Nutrient circulation and biological production from forests to coastal waters

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We studied the effects of land-use and human activities on the circulation of nutrients and biological production in rivers and coastal waters in three watersheds in Kyoto and Oita prefectures. In Kyoto's Yura River dissolved phosphorus, dissolved nitrogen and dissolved iron densities did not show a clear relationship with forested area, but had significant positive correlations with farm lands and urban areas.Phosphorus limited phytoplankton production in the river waters and nitrogen in coastal waters. Dissolved iron was not a limiting factor of primary production in river or coastal waters. With regards to carbon utilization, some macrobenthos with cellulase consumed terrestrial organic matter in downstream and shallow coastal areas. In addition, carbon stable isotope ratio ($\delta^{13}C$) analysis suggested that seabass juveniles that migrated into the downstream areas grew on a trophic chain connected to terrestrial plants. We compared Oita's Katsura River, with a high forested area, and the Iroha River with low forested area. Nutrients, biodiversity and biological productivity tended to be higher in the Katsura River than in the Iroha River. It is possible that nutrients are supplied by forests within the Katsura River system. These results suggest that the structure of ecological linkage from forests to coastal waters is different in each watershed system.

Keywords: nutrient circulation, biological production, watershed

Variety of impacts of the freshwater-derived nutrients on the marine ecosystem

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The discharge of terrestrial freshwater and associated nutrients to coastal areas is considered to increase the growth of planktonic and benthic algae which in turn increases the biomass of filter feeders and the other fishery resources. However, species of the primary producers and their biomass that can receive the positive influence from the freshwater discharge are not consistent depending on many environmental factors: benthic substrate, residence time of the water mass, limiting nutrients, light intensity (turbidity), salinity and existence of dormant cyst etc. Furthermore, the impact from the increased phytoplankton will not be always positive. Some species enhance the growth rate of bivalves and zooplanktons as food sources, but the others damage the growth of the organisms severely by its toxins.
Rapidly grown phytoplankton during rainy season due to nutrient-rich freshwater could also contribute to the formation of the hypoxic water mass. Because organic matters derived from phytoplankton are generally labile components, they are accumulated and decomposed by bacteria under the thermocline in summer. Many studies suggest that the content of silica frustules, sulfur compounds such as dimethylsulfoniopropionate (DMSP) and other compounds varies depending on phytoplankton species and environmental conditions, which means that the decomposition rate and oxygen consumption rate in the water column should vary as well. Although this hypoxic water is known to cause mass mortality of benthic organisms, our recent studies suggest that the anaerobic autotrophic bacterial mat itself can be a potential food source for benthic filter feeders and the other organisms at a higher trophic level.
Therefore, to evaluate the impact of freshwater discharge on the fishery resources, it is important to consider various environmental changes and carefully monitor the marine environments in the long-term.

Keywords: Marine Ecosystem, Freshwater Input, Fishery Resources

Water-energy-food nexus: Effects of groundwater use as heat energy on fishery resources in the coastal area

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Water, energy, and food are the most fundamental resources for human well being and a sustainable society. Demands for these resources are estimated to drastically increase in the near future because of increases in population and changes in lifestyle. These three resources have also been inter-related, and make a “nexus” which causes tradeoff between resources and conflict between stakeholders. In this study, the groundwater-energy-fishery nexus is analyzed and evaluated in the snowy area of Obama City, Fukui Prefecture, Japan. The objective of this study is to evaluate the effects of groundwater used as heat energy for the melting of snow accumulated on roads, on fishery productions in the coastal area. The submarine groundwater discharge which carries nutrients into the ocean is reduced by excess groundwater pumping for melting snow. Positive correlation has been found between primary production rates in Obama Bay and radon concentrations which show the magnitude of the submarine groundwater discharge. Therefore, the increase in groundwater pumping on land may reduce fishery productions in the ocean. Results of 3D numerical simulations of the basin scale groundwater model show a reduction of SGD by 5 percent due to an increase in groundwater pumping by 1.5 times. This reduction of SGD caused a 3.7 ton decrease in fishery production under the aforementioned assumptions. The groundwater-energy-fishery nexus was found in Obama Bay, Japan and the tradeoff between water and food was evaluated.

Keywords: Water-energy-food nexus, submarine groundwater discharge, land-ocean interaction

Location estimation of submarine groundwater discharge from Mt. Fuji in Suruga Bay (III)

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Around the foot of Mt. Fuji, the main flow passages of groundwater are thought to be in the Younger Fuji volcano, which consists of the pervious basaltic lavas in new volcanic stage. Especially, the Fujikawa-kako fault zone, which stretches south to north in the southwestern side of Mt. Fuji, has a potentially effect on the local groundwater flow system into Suruga Bay. Therefore, precipitation at Mt. Fuji have been considered to be discharging partly from seabed in Suruga Bay and making a great impact on the biological production at the coastal sea area.
For the purpose of contribution to make sense of the rich coastal ecosystem in Suruga Bay, we conducted a survey for submarine groundwater discharge (SGD) in Oku-Suruga Bay: from the mouth of the Fuji River, at which the fault is found, to Tagonoura, where the lavas of the Younger Fuji volcano are distributed from 100 to 200 m below sea level. We tried to estimate some locations of SGD from bottom topography, condition of seabed and geological structure by using multibeam sonar, side scan sonar and sub-bottom profiler, respectively. We also used a remotely operated vehicle (ROV) for photographing for the image of the extrapolated spring points, sampled seawater containing sea bottom spring water and conducted water quality analyses. In this presentation, we introduce our works noted above.

Keywords: submarine groundwater discharge (SGD), Mt. Fuji, remotely operated vehicle (ROV), water quality analyses

Estimation of submarine groundwater discharge and associated nutrient fluxes in Otsuchi Bay, northeast Japan in summer

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Otsuchi Bay is a small semi-enclosed bay along the Sanriku ria coast. Although the watershed of the bay has large amounts of groundwater resources, the rates of groundwater input into the bay and associated nutrient fluxes are still unclear. In this study, we estimated the rates of submarine groundwater discharge (SGD) and associated nutrient fluxes into Otsuchi Bay using the radon-222 (^{222}Rn) and salinity mass balance model during the spring and neap tides in summer. As a result, SGD rates ranged from 0.10 to 1.07×10^{6} m^{3} day^{-1} (1.29 to 13.16 cm day^{-1}) with a mean of 0.43×10^{6} m^{3} day^{-1} (5.28 cm day^{-1}) during the four sampling periods. This value was similar to the annual groundwater recharge rate (0.63×10^{6} m^{3} day^{-1}) estimated by the water balance method in the whole basin. Estimated fluxes of dissolved inorganic nitrogen (DIN) and phosphorous (DIP) through the SGD were 50.2 to 511.6 kg day^{-1} and 0.4 to 4.2 kg day^{-1}, respectively. In contrast, these fluxes through the river water were 127.9 to 336.6 kg day^{-1}, 1.7 to 7.8 kg day^{-1}, respectively. Nutrient fluxes through the SGD were approximately 40 and 33 % of all terrestrial fluxes of DIN and DIP, respectively. In addition, DIN flux of the SGD was approximately 7.7 % of that of the oceanic water even though DIP flux of SGD was only 0.2 %. In Otsuchi Bay, the N/P ratio in bay water during the stratified period was often lower than Redfield ratio. Therefore, DIN supply from the SGD would have a non-negligible contribution on primary production during the stratified period.

Keywords: submarine groundwater discharge , Otsuchi Bay

Ongoing stress of transboundary air pollution: Assessment of effects of increasing nitrogen loading from the watershed on coastal ecosystem in Wakasa Bay

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Anthropogenic emissions of reactive nitrogen (N) due to fossil fuel combustion and modern agriculture practices have dramatically increased in global scale. In the Japanese watershed along the Sea of Japan, large amounts of reactive N emitted from northeastern Asia have deposited onto forest ecosystems, and thus N concentrations in river and groundwater have been increased year to year. Remotely modified N concentrations of terrestrial waters in local watersheds would affect coastal ecosystems. However, influence of N export from the watershed along the Sea of Japan on coastal ecosystem is still unclear. In this study, we assessed the effect of increasing nitrogen loadings from the watershed on coastal ecosystem in Obama Bay using the sediment cores. Mean sedimentation rates estimated from $^{210}Pb_{ex}$ within the bay increased from 0.13 g cm^{-2} yr^{-1} in 1960-1980 to 0.55 g cm^{-2} yr^{-1} in 2000-2015. Corresponding to long-term increase of N concentrations in the rivers, nitrogen contents of the sediment cores that were mainly composed of marine autochthonous organic matter have also increased year to year. These results suggested that an increase of nitrogen loading from the watershed would promote production rates of autochthonous particulate organic materials. In addition to N-limited condition of the past, a drastic decrease of seagrass and seaweed might facilitate remarkable increase of sedimentation rates and nitrogen content.

Keywords: sedimentation rate, eutrophication, nitrogen deposition, Sea of Japan

Long term variation in dissolved oxygen and COD budgets in the inner area of Ariake Sea in summer

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[Introduction]
In the inner area of Ariake Sea, the hypoxia occurs every summer now. Since it induced massive kills of bivalves, it became a big problem. The increase in oxygen consumption by organic matter decomposition is one the potential mechanisms for the long term increase in hypoxia. In the inner area of Ariake Sea, the monitoring of the Chemical Oxygen Demand (COD) in water has been carried out for the index of the concentration of the organic matter. Therefore, in order to clarify the long term variation in the bottom DO in summer and to understand the mechanism of the variation, we made data analysis.
[Data and methods]
The data we used are the monthly monitoring data taken by the Saga Prefectural Ariake Fisheries Research and Development Center and the Fukuoka Fisheries and Marine Technology Research Center Ariake-Sea Laboratory from 1972 to 2014. And also, the river discharge and riverine input of COD through the 4 class A rivers (Chikugo, Yabe, Kase and Rokkaku River) flow into the inner area of Ariake Sea were used. As the river discharge and COD loads, the dataset by Tezuka et al (2013) and supplement until 2014 were used. The bottom DO in the inner area of Ariake Sea in summer fluctuates largely affected by the variation in stratification caused by the river discharge. Therefore, In order to remove the effect of the variation in stratification, we calculated the potential of hypoxia DO_s using the method by Hayami et al (2006). In order to understand the mechanism of the long time variation in COD, we made a box model analysis of COD for the inner part of the Saga and Fukuoka waters (Fig.1). We calculated the average salinity in the box 1 and 2 during 11 consecutive years. Using these salinities and river discharge, the salinity budget for the box 1 was calculated to get the water exchange flux between the box 1 and 2 (q). Using q, river discharge, riverine input of COD and the average COD in the box 1 and 2 during 11 consecutive years, we calculated the COD budget for the box 1. From this calculation, we got the internal production of COD in the box 1. It is the balance between the organic matter production by algae and the consumption of organic matter by grazers.
[Results and discussions]
The DO_s in the Saga water in July decreased from 1970s to early 90s then recovered slightly (Fig.2). The COD in the bottom water in July increased from 70s to early 90s then decreased slightly (Fig.2). There was a strong negative correlation between DO_s and 11 year running mean of the bottom COD (R=-0.94).
The COD in the box 1 in July and August increased from 80s to early 90s (Fig.3). There are 4 potential reasons for this increase, 1) the increase in the initial value (COD in June), 2) the increase in internal production, 3) the decrease in the fluxes by advection and water exchange and 4) the increase in riverine input. The flux by water exchange decreased and the advective flux and riverine input remained almost in the same level (Fig.4). The initial value increased from 1986 to 1988 but then decreased. On the other hand, the internal production increased. It means that the organic matter production in the sea increased or the consumers of the organic matter (grazers) decreased. In the same period, the catch of bivalves in Saga and Fukuoka prefectures decreased. Moreover, there were oyster reefs of the area of 546 ha, but it decreased to 161 ha now (Fisheries Agency, 2011). These facts indicate that the decrease in grazers actually occurred. The increase in

COD without the increase in terrestrial input suggests that such increase in COD was due to the organic matter production in the sea. Moreover, these results suggest the negative feedback control that the decrease in bivalve lead the increase of phytoplankton and it lead the increase of organic matter in the bottom water to decline the bottom DO with the decrease of the benthos.

Keywords: long term variation, dissolved oxygen, chemical oxygen demand, box model, Ariake Sea

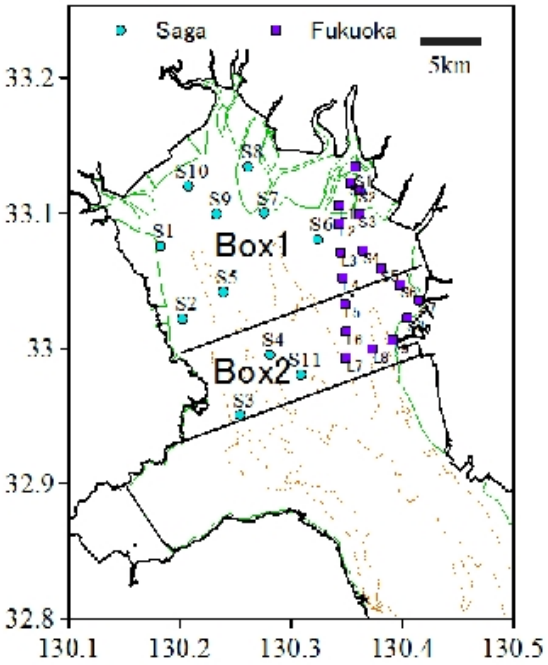

Fig.1 Map of the inner area of the Ariake Sea and location of the observation stations.

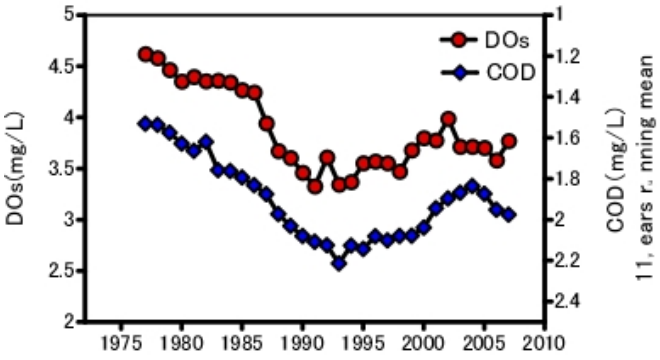

Fig.2 Variations in DO_s and COD (11 years running mean) in the bottom layer in Saga water in July.

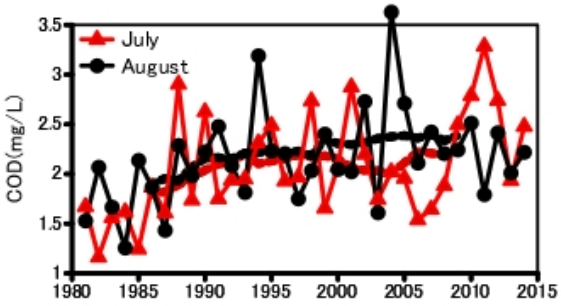

Fig.3 Variation in COD in Box1 in summer. Brocken lines are 11 years running mean.

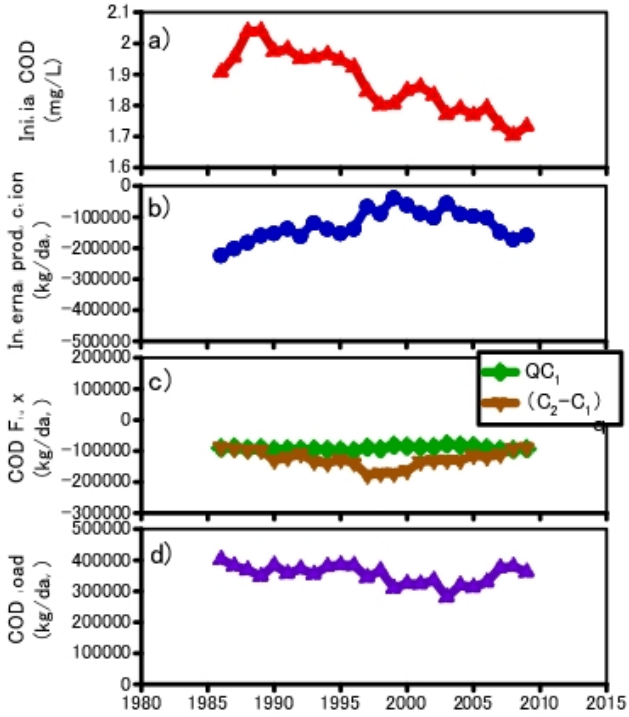

Fig.4 Variations in a) initial COD, b) internal production of COD, c) COD flux by advection and water exchange between box1 and box2 and COD load from rivers.

Stable isotope analysis of surf clam *(Pseudocardium sachalinense)* in Hamanaka Town, Hokkaido, and the connection between Kiritappu Wetland and coastal waters

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The suspension-feeding benthos surf clam *Pseudocardium sachalinense*, living on phytoplankton, benthic microalgae and detritus, is one of the most important marine products in Hamanaka Town, Hokkaido. We measured stable carbon and nitrogen isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) and carbon-nitrogen (C/N) ratios of surf clam (adductor muscle and stomach contents), oceanic particulate organic matters (POM), oceanic sediments, riverine POM and soil as well as physical and chemical parameters such as temperature and salinity, chlorophyll-a and nutrients in April through September, 2015 in coastal areas in Hamanaka Town, Hokkaido. We also examined the food sources that support surf clam, the possible connection between wetland and coastal waters, and also spatial and seasonal variation. Additionally, taste comparing and free amino acid analysis were conducted for further investigating taste differences of surf clam in different fishing areas. The results show that taste of surf clam was different among fishing areas, which might be caused by the difference in free amino acid content. Our results also show that the isotope and C/N values of surf clam and oceanic organic matters were significantly different from those of riverine organic matters, and that there was no significant difference among the fishing areas. This means that land-derived organic matter is not direct food source of surf clam and land-derived organic matter does not affect the coastal environment. Also, benthic microalgae and epiphytes are considered to be the major food sources of surf clam in all sampling seasons since they have close isotope and C/N values to surf clam. The overall results imply that excess inflow of land-derived organic matter may harm surf clam and the coastal environment, suggesting the importance of the importance of the role of the wetland and the conservation.

Keywords: surf clam, carbon, nitrogen, isotope, organic matter, wetland

Analysis of the coastal food web and influence of terrestrial input in Toyama Bay using δ ^{13}C and $\delta^{15}N$

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Toyama Bay is a semi-enclosed bay facing the Sea of Japan, which has a distinctive coastal environment. It receives a large amount of freshwater (such as river and submarine groundwater discharge (SGD)) and it is also affected by the Japan Sea water. In this study, to evaluate terrestrial effect on coastal organisms in Toyama Bay, we analyzed food web structure and estimate utilization situation of organic matter and nutrient (NO_3^-) derived from land in food web using stable isotope ratios ($\delta^{13}C \cdot \delta^{15}N$; $\delta^{15}N \cdot \delta^{18}O$ in nitrate).

The $\delta^{13}C$ values of consumers (such as bivalve, crustacea and fish) in the coastal area of Toyama Bay were clearly higher than those in the riverine particulate organic matter (POM). This indicates that consumers do not use terrestrial organic matter as their carbon source. The calculated contribution of benthic microalgae to diet of consumers was about 30 - 60 %, suggesting that ^{13}C-enriched benthic microalgae is an important carbon source for the coastal food web in Toyama Bay. Primary producer in coastal area of Toyama Bay shows much lower $\delta^{15}N$ values than typical primary producer in other coastal area. In addition, $\delta^{15}N$ (NO_3^-) values of coastal area in Toyama Bay are also lower than the $\delta^{15}N$ (NO_3^-) values of deep seawater of Toyama Bay and Japan Sea water. Low $\delta^{15}N$ (NO_3^-) values were also observed in the rivers and SGD around Toyama Bay. Our results suggest that coastal organisms in Toyama Bay are influenced by terrestrial input of low $\delta^{15}N$ (NO_3^-) through the rivers and SGD.

Keywords: Toyama Bay, Carbon and Nitrogen stable isotope ratio, Food web

Numerical Simulation of the relationship between water quality and the catch of sand-eel in Set-Inlad-Sea

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In Seto-Inland-Sea, the catch decrease of sand-eel is viewed with suspicion.
In Harima-Nada, there is relationships between water quality (DIN) and the cath of sand-eel.
It is considered there are some any relationships between nutrient load from a continental area and fish catchs.
Here, material cycle of nutrints, phytoplankton, zooplankton and sand-eel were calucurated by used of the numerical simulation model.

Keywords: ecosystem model, Osaka-Bay, Ammodytes personatus, Plankton -eating fish, nutrient reduction

Possible effects of the global warming on fish species diversity and production through submarine groundwater in coastal areas

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In order to forecast possible effects of the global warming on fish species diversity and production through changes in submarine groundwater discharge, physical and biological surveys were conducted at three sites in Japan (Yuza, Yamagata Pref., Obama, Fukui Pref., Takehara, Hiroshima Pref.), where submarine groundwater discharge has been observed.. Number of fish species, fish abundance and biomass were compared between areas of different levels of Radon concentration at each site. Contribution of nutritional matters of terrestrial origin through submarine groundwater was evaluated by analyses of stomach contents and stable isotopes of fishes.

Keywords: submarine groundwater, fish, distribution, species diversity, biomass, wood web

Summary of investigation for submarine groundwater discharge in Suruga Bay

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Submarine groundwater discharge (SGD) in coastal area has been recognized as an important pathway from land to ocean. Suruga Bay is adjacent to the foot of Mt. Fuji where active groundwater flow system exist, and it could be occurred that large amount of groundwater directly discharges into the bay.

To evaluate SGD and groundwater flow system in the coastal area of Suruga Bay, some geophysical and geochemical surveys have been conducted from 2013 to 2015. Side scan sonar and sub bottom profiler was used to detect an anomaly of sonic wave at the bottom of sea. Flow direction and velocity around the coast were observed by the Acoustic Doppler Current Profiler. Distribution of radon and salinity in surface water was investigated by towing survey. Bottom water of the bay was also collected by using the Niskin sampler and analyzed for radon. This study attempts to combine each survey result and summarize the investigation of submarine groundwater discharge in Suruga Bay.

Keywords: submarine groundwater discharge, Suruga Bay

Spatial distribution of oxygen and hydrogen isotope ratios of seawater in the nascent Kuroshio of Lamon Bay

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The vertical and horizontal variations of oxygen ($\delta^{18}O$) and hydrogen ($\delta^{2}H$) isotopic composition of seawater were investigated in Lamon Bay and offshore waters, east of Luzon Island (14°-19°N, 122°-126°E; Fig. 1a) during a research cruise of the R/V Roger Revelle in April/May 2012. The $\delta^{18}O$ increased with depth from the surface, reaching a maximum of +1.5‰ to +2.0‰ at the salinity maximum of North Pacific Tropical Water between 100 m and 200 m. Then, the $\delta^{18}O$ decreased toward the salinity minimum of North Pacific Intermediate Water near a depth of 500 m. Below this salinity minimum, the $\delta^{18}O$ remained within a narrow range between -1‰ and 0‰ to 4,000 m. The $\delta^{18}O$ of surface water showed a spatial gradient from the nearshore (southwest) area of the Bay (-0.3‰) to the offshore (northeast) waters (+0.6‰) and significantly correlated to the salinity ($p < 0.0001$; Fig. 1b), reflecting influence of freshwater input from the Island. By linear regression, the $\delta^{18}O$ of freshwaters supplied to Lamon Bay could be estimated to be around -5.3‰, which is consistent with the riverwater $\delta^{18}O$ found in the central Philippines. Variation of the $\delta^{2}H$ followed similar patterns as observed for $\delta^{18}O$, although relatively high $\delta^{2}H$ values compared to $\delta^{18}O$ were recorded in surface waters of nearshore area, reflecting the deuterium excess of freshwater supplied from the land. The $\delta^{18}O$ and the salinity were distinctly lower in the cyclonic dipole (see Gordon et al., 2014), corresponding to the part of Lamon Bay between the nascent Kuroshio and Luzon Island. The average pH in this area (8.114±0.007) was also significantly ($p < 0.003$) lower than the other parts of the observed area (8.125–8.134; Fig. 1c). This spatial trend implies that the extent of freshwater inflow including lowered pH on Lamon Bay and offshore waters is constrained by the flow path of the nascent Kuroshio and its feeder current. On the other hand, the average pH of the nascent Kuroshio was slightly higher than the feeder current and the anticyclonic dipole waters (8.134 vs. 8.126, $p = 0.0329$), which suggests unexplored biogeochemical process that keeps pH in the Kuroshio high relative to that of the freshwater input.

Keywords: oxygen isotope ratio of seawater, vertical structure, freshwater input, pH, Lamon Bay

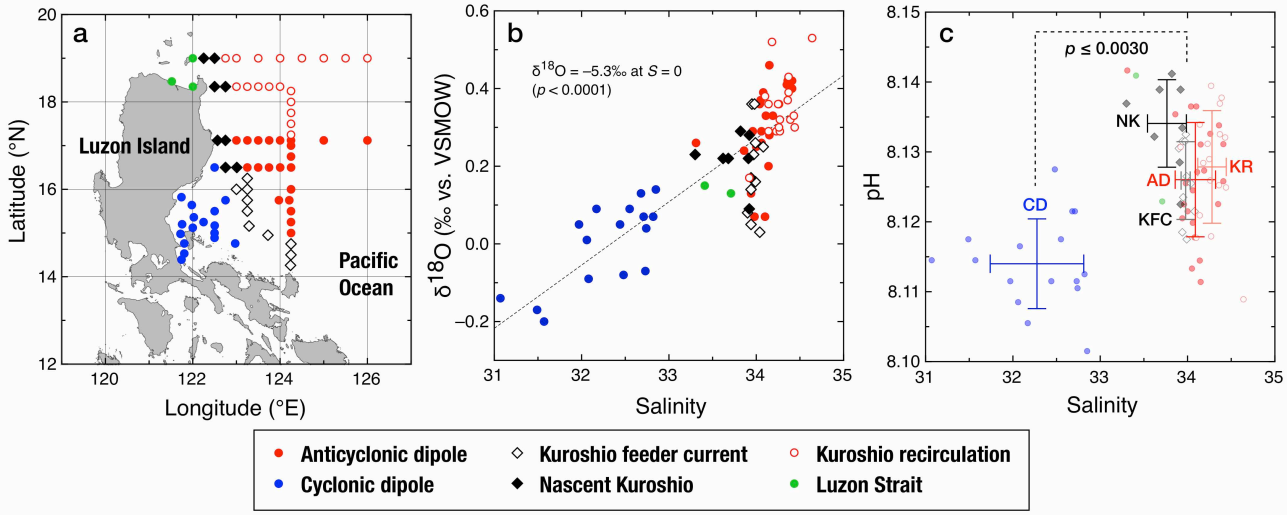

Fig. 1. Location of water sampling points (a), and plots of $\delta^{18}O$ (b) and pH (c) vs. salinity in surface seawater samples. Water areas are defined according to Gordon et al. (2014), doi:10.1002/2014JC009882.

Dynamics of dissolved inorganic nitrogen and phosphorous of the river water in the Kunisaki Peninsula in summer

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Kunisaki Peninsula Usa area in Oita Pref. was designated as GIAHS (Globally Important Agriculture Heritage Systems) in 2013. It has an abundant SATOYAMA represented by KUNUGI (Quercus acutissima) and a unique water use system connected by a number of small ponds. This unique water use system would affect river water quality in each watershed as well as estuarine and coastal biological production. However, its influence is still unclear. In this study, we assessed the effect of forest and water use system on nutrient concentrations in each river water and nutrient transport to coastal region.
Concentrations of DIN, DIP and d-excess of water isotopes ranged from 6.3 to 153.4 μM, from 0.1 to 4.1 μM and from 8.9 to 15.5, respectively. Fluxes of DIN and DIP from each watershed to coastal regions ranged from 0.8 to 140 kg d^{-1}, and from 0.2 to 22 kg d^{-1}, respectively. Although the fluxes were mainly dominated by river discharge, the molar ratio of DIN and DIP (DIN/DIP) varied from 6 to 39. We found positive exponential relationship between DIN/DIP and d-excess. These results suggests that unique water use system affected the difference in DIN and DIP dynamics within the watershed, since a number of ponds increased d-excess values from upstream to downstream. Moreover, in the Kunisaki Peninsula, the forest supplied DIN to the river, while DIP was mainly supplied from the agricultural land.
Therefore, higher d-excess and DIN/DIP showed lower retention time and larger impacts of forest. On the other hand, lower d-excess and DIN/DIP showed higher retention time and larger impacts of agricultural land.

Keywords: Nutrients, stream water, agricultural land, forest, GIAHS

A comparative study of in situ primary productivity under different sites of submarine groundwater discharge impacts in Japanese coasts

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In recent years, a number of studies have shown that submarine groundwater discharge (SGD) is an alternative nutrient pathway and can drive primary production in coastal seas. However, very little is known about an exact relationship between input of groundwater and response of primary production. To clarify the relationship, we conducted in situ measurements of primary productivity using stable ^{13}C tracer method under different strength sites of SGD in the Japanese coasts (Site A: Obama Bay, Site B: Beppu Bay and Site C: the coastal area of Mt. Chokai) in summer from 2013 to 2015. Simultaneously, ^{222}Rn activity was measured as SGD index. ^{222}Rn activity in Site A, B and C varied from 0.8 to 6.0 dpm L^{-1}, 3.6 to 11.2 dpm L^{-1} and 0.4 to 444.5 dpm L^{-1}, respectively. In situ primary productivity in Site A, B and C ranged from 7.0 to 49.5 μg C L^{-1} h^{-1}, 10.7 to 38.4 μg C L^{-1} h^{-1} and 0.8 to 11.8 μg C L^{-1} h^{-1}, respectively. In site A, there was significant relationship between in situ primary productivity and ^{222}Rn activity. Although light intensity and water temperature were different in each station and month, concentrations of nutrients limited primary productivity. In site B and C, concentrations of dissolved inorganic nitrogen and phosphorus showed significant increasing trends with an increase of ^{222}Rn activity, indicating nutrients in coastal regions were mainly derived from the SGD. However, there were no clear relationships between in situ primary productivity and ^{222}Rn activity, since primary production would be limited by light intensity as well as nutrients. Our experimental studies clearly showed that nutrients through the SGD affect crucial impact on primary production in coastal ecosystems.

Keywords: Primary productivity, 222Rn, Submarine groundwater discharge, Coastal seas

Analysis of harmful phytoplanktons in Yodo River mouth by the numerical ecosystem model

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Red tide of Alexandrium tamarense occurred in Yodo River estuary in Japan in 2007, 2011 and 2013. A. tamarense is marine phytoplankton and causes shellfish poisoning. We had made in-situ observation on April 2-3, 2012, and analyzed the temporal variation of marine phytoplankton by using the numerical ecosystem model. CTD and ADCP observation and water sampling were carried out with the tidal change. Nutrient and Chl.a concentrations and the cell density of A. tamarense were analyzed. Seawater ran to upstream in the surface layer. And fresh water went to the sea in the bottom layer. It is the typical estuary circulation. The estuary which have 2800m in length was divided to three layers, 0-0.5m, 0.5-1.5m and 1.5m-bottom. The thickness of the bottom layer is changed with the tidal change. Nutrient, phytoplankton, the dissolved organic matter and the particulate mutter are in each layer, and the bio-chemical process, photosynthesis, mortality, decomposition and so on, were formulated. Diurnal migration, salt limitation and utilization of organic matter for the photosynthesis and mortality by low salinity were considered in the bio-chemical process of A. tamarense. Then the temporal variations of each morphology and A. tamarense were calculated. The variation of phytoplankton in each layer was almost reproduced in-situ data. Marine phytoplankton was not hardly produced in Yodo River estuary and was supplied from the ocean. Phytoplankton which cannot swim by oneself almost floated by the horizontal advection, it is the estuary circulation. But only 27% of A. tamarense transported from the ocean to the bottom layer go through upstream. 36% of it returned to the ocean in the middle and the surface layer, and other 36% died in the surface layer. Weak estuary circulation is effective to the transport limitation to the upper stream of tamarense in Yodo River estuary.

Keywords: Yodo River , harmful phytoplanktons , numerical ecosystem model

The inflow of hot spring heat impact on fish communities around estuaries in Beppu, Oita prefecture

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Hot spring drainage flows into a river and then flow into the coastal area in Beppu, Oita prefecture which is a region with many hot springs in Japan. In Hirata River where many hot spring drainage flow into, hot spring drainage creates a better habitat for *Oreochromis niloticus* (Nile tilapia), a foreign species, in terms of available food and water temperature. Hot spring drainage flow into the river except Hirata River in Beppu area. However, it is not clear that the influence of hot spring drainage on ecosystem of those rivers. In order to evaluate the impact of thermal energy from hot spring drainage on the fish communities near the estuary, we investigated water temperature, flow rate and fish communities near the estuaries of six rivers in Beppu area.
We sampled the fish using a small seine net in January 2015. Although the number of fish collected in four rivers was very small, Nile Tilapia and *Opsariichthys platypus* was collected in Hirata River and Haruki River, respectively. Hot spring drainage flow into these two rivers, however, there is a big difference in the water temperature near the river mouth in these two rivers. These results suggest the possibility that the difference in inflow of the hot spring heat affects the dominant species of the fish community near the estuary. In this presentation, we will discuss the inflow of hot spring heat impact on fish communities near the estuary with the result of the summer investigation.

Keywords: hot spring heat, fish community, around estuary, hot spring drainage

Comparative study of growth in Manila clam under different environmental conditions of submarine groundwater discharge

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Submarine Groundwater Discharge (SGD) is often characterized by high concentration of nutrients and documented as an important pathway between land and sea contributing to the biological productivity in coastal waters. We investigated to what extent SGD contributed to the growth of primary consumer by the field rearing experiments of Manila clam at two sites (Mega and Torisaki) along the Mt. Chokai volcanic coast in northern Japan from June to August 2015. Average Radon 222 (^{222}Rn) concentration at surface layer of Mega and Torisaki for two months were 4037 Bqm^{-3} and 241 Bqm^{-3}, respectively. The $\delta^{13}C$ of shell of Manila clam ($\delta^{13}C_{SHELL}$) reflected the $\delta^{13}C_{DIC}$ of the ambient water, i.e. lower $\delta^{13}C_{SHELL}$ value at Mega than that at Torisaki. There was the positive correlation between ^{222}Rn activity and DIN concentration ($r=0.881$ $p<0.01$). Contrary to expectations, the average growth rate of Manila clam reared at Mega was slightly smaller than that at Torisaki. The concentration of chlorophyll-a was almost the same at two sites. However water temperature at Mega was about 2 ℃ lower than Torisaki. Kobayashi and Toba (2005) reported that clear positive correlation between the growth rate of Mania clam and rearing water temperature. This suggested the negative effect of low temperature on the growth of manila clam. This study showed the seepage area does not always have a favorable influence on fisheries resources. The larger-scale effects of SGD on biological production of primary consumer is necessary.

Keywords: submarine groundwater discharge, Manila clam, growth , stable carbon isotope ratio

