Preventing red-soil runoff in the Ryukyu Islands, Japan, considering biodiversity and environmental economics

*Hiroya Yamano[1]

1. National Institute for Environmental Studies

After the reversion of Okinawa (Ryukyu Islands) to Japan in 1972, extensive urban and agricultural development resulted in a significant increase in red-soil discharge to coastal waters. The release of red-soil has caused the degradation of freshwater and coastal ecosystems and biodiversity. A consideration of catchment-to-reef continua, as well as agricultural (socioeconomic) factors is necessary for establishing proper land-based management plans for the conservation of the island environment. We have set up a framework to integrate biophysics and socioeconomics: 1) setting a conservation target and threshold, 2) identifying the sources and processes, and 3) examining cost-effectiveness and management priorities. The framework was applied to Kume Island, Ryukyu Islands.

Land-sea pathways between snowmelt and fishery production

*Satoshi Nakada[1]

1. Graduate School of Maritime Sciences, Kobe University

Cultured scallop (*Patinopecten yessoensis*) is a typical coastal fishery in Funka Bay. The annual spat density of scallop is highly correlated with the snowmelt runoff or accumulated snowfall. We investigated the land-sea pathways in Funka Bay, Japan, a typical semi-enclosed bay during snowmelt period to understand how the snowmelt runoff can improve the spat density or production of scallop larvae associated with ocean primary production, by analyzing hydrological and oceanographical data produced by a land-sea integrated model in conjunction with newly compiled datasets of riverine nutrient concentrations and of the particle tracking simulation. The model successfully estimated the riverine dissolved inorganic nitrogen (DIN) flux that is dominated by the temporal variation of the river runoff rather than that of the riverine DIN concentration. Ocean simulation indicated that the freshwater flux supplied by the snowmelt runoff enhances the clockwise circulation along the coast of the bay. The close relationship between the annual spat density of scallop and the snowmelt runoff associated with high DIN concentrations can be explained as follow; riverine nutrients can increase the biomass of phytoplankton in near-shore seas and improve food availability for scallop spawners, resulting in increased egg production in March to April. Therefore, the nutrient flux from agricultural source areas through the large snowmelt runoff has an important role in larvae production. Land-sea pathways need to be identified to design sustainable and synergetic systems of aquaculture and agriculture for the integrated management of coastal regions.

Keywords: Land-sea pathway, Snowmelt runoff, Nutrients, Coastal fishery prodcution

Evaluation of submarine groundwater discharge in a ria coast at the eastern Kyushu island using Rn isotopes

Hiroyuki Nishimura[1], Shusaku Otake[2], Kazuyoshi Miyamura[2], *Ryo Sugimoto[1]

1. Faculty of Marine Biosciences, Fukui Prefectural University, 2. Oita Prefectural Agriculture, Forestry and Fisheries Research Center

Ria coast is thought to have a high potential for groundwater discahrge adn related nutrient fluxes from land to coastal sea due to a topgraphic property. However, there is little knowledge about submarine groundwater discharge in ria coast in Japan. In this study, we have evaluated the rate of submarine groundwater discahrge and associated nutrient fluzes in the small coastal embayment along the ria coast at the eastern Kyusyu uinsg ^{222}Rn.

Keywords: Submarine groundwater discharge, Ria coast, 222Rn

Seasonal variation in dissolved and particulate nutrient delivery from two subtropical mangroves to outer ocean

*Toshihiro Miyajima[1]

1. Marine Biogeochemistry Group, Division of Ocean-Earth System Science, Atmosphere and Ocean Research Institute, The University of Tokyo

Estuarine mangroves enhance longitudinal mixing of seawater and freshwater and actively exchange nutrient materials such as carbon (C), nitrogen (N) and phosphorus (P) with the water phase. Mangrove vegetation takes up and fixes atmospheric CO_2 by photosynthesis, and some of the fixed carbon is sequestered within the sediment for a long term, while the other part is released later as respired CO_2 and detrital organic C (OC) into river and sea water and eventually exported to the outer ocean. The released OC fuels heterotrophic animal and microbial communities inside and around the mangrove, and the exported CO_2 locally enhances ocean acidification in coastal ecosystems. Mangroves are also known as a nutrient filter that captures and removes dissolved inorganic N (DIN) from river water by denitrification, thereby preventing N loading to coastal ocean. In subtropical mangroves, inherent biological activities of mangrove ecosystems, such as photosynthesis, remineralization, and denitrification, as well as external nutrient inputs to mangroves through river waters or atmospheric deposition, can vary widely depending on seasons. However, knowledge about seasonal variability of ecosystem functioning of mangroves is still very limited, especially for subtropical ones. We investigated biogeochemical properties of two subtropical estuarine mangroves of Ishigaki Island, Okinawa, Japan, with an emphasis on seasonal variability. Intensive water sampling was conducted at mangrove-ocean interfaces and several streams flowing into the mangroves in different seasons (March, June, September, and December), and concentrations and isotopic compositions of dissolved and particulate constituents were determined to create and compare the salinity-property diagrams. Mangroves were always a net source of dissolved inorganic C (DIC) to the water phase. The $\delta^{13}C$ of DIC in the brackish zone was more negative in warmer seasons, indicating temperature dependence of soil respiration. Nitrate dominated in DIN in river waters. Dissolved inorganic P (DIP) usually behaved conservatively across the salinity gradient, while the mangroves seemed to be a net sink for nitrate and a net source of nitrite and ammonia. The ratio of DIN to DIP was the lowest in March. In most cases, the weight ratio of particulate organic C (POC) to chlorophyll *a* exceeded 500, indicating the predominance of detrital organic matter produced within the mangroves. The ratio of POC to particulate N (PN) was the highest and the $\delta^{13}C$ of POC was the most negative in December. The $\delta^{15}N$ values of both nitrate and PN in the brackish zone was higher in warmer seasons, which suggested that denitrification in the watershed and the mangrove depended on temperature. Our results suggested that the ecosystem functioning of subtropical mangroves vary significantly between different seasons, and that such a seasonal variation could be due to seasonal changes in both internal metabolic activities and external factors such as hydrology and nutrient loading from the watershed. We discuss these characteristics of subtropical mangroves in comparison with mangroves under different geographical and climate conditions.

Keywords: Mangrove, Dissolved inorganic carbon, Dissolved inorganic nitrogen, Particulate organic matter, Salinity gradient, Stable isotope ratio

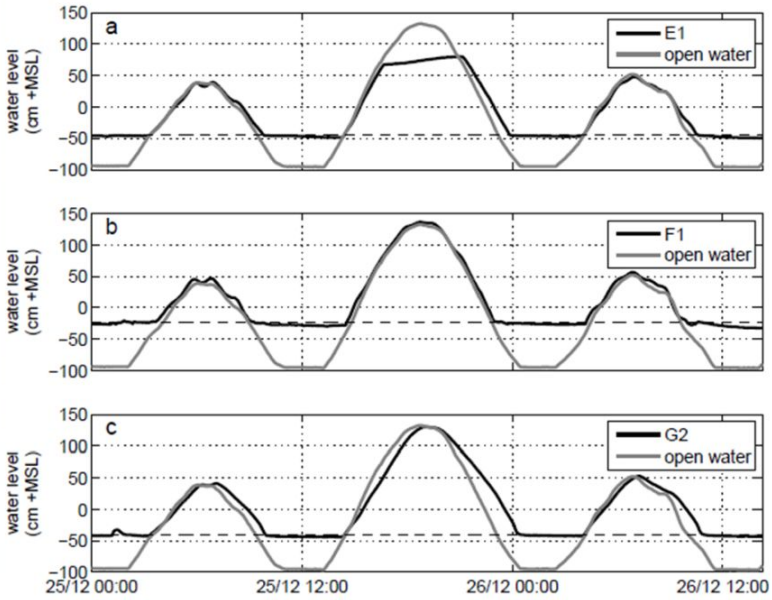
Testing Hydrological Suitability for Mangrove Restoration in Vietnam and Indonesia

*Anne Frederike Van Loon[1], Bram Te Brake[2,3], Marjolein H.J. Van Huijgevoort[4], Roel Dijksma[3]

1. School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, United Kingdom, 2. Land Environmental Engineering, Ede, the Netherlands, 3. Hydrology and Quantitative Water Management Group, Wageningen University, Wageningen, the Netherlands, 4. Program in Atmospheric and Oceanic Sciences, Princeton University, Princeton, USA

Mangrove restoration projects, aimed at restoring important values of mangrove forests after degradation, often fail because hydrological conditions are not properly restored. We present a simple, but robust methodology to determine hydrological suitability for mangrove species, which can guide restoration practice. In 15 natural and 8 disturbed sites (i.e. disused shrimp ponds) in three case study regions in south-east Asia, water levels were measured and vegetation species composition was determined. Using a hydrological classification for mangroves, sites were classified into hydrological classes, based on duration of inundation, and vegetation classes, based on occurrence of mangrove species. In the natural sites, hydrological and vegetation classes were similar, showing a clear differentiation of mangrove species between wet and dry sites. Application of the classification to disturbed sites showed that in some locations hydrological conditions had been restored enough for mangrove vegetation to establish, in some locations hydrological conditions were suitable for various mangrove species but vegetation had not established naturally, and in some locations hydrological conditions were too wet for any mangrove species (natural or planted) to grow. We quantified the effect that removal of obstructions such as dams would have on the hydrology and found that failure of a restoration project at one site could have been prevented. In this presentation we will discuss the use of a hydrological classification in mangrove restoration projects compared to using elevation only. We conclude that the hydrological classification gives important information about how to restore the hydrology to suitable conditions to improve natural regeneration or to plant mangrove species, which could not have been obtained by estimating elevation only. Based on this research a number of recommendations are given to improve the effectiveness of mangrove restoration projects.

Keywords: mangrove, restoration, hydrological classification, Vietnam, Indonesia



Heat-flux from the submarine groundwater discharge at the coastal area: A case from the Obama Bay, Japan

*Makoto Yamada[1], Ryo Sugimoto[2], Hisami Honda[1]

1. Research Institute for Humanity and Nature, 2. Reseach Center for Marine Bioresources, Fukui Prefectural University

Various studies regarding submarine groundwater discharge (SGD) have been performed. Although SGD has been recognized as an important pathway for nutrients transport from land to coastal ocean, SGD also supplies other chemical compositions as well as heat in the form of thermal energy. Especially, there is a difference in water temperatures of SGD and seawater, since groundwater temperature is almost constant throughout the year and seawater temperature varies. However, it is not clear that how much heat energy is supplied by SGD and its associated impacts on coastal ecosystems. Several studies assessing the impact of drainage water from the power plants have indicated that the water temperature has a significant impact on the coastal ecosystems. It highlights the need for assessing the impact of SGD on coastal ecosystems not only by considering the nutrient influx but also by giving equal importance to inflow water temperatures. To investigate this hypothesis, we undertook a study in a coastal area of Obama Bay, Fukui Prefecture, Japan.
In Obama Bay, SGD rate has been estimated using ^{222}Rn and salinity mass balance model (Sugimoto et al., 2016). We calculated the heat quantity from SGD by using the formula [E = Q * Cp * ΔT], where, E is the heat quantity from SGD; Q is the SGD rate from Sugimoto et al. (2016); Cp is the specific heat at constant pressure; and ΔT is the difference between seawater and groundwater temperatures. The following results are obtained from this study: The SGD resulted in hot and cold heat influx to the coastal areas during winter and summer seasons, respectively. Although SGD rate is observed much less than the river discharge, cold heat flux from SGD was greater than the river during summer. SGD resulted in lowering the sea water temperature at the bay during the summer. In this presentation, we will additionally discuss about the magnitude of this heat-flux as compared to the results of SGD heat-flux at another study site.

Keywords: submarine groundwater discharge, heat flux, coastal area

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

*Yasuhide Muranaka[1], Takafumi Kamitani[1], Koichi Ohyama[1], Noriaki Hushimi[1], Rika Koda[1], Masahiko Ono[2], Atsunao Marui[2]

1. Shizuoka Institute of Environment and Hygiene, 2. National Institute of Advanced Industrial Science and Technology

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. Most of rainfall and melted snow have been considered to be percolating into underground, turning to groundwater, flowing down in the layers of the Younger Fuji volcano and partly discharging from seabed in Suruga Bay. 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 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)

Influence of submarine groundwater discharge on phytoplankton primary productivity at nearshore coasts in Beppu Bay and Otsuchi Bay

*Hisami Honda[1], Ryo Sugimoto[2], Taketoshi Mishima[3], Shinji Ohsawa[3], Jun Shoji[4], Osamu Tominaga[2], Makoto Taniguchi[1]

1. Research Institute for Humanity and Nature, 2. Faculty of Marine Bioscience, Fukui Prefectural University, 3. Institute for Geothermal Sciences Graduate School of Sciences, Kyoto University, 4. Hiroshima University

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, little is known about a relationship between input of nutrients through the groundwater and response of primary production. To clarify the relationship, we conducted *in situ* measurements of primary productivity (PP) using stable ^{13}C tracer method under different strength sites of SGD at nearshore coasts in Beppu Bay and Otsuchi Bay during the summer in 2016. Considering the differences of light intensity and water temperature at each site, we have also incubated the bottles taken from each site under same conditions of light and water temperature on land. In both bays, significant positive relationships between *in situ* PP and *ex situ* PP ($r > 0.91$, $p < 0.01$) indicated that *in situ* PP would be controlled by nutrient availability. In Beppu Bay, i*n situ* PP and ^{222}Rn activity ranged from 4.4 to 23.3 $\mu g\ C\ L^{-1}\ h^{-1}$ and 69.8 to 586.8 Bq m^{-3}, respectively. Although there was no clear relationship between *in situ* PP and ^{222}Rn activity, biomass specific PP (P_B, $\mu g\ C\ \mu g\ chl\ a^{-1}\ h^{-1}$) showed the positive correlation with ^{222}Rn activity. In Otsuchi Bay, i*n situ* PP and ^{222}Rn activity ranged from 4.5 to 10.7 $\mu g\ C\ L^{-1}\ h^{-1}$ and 298 to 765.8 Bq m^{-3}, respectively. ^{222}Rn activity did not related to *in situ* PP and P_B. This could be due to low phosphate concentrations in terrestrial confined groundwater. Our experimental studies suggested that the mechanism by which SGD affects phytoplankton production differs from one ecosystem to another.

Keywords: Primary productivity, 222Rn, Submarine groundwater discharge, Nearshore coast

Evaluation of the environmental condition of Submarine Groundwater Discharge (SGD) by using carbon stable isotope ratio recorded in the shell of sessile bivalve

*OSAMU TOMINAGA[1], Ryo Sugimoto[1], Katsuhiro Kitagawa[1], Masaru Takeuchi[1], Makoto Yamada[2], Jun Shoji[3], Hisami Honda[2], Shiho Kobayashi[4], Makoto Taniguchi[2]

1. Fukui Prefectural Univ., 2. RIHN, 3. Hiroshima Univ., 4. Kyoto Univ.

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. In the present study we investigated two subjects 1)whether the $\delta^{13}C$ of ambient water reflect the proportion of fresh water flux in SGD, 2)whether the $\delta^{13}C$ recorded in the shell of the sessile bibalve reflect the that of the ambient water. The SGD flux and the proportion of fresh water flux in SGD were measured by the seepage meter at Kamaiso beach along the Mt. Chokai volcanic coast in June and September 2016.The rock-oyster (*Crossostrea nippona*) was also sampled at Kamaiso Beach and adjacent 3 areas (Mega, Takinoura, Torisaki). There was a positive significant relationship between salinity and the δ 13C of ambient water ($p<0.01$). The $\delta^{13}C$ of the rock-oyster shell was high where the SGD flow rate was high and the positive significant correlation was found between the $\delta^{13}C$ of the rock-oyster shell and that of ambient water. In order to estimate the proportion of fresh water flux in SGD from the $\delta^{13}C$ of the rock-oyster shell, we used the two end member mixing equation including DIC concentration of both sea water and underground water. The average proportion of fresh water flux in SGD estimated from the mixing model ranged from 4 % (Torisaki) to 35 % (Mega). These values are higher than those estimated from the $\delta^{13}C$ of ambient water (1.3 % Torisaki and 18.1 % Mega). The difference of these results are seems to be the difference of local SGD environment around rock-oyster.

Keywords: Submarine groundwater discharge, sessile bivalve, Rock-oyster, carbon stable isotope ratio, SGD flow rate, the proportion of fresh water flux in SGD

Numerical analysis of the ecosystem responses to the changes of nutrient supply in the Western Seto Inland Sea, Japan

*Naoki Yoshie[1], Hayato Mizuguchi[1], Miwa Nakagawa[1], Xinyu Guo[1]

1. Center for Marine Environmental Studies, Ehime University

The Seto Inland Sea is a representative coastal sea in Japan, and the nutrients in this region are mainly contributed by the following three nutrient sources; river, sediment, and open ocean. The nutrient supplies from the river and sediment have been reduced through the efforts for environmental cleanup over the last several decades. As a result of such excessive environmental cleanup, oligotrophic condition frequently occurred in this region in recent years. On the other hand, the nutrient supply from the open ocean associated with the oceanic water intrusions is rich in its variations because the oceanic water intrusions are closely associated with the current speed and position of Kuroshio Current south of Japan. In this study, we investigated the responses of the lower-trophic level ecosystem in the Western Seto Inland Sea to the variations of the above three nutrient supply amounts using an ecosystem model. Sensitivity analysis showed that the nutrient supply amount from the open ocean has much larger impact on the ecosystem than the nutrient supply amounts from the river and sediment. Large phytoplankton (diatom) and mesozooplankton (copepod) are dominant in the plankton assemblage in this region and they are highly sensitive to the variations of the nutrient supply amount.

Keywords: ecosystem model, nutrient, oceanic water intrusion, oligotrophic condition

Effects of submarine groundwater on growth of fishes: a cage experiment for flatfish juveniles

*Jun Shoji[1], Ryo Sugimoto[2], Hisami Honda[3], Makoto Taniguchi[3]

1. Hiroshima University, 2. Fukui Prefectural University, 3. Research Institute for Humanity and Nature

In order to detect the possible effects of submarine groundwater discharge (SGD) on fish growth, a cage experiment were conducted in coastal waters of central Seto Inland Sea, Japan. Growth of juveniles of marbled sole, a flatfish species, temperature, prey availability in water and stomach contents of the juveniles were compared between sites with high and low SGDs monitored by the use of radon concentration. Juvenile growth rate, prey availability, stomach content weight per fish were higher at the site with high SGD while temperature did not differ between the two sites. The SGD was suggested to promote growth and feeding the juveniles in the tidal flat.

Keywords: water-food NEXUS, Fishery resources, submarine ground water, flatfish, feeding, growth

Influence of Kiso rivers discharge on surface residual currents and distribution of Chlorophyll a in Ise Bay

Hajime Naganuma[1], Masataka Hayashi[1], Hidenori Aiki[2], *Joji Ishizaka[2]

1. Graduate School of Environmental Studies, Nagoya University, 2. Institute for Space-Earth Environmental Research, Nagoya University

Ise Bay is a semi-enclosed bay located in the center of Honshu island of Japan, and it is coastal area where the rate of fresh water flows is greater than that in Tokyo Bay and Osaka Bay of the similar size. In such a bay, estuary circulation induced by the inflows of fresh water would be prominent. However, it has not been known how fresh water inflows influence the variability of horizontal circulations in the bay. This study is, thus, aimed at understanding the surface residual currents by using High Frequency radar (HF radar) in Ise Bay, which allows us to investigate the influence of Kiso rivers to the surface residual currents. In summer in Ise Bay, red tides occur frequently owing to the excessive increase of phytoplankton. However, as there have been no study on the relationship between flow fields and phytoplankton of Ise Bay, we also studied the influence of the surface residual currents to the distribution of chlorophyll a.

Surface residual currents were calculated by the harmonic analysis of hourly data of HF radar from January 1, 2010 to December 31, 2013. We used the data of the daily mean discharge rate of the Kiso rivers (Kiso River, Nagara River and Ibi River). For wind directions and speeds, we used hourly data of the vane anemometers installed at Ise-Wan Sea Berth (Bay head), Chubu International Airport, and No.4 lighted buoy (Mid-bay). The distribution of chlorophyll a was calculated from the data of MODIS –the ocean color sensor mounted on the satellite Aqua. In this study, we focused on the variability in summer (June –August) when red tides frequently occur, after having understood the seasonal variability.

The monthly mean discharge of Kiso rivers was low in winter, and high in summer with the highest discharge of 1015.6 $m^3 s^{-1}$ in July. As river discharge reflected the seasonal variability of precipitation, the increase of the discharge in summer suggested the influences of the rainy season and typhoons. The monthly mean surface residual currents in Ise Bay generally flowed from the north to the south during January to May, and during September to December, and the current was stronger at the eastern part than at the western part. On the other hand, in July, the current speed was faster at the western part than at the eastern part, and in August, a cyclonic circulation appeared at mid-bay. The monthly mean concentration of chlorophyll a was low in winter when the river discharge was low, but it became high when the discharge rate increased in summer. In July, when the highest concentration of 10 mg m^{-3} was observed, chlorophyll a was distributed from bay head to the coast of Mie prefecture. From these seasonal variability, the change of characteristic in the surface residual currents and in the chlorophyll a distributions in summer were identified, and it was thought that they were largely influenced by Kiso rivers discharge.

Then, in order to identify the factors that influences the directions of the surface residual currents in summer, we compared the daily mean direction of the surface residual currents in bay head at 34.823º N, 136.724ºE with the daily mean of the river discharge. As a result, when the river discharge became three times as much of the annual mean (1500 $m^3 s^{-1}$) or more, the surface residual currents flowed to west. On the other hand, when the discharge was less than 1500$m^3 s^{-1}$, direction of the residual currents was varied. It is thought that, when the river discharge was high, they were turned to west due to the Coriolis force. Furthermore, as we compared the flow and the wind direction and speed, it was revealed that the residual currents were greatly affected by the wind of mean speed 5.7 m s^{-1} and higher.

Then, in order to study the changes in chlorophyll a distributions and advection, we compared the daily

distribution of chlorophyll a, the daily mean of the residual currents and that of the river discharge. After the discharge of 1500 $m^3 s^{-1}$ or more, water with high chlorophyll a of 10 mg m^{-3} or higher was distributed from bay head to the coast of Mie prefecture, and after the discharge of less than 1500 $m^3 s^{-1}$, high chlorophyll a water was distributed in bay head, or from bay head to the coast of Chita Peninsula. It was suggested that the high chlorophyll a water was probably drifted from the bay head to the coast of Mie prefecture when the river discharge rate was high, and it stayed in the bay head or drifted to the coast of Chita Peninsula when the river discharge was low.

Keywords: Ise Bay, surface residual current, HF radar, river discharge, Chlorphyll a

Re-evaluate particulate organic carbon flux in the East China Sea

*Chin-chang Hung[1]

1. National Sun Yat Sen University

Fluxes of particulate organic carbon (POC) in the East China Sea (ECS) have been reported to decrease from the inner continental shelf towards the outer continental shelf. Recent research has shown that POC fluxes in the ECS may be overestimated due to active sediment resuspension. To better characterize the effect of sediment resuspension on particle fluxes in the ECS, rare earth elements (REEs) and organic carbon (OC) were used in separate two-member mixing models to evaluate trap-collected POC fluxes. The ratio of resuspended particles from sediments to total trap-collected particles in the ECS ranged from 82-94% using the OC mixing model, and 30-80% using the REEs mixing model, respectively. These results indicate that REEs may be better proxies for sediment resuspension than OC in high turbidity marginal seas because REEs do not appear to undergo degradation during particle sinking as compared to organic carbon. Our results reveal that REEs can be used as tracers to provide quantitative estimates of POC fluxes in marginal seas.

Keywords: carbon cycle, POC, East China Sea, sediment trap

Sea Turtle-Friendly Zonation Area, Case Studies Goa Cemara Beach, Yogyakarta, Indonesia

*Sry Handini Puteri[1], Intan Elvira[1], Adhera Sukmawijaya[1]

1. UGM

Sea turtle is one of the ocean - creature that has a specific habitat, which is coastal ecosystem. The suitable coastal ecosystem for sea turtles are consisting of some specific geomorphic characteristics. Geomorphic characteristics consists of several parameters, ie slope, wind, climate, waves, currents, and grain size of sand.

One of the Sea turtle habitat is located in Goa Cemara Beach. The beach has been converted into a tourist area by now. Rapid changes are not equipped with an insight of local wisdom and environmental assessment, thus it threatened the habitat of sea turtle. This study aims to determine the appropriate geomorphic conditions for sea turtle nesting habitat. The second objective is to recommend the spatial zoning that is friendly to the sea turtle’ s habitat. The data used in this research are primary data and aerial photo interpretation. Primary data conducted by observation and direct measurement in the field. The expected output of this research are map of the spatial zoning that is turtle-friendly and map of the former turtle’ s nest.

Keywords: Sea Turtle, Coastal Zonation, Aerial Photography

Occurrence of fishes around area with submarine groundwater seepage in the central Seto Inland Sea, with special emphasis on flatfishes

*Jun Shoji[1], Ryo Sugimoto[2], Hisami Honda[3], Makoto Taniguchi[3]

1. Hiroshima University, 2. Fukui Prefectural University, 3. Research Institute for Humanity and Nature

In order to examine the effects of submarine groundwater discharge (SGD) on fish community structure and production, physical and biological surveys were conducted at a tidal flat in Seto Inland Sea, Japan. Flatfish species were dominant among fish community in and around the area with high SGD detected by monitoring survey by the use of radon concentration as a SGD tracer. Stomach content and stable isotope analyses indicated dependence of the fish species on nutrients derived from terrestrial sources through SGD. Marbled sole juveniles > 40 mm showed a higher dependence on the land-originated nutrients than other species.

Keywords: water-food NEXUS, fishery resources, submarine ground water, flatfish, Seto Inland Sea, Hiroshima

