampling points of the well waters, respectively. CFC-113 in EOR comes from industrial areas, indicates the source of SF6 in EOR in groundwater can be separated from industrial pollution of groundwater by CFC-113. CFCs in EOR must reflect the vertical infiltration of anthropogenic CFCs polluted surface waters in the basin. NO3-N is also likely to increase with the concentration of CFCs in EOR. The relationship between concentrations SF6 (Csf6) and CFC-12 (C12) indicates that groundwater flow can be explained as 'piston flow model' in shallow and deep aquifers in Matsumoto basin and that CFC-12 of three groundwaters are decomposed under DO $<$1.0 and pH $>$8. Although isotopic ratios of oxygen and hydrogen indicate that the source areas of groundwaters are mountains side of 1,500 m (a.s.l.) and highland of 800 m (a.s.l.) surrounding basin, the SF6 and CFCs tracers suggest that vertical infiltration of groundwaters from surface to well depth occurs within the basin. It is modeled that many recharged waters at mountain side move to the basin via river system and recharge again within sedimentary basin. Using SF6 tracer, average residence time of groundwaters ranges from 4 years to 37 years.

Keywords: groundwater, dating, SF6, CFCs

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AHW30-09 Room:202 Time:May 22 16:45-17:00

Water and Nutrients Dynamics in and around Eucalyptus Forests. Part 2

Norio Tase[1*], Shin-ichi Onodera[2], Tsutomu Yamanaka[1], Kenji Tamura[1], HAYASHI, Hisayoshi[1], Takaaki Nihei[3], TAKIZAWA, Sachika[1], Seongwon Lee[1], HIRATA, Ricardo[4], SARAIVA, Fernando[4], TERADA, Rafael[4], SHIROTA, Ricardo[4]

[1]University of Tsukuba, [2]Hiroshima University, [3]Hokkaido University, [4]University of Sao Paulo

Brazil is the biggest eucalyptus forestation country in the world, and 0.6% of a country or 3,500,000 ha is eucalypt forest already. Though there have been several studies reporting environmental impacts of eucalyptus plantation such as over-uptake of water and nutrition, biodiversity loss, volatilized or emitted harmful substances, in Brazil salient issues have not occurred. At first, this project evaluates scientific backgrounds and finds threshold conditions to environmental mal-impacts.

Based on verifying environmental functions of eucalyptus such as uptake of over excessed or contaminated nitrate from groundwater and soil erosion control, sustainable crop producing systems with coupling with eucalyptus plantation in land-use sequences could be proposed.

The study site, Rio Claro, is located 35km north of Piracicaba, Sao Paulo State of Brazil, where sugar cane field and eucalyptus forest are set out sequentially. Piracicaba area is covered by silty sand layers on the undulating peneplain. The annual mean temperature is 21.4 degree C., and average annual precipitation is 1279mm. The year of 2012 has an average annual rainfall though there was quite little rainfall in July through October. The stands of the eucalyptus are about 5 years old and their heights are around 15m. Sets of monitoring wells with 3 to 8 m-depth were installed, and groundwater chemistry is analyzed and water levels are surveyed regularly.

Water chemistry of groundwater, spring water and river water around the study site have relatively less minerals and nutrients, groundwater in the sugar cane fields are affected a little by fertilization, that is relatively high nitrate concentration.

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Keywords: Eucalyptus, Land-use sequences, Groundwater contamination, Environmental conservation, Brasil

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AHW30-10 Room:202 Time:May 22 17:00-17:15

Nitrate leaching in Andisol field under different organic matter management

Sadao Eguchi[1*], ASADA, Kei[1], IWATA, Yukiyoshi[2], KOGA, Nobuhisa[2]

[1]National Institute for Agro-Environmental Sciences, [2]National Agriculture and Food Research Organization Hokkaido Agricultural Research Center

Organic matter management in agricultural soils should affect not only the soil carbon accumulation but also the nitrate leaching to below the crop root zone. This presentation shows the monitoring results about the influence of different organic matter management systems in relation to the crop residue incorporation, cattle manure compost (CMC) amendment, and timing of CMC amendment in Andisol fields with loamy or sandy-gravel subsoils.

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AHW30-11 Room:202 Time:May 22 17:15-17:30

Migration of radiocaecium in forests with water flow through canopy, litter layer, and mineral soil

Masahiro Kobayashi[1*], Yasuhiro Ohnuki[1], Yoshiki Shinomiya[1], Toshihide Hiruta[2]

[1]Forestry and Forest Products Research Institute, [2]Fukushima Prefectural Forestry Research Centre

After the accident of the Fukushima Daiichi Nuclear Power Plant, a huge amount of radionuclides deposited over a wide range in Japan. In forested area, radiocaesium which has long half-life, first trapped mainly at the canopy and the litter layer, then will move to the mineral soil. The objective of this study is to clarify the migration of radiocaesium in forests with water flow through the canopy, litter layer, and mineral soil.

Throughfall (TF), litter leachate (LL), and soil water (SW) were collected in forested catchments in Ibaraki and Fukushima prefectures. The sampling plots were located in a conifer plantation in Ibaraki, and conifer plantation and deciduous secondary forest in Fukushima. Radiocaesium (Cs-134, Cs-137) of the water samples were measured by the gamma-ray spectroscopy using germanium detectors. The radioactivity measurements were made essentially without filtrations.

The concentrations of Cs-137 of the TF collected at the Ibaraki site in March and April 2011, immediately after the accident, were 14 - 60 Bq/L while the LL in the same period showed the concentration less than 10 Bq/L. A large proportion of deposited radiocaesium was thought to be trapped and held in the litter layer in the early stage after the accident. Then the concentration of TF and LL both increased in summer and decreased in winter.

In the Fukushima site, in which the sampling started from 2012, the radiocaesium concentrations (Cs-134, Cs-137) of TF and LL also tended to increase in summer. In late July, the concentration of LL from conifer plantation has once exceeded 100 Bq/L. This sample contained a noticeable amount of suspended particulate matter, and the radiocaesium concentration markedly decreased to 3 Bq/L after filtration.

The radiocaesium concentrations for SW samples were all under detection limit, suggesting strong capture of caesium by the mineral soil.

Keywords: Forest, Radiocaesium, Water flow, Litter layer