Urban Subsurface Environments

Newsletter Volume 8 October 2009

The full implementation of the project "Human Impacts on Urban Subsurface Environment" continues in 2009 and the project members have conducted field experiments, surveys and data gathering in the target cities.

Summary of the group activities of the Social Economy and Material groups and research results are featured in this volume of our project's newsletter. This issue also contains introduction of new method by Water Group, and a report by Prof. Bill Burnett, who spent 3 months at RIHN working on the urban subsurface environments project.

Inside this issue

Project Activities and Plans

Makoto Taniguchi, RIHN

The Fourth RIHN International Symposium "The Dilemma of Boundaries: Toward a New Concept of Catchment " which will be organized by Urban Subsurface Environment project (USE) and Amur-Okhotsk project, will be held in RIHN, Kyoto from October 20 to 22, 2009 (http://www.chikyu.ac.jp/archive/topics/2009/091020-22symposium-e.html).

The domestic meeting to summarize the project results on the USE project will be held on October 28-30, 2009 at Otsu, Shiga prefecture where is just beside Lake Biwa. All Japanese members of USE project will meet to discuss the results.

Another important meeting on our project is the Third International Symposium on "Human impacts on urban subsurface environment" which will be held at Academia Sinica, Taipei, from November 16 to 21, 2009. More than 40 project members will meet at Taipei to summarize the project results. The results will be published in the book from Springer, and some international journals.

This year is extreme important for the USE project, because we will face the project evaluation on February 2010. We plan many international meetings, project meetings. and sub-group meeting, and we hope to integrate the whole results through this year to get final results and conclusion.

Social Economy sub-group Report

Shinji Kaneko

Graduate School for International Development and Corporation,

Hiroshima University, Japan

This article reports two major activities conducted by the Social Economy sub-group during this year: the field survey in Jakarta and the workshop which is jointly organized by the Material sub-group in Kyoto.

1. Field survey in Jakarta

1.1 Objective of fieldwork survey

The survey in Jakarta was conducted during the period March 23 to March 27, 2009. The survey members are Shinji Kaneko (Hiroshima Univ.), Tsuyoshi Imai (Yamaguchi Univ.), Daisaku Goto (Hiroshima Univ.) and Tomoyo Toyota (Hiroshima Univ.). The objective of the survey was to gather information and data on urbanization and water quality and quantity in Jakarta from related organizations and government entities.

1.2 List of organizations visited

(1) Statistical Bureau (BPS: Badan Pusat Statistik Propinsi) of DKI Jakarta (Jakarta City Government)

The BPS of DKI Jakarta mainly develops the socioeconomic and demographic statistical database of Jakarta city. We discussed about the data availability of annual indicators of Jakarta city and requested them to provide necessary data for our study. We agreed that the office will provide necessary data after the meeting in two months through email. The data provided later include population (1895-2007), GRDP structure (1993-2008), ambient air quality indicators (NOx, SOx, TSP: 2001-2007) and ground water abstraction (1978-2007).

(2) BPS of Indonesia

The BPS of Indonesia is responsible for the construction of database of nation-wide socio economic and demographic indicators. The database includes regional statistics at provincial, city, and district levels, but the original data is collected by the BPS of regional governments. Therefore, we did not need to collaborate. However, we were able to obtain necessary national data for our study such as GDP structure (1880-2007) and GRDP for all provinces (1980-2003).

(3) Ministry of Public Works

We had a joint meeting with multiple divisions in the Ministry of Public Works including Solid Waste Division, Sanitation Division, and Water Supply Division. We found that since 2003 due to decentralization policy of Indonesia, government services on waste water management and water supply of Jakarta city have been transferred to the DKI Jakarta. Therefore, historical data and information related to waste water management and water supply is separately owned by Ministry of Public Works and the DKI Jakarta. Old data (before 2003) are with the Ministry of Public Works and data for the following years are collected by DKI Jakarta. The old data however, are generally not well maintained and not readily available.

(4) BAPPEDA

BAPPEDA (Badan Perencana Pembangunan Daerah) is the Regional Body for Planning and Development of DKI Jakarta. From a planning perspective, the office has historical information on urban planning and therefore fundamental information on urbanization is available. However, the information is not the form of a consistent statistical data. We learned the basic history of urbanization of Jakarta city since 17th century during the Dutch colonial period. The office also plays a coordinating role among multiple stakeholders including Ministries of central government, local governments, international donor agencies and NGOs for flood control and management. Hence, we were also able to get information on flooding in Jakarta city.

(5) PD PAL JAYA

This is the Wastewater Management Enterprise of the city of Jakarta. They managed the only waste water treatment facilities in Jakarta city.

(6) Department of Public Works of DKI Jakarta

The office is responsible for water supply, waste water treatment and waste management including night soil collection since the decentralization policy was launched. However, the office does not maintain old data before the decentralization; hence the office cannot provide historical data of our needs.

(7) AETRA Air Jakarta

AETRA is one of the two private companies in Jakarta which is commissioned by DKI Jakarta for water supply operation. AETRA covers the eastern part of Jakarta (Fig. 1), while PAM Lyonnaise Jaya (PALYJA) serves the western part of Jakarta. Both companies operate under the supervision of the city-owned company PAM Jaya. AETRA started the operation since 1998 and complete data on water supply was provided to us.

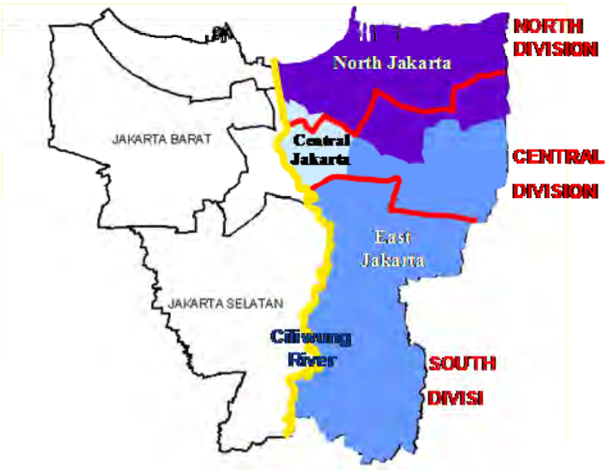


Fig. 1. Water Supply Area of AETRA

(Source: AETRA)

(8) PAM Jaya

PAM Jaya (Perusahaan Air Minum) is public company of Jakarta for water supply since 1977. Since 1998, the operation of water supply was taken over by two private companies therefore, data on water supply from 1977 until 1998 was maintained by the PAM Jaya when the water supply tasks were taken over from the Ministry of Public Works.

(9) Jakarta Provinsial Government, Regional Environment Management Board (BPLHD)

The director of subdivision of environmental monitoring agreed to provide data for the last five years and come to Japan to share the information at the workshop in RIHN. Due to administrative practice in DKI Jakarta, where usually director is rotated every five years and data is not transferred to the next director, available data for the current director is only for five years.

(10) AMDAL, Environmental agency

This office manages and monitors the groundwater in Jakarta. They have paper base data of groundwater abstraction for 5 years.

1.3 Highlights of the visit

(1) Water Supply in Jakarta City

In Indonesia, only about 18% of the total population are connected to piped water supply. Even in urban areas about 40% of residents receive piped water. The remaining urban population depends on individual wells or small-scale providers. As for Jakarta city, water supply ratio is 60%. Non-connected people pump up the groundwater by themselves. Therefore, even the city government doesn't get a clear grasp of the total water consumption in Jakarta city.

There are two water supply companies in Jakarta, AETRA and PLYJA. In this fieldtrip, we visited to AETRA (Pic.1 to Pic.3). This company provided about 140 million cubic meters in 2008. The service coverage ratio of AETRA reached 65.9% of total population in eastern Jakarta.

Pic.1 Visiting to AETRA

Pic.2 Waterworks at AETRA

Pic.3 Examination of water quality

(2) Sewage System in Jakarta City

There is no policy or regulation about wastewater in Jakarta city. PD PAL JAYA was established in 1991 by Wastewater Management Board with the aim of providing wastewater pipeline service. This enterprise covers the whole area of DKI Jakarta.

PD PAL JAYA manages the only waste water treatment facilities in Jakarta city (pic.4). However, sewage equipment here only covers 3% of the total area of Jakarta City (pic. 6), and water purification equipment only operates 6 hours per day. The treatment capacity is 450 liters per second. The actual annual treatment is 150 liters per second, which means 12,000 cubic meters per day.

Sewage is collected the same sewage water pile (pic. 6). Gray water and black water is treated together. The water is highly polluted (pic.7), and a plan to construct a new sewage facility is underway.

Pic.4 Sewage plant of PD PAL JAYA

Pic.5 Coverage area of sewage system

Pic.6 Sewage water pipe

Pic.7 Collected sewage

2. Workshop on Water Quality Management in Developing Asian Megacities

2.1 Summary of Workshop

The “Workshop on Water Quality Management in Developing Asian Megacities” was held at the Research Institute for Humanity and Nature (RIHN) on July 18, 2009. This Workshop was attended by 15 participants. The objectives of the workshop are to exchange information with experts on water management and water quality changes in selected Asian metropolitan areas (DKI Jakarta, Metro Manila and Bangkok Metropolitan Area), and to present the initial results of our research activities on water quality under this project. This was a good opportunity to discuss different water management strategies conducted in these metropolitan areas and the lessons learned from the process.

Given below are the presentations during the workshop, together with the names and affiliations of the speakers:

Part I: Outline and Intermediate Results of the Project

City comparison on water quality observations in RIHN Project: Shinichi Onodera(Hiroshima University, Japan)

Groundwater Pollution in Asian Megacities - Pollution status and mechanism -: Hosono Takahiro (Kumamoto Univ.)

Part II: Water quality in urban water bodies: Jakarta, Manila and Bangkok

Long-term Urban Development & Water Quality in Jakarta: Andono Warih (Jakarta Provincial Government Regional Environment Management Board, Indonesia)

Long-term Urban Development & Water Quality in Manila: Renato Cruz (Environment Management Bureau, Department of Environment and Natural Resources, Philippine)

Long-term Urban Development & Water Quality in Bangkok: Wijarn Simachaya (Pollution Control Department, MONRE, Thailand)

Part III: Water Management in Meagacities

Regional Environment Simulator and Its Applications: Takao Yamashita (Hiroshima University)

Water Management for Mega-Cities: The Houston Experience: David Eaton (The University of Texas at Austin, USA / Hiroshima University, Japan)

2.2 Documents or data acquired

Paper:

“Long-term Wastewater Management in Megacities:Case Study of Bangkok, Thailand”

By Wijarn Simachaya, Ph.D. Pollution Control Department of Thailand

“Status of Water Quality of Metro Manila Water Bodies (1980 - present)”

By Renato T. Cruz, Environment Management Bureau of Philippine

“Historical water quality changes in emission source”

By Andono Warih (Jakarta Provincial Government Regional Environment Management Board of Indonesia)

Data:

The water quality data in observatory at coastal, river and shallow well around Jakarta city from 2004 to 2008. (PH, Conductivity (ms/cm), Turbidity (NTU), DO: Dissolved Oxygen (ppm), Suhu (OC), Salinitas (%), Angin, etc…)

Water Quality data in observatory in Chaopraya river from 1987 to 2009: (DO (mg/l), BOD: Biological Oxygen Demand (mg/l), FECAL(mpn/100mi), etc…)

Water Quality data of river in Metro Manila from 1980 to 2008 (BOD, DO, TSS: Total Suspended Solids (mg/L)) and Total Coliform Count (MPN/ 100mL) in Manila Bay, 1980-2008.

We also request the following data and information from DKI Jakarta, Metro Manila and Bangkok.

1. Nutrients: TN, NO3-, NH4+, TP, PO4-, Si, DOC,
2. Major ions
3. Heavy metal
4. Discharge
5. Cover Ratio of sewage service (population base or area base
6. Definition of sewage service
7. Information related with sewage: septictank, regulation for each establishment.

(References)

BAPEDA HP, available at http://bappeda.jawatengah.go.id/index-n.php/lang.eng/index.home

Karen Bakker et al.(2006), "Disconnected: Poverty, Water Supply and Development in Jakarta, Indonesia", Human Development Report 2006, Human Development Report Office OCCASIONAL PAPER, UNDP.

Asian Development Bank (2007), "Proposed Loan Republic of Indonesia: West Jakarta Water Supply Development Project", ADB.

Nicola Colbran, 'Will Jakarta be the Next Atlantis? Excessive GroundwaterUse Resulting from a Failing Piped Water Network',5/1 Law, Environment and Development Journal (2009), p. 18, available at http://www.lead-journal.org/content/09018.pdf"

Research Progression of Material Group in Fourth Year of the Project: some results.

Shin-ichi Onodera

Graduate school of Integrated Arts and Sciences, Hiroshima University, Japan

Introduction

We have already done this research for more than three years, that is, we have only the research period for less than two years. In addition, we will have RIHN International Workshop in Taipei next November as well as we will receive final recognition next March. So we need also to summarize main results in this news letter. Our progression for last three years is as follows, the intensive researches in each main city in 2006 and 2007 of the first and second year including the intensive chemical and isotopic analysis of samples, submarine groundwater discharge monitoring in Manila, Bangkok, and Jakarta since 2008, and joint discussion with Urban Economy Group since 2008 to 2009. Then we have already published a part of the results in STOTEN, IUGG in Italia, HydroChange, and IAHS in Indo etc.. We confirmed some accumulations of pollutants in soil, groundwater and marine sediment, their sources and transport process, solute flux into the ocean in each city. I would like to describe some results and suggest views of the goals of our group in this news letter.

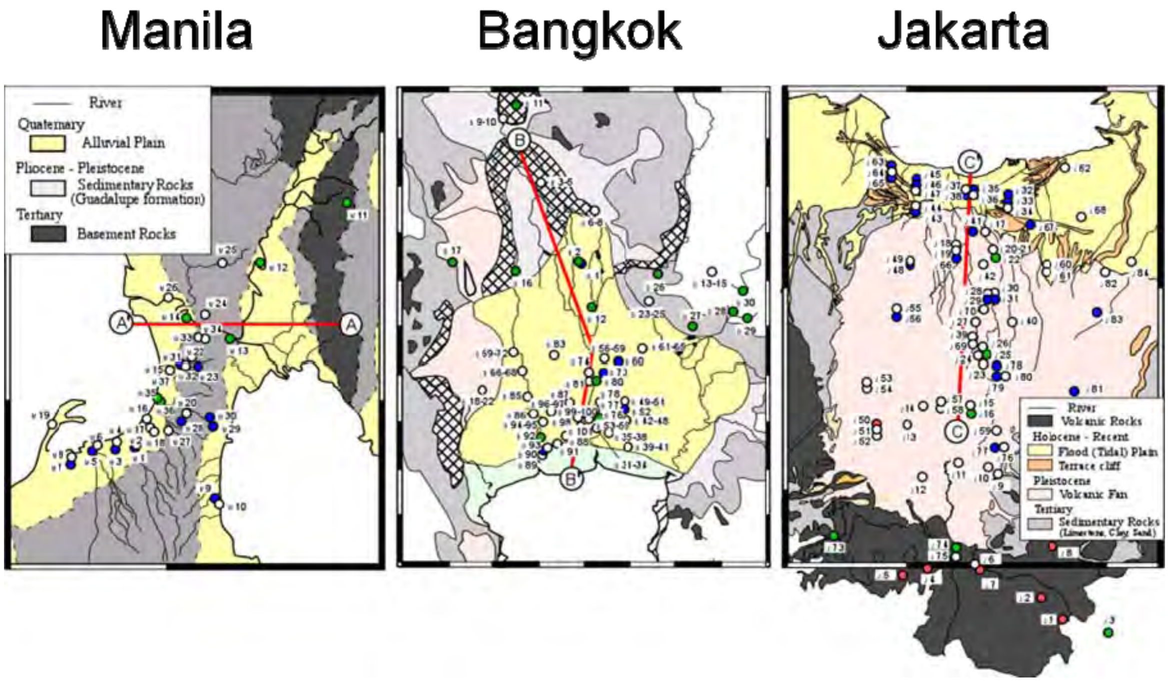


Fig.1 Geological setting and water sampling points in Manila a), Bangkok b) and Jakarta c). (Umezawa et al., 2009).

Research Member

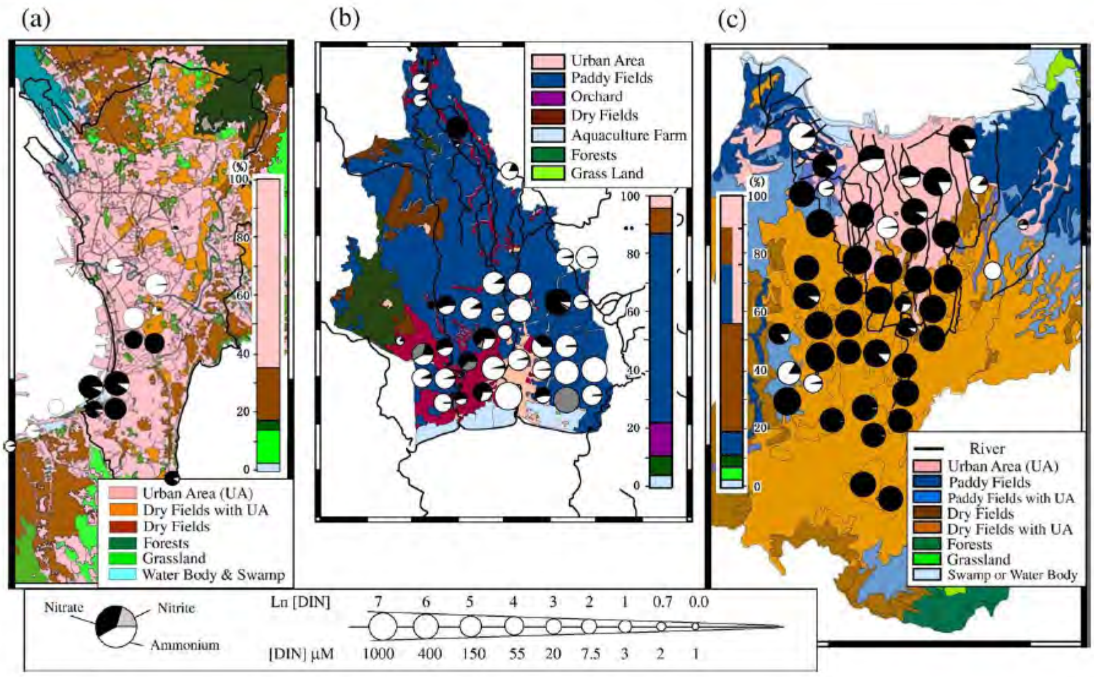


Fig.2 Nitrogen contamination and land use in megacities, a)Manila, b) Bangkok and c) Jakarta (Umezawa et al., 2009).

Our group is composed of Japanese members, and field counterpart members in Korea, Taiwan, Philippine, Thailand, and Indonesia. 8 Japanese members participated in field researches in the first year of this project and pre research. The detail is as follows,

- Core member: Shin-ichi Onodera (Hiroshima Univ.), Takanori Nakano (RIHN), Takahiro Hosono (Kumamoto University), Yu Umezawa (Nagasaki University), Shinji Nakaya (Shinsyu University), Mitsuyo Saito (Ehime University), Kazuhiro Ohkawa (Akita University), and Jun Yasumoto (Ryukyu University).

- Student member: Yuta Shimizu, and Yoshiaki Kato (Hiroshima Univ.)

In addition, our group has conducted the researches in all mega-cities of 6 countries. The international members in all countries have supported our activities and managed the monitoring system.

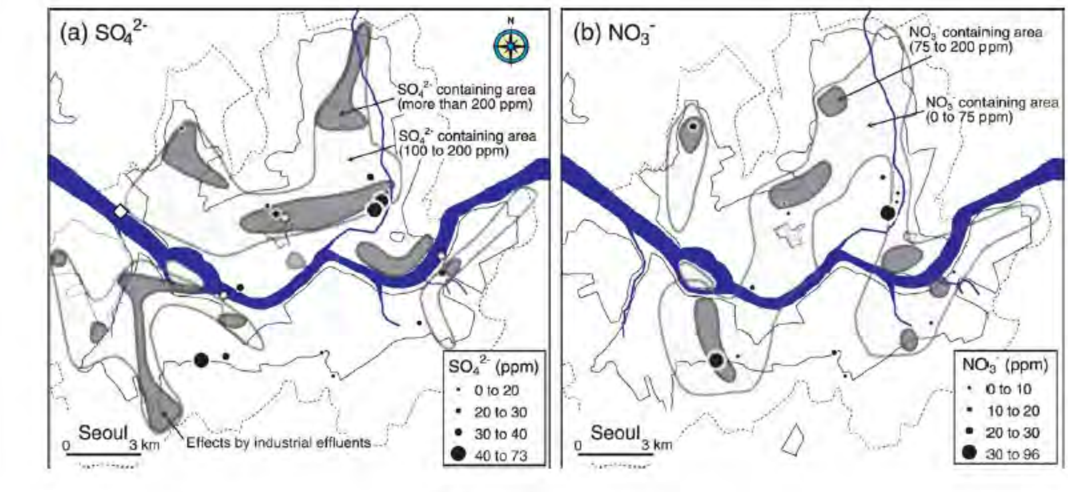


Fig.3 SO_4^{2-} and NO_3^- concentration of groundwater at sampling wells in Soul (Hosono et al., 2009).

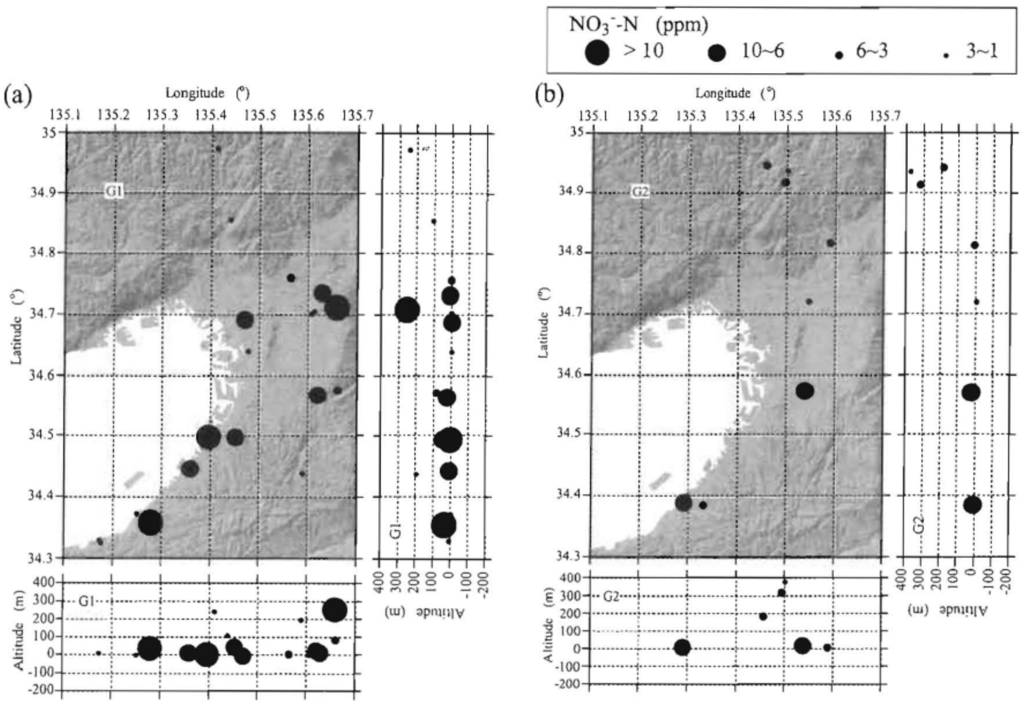


Fig.4 NO_3^- concentration of groundwater at sampling wells in G1 and G2 aquifers in Osaka (Nakaya et al., 2009).

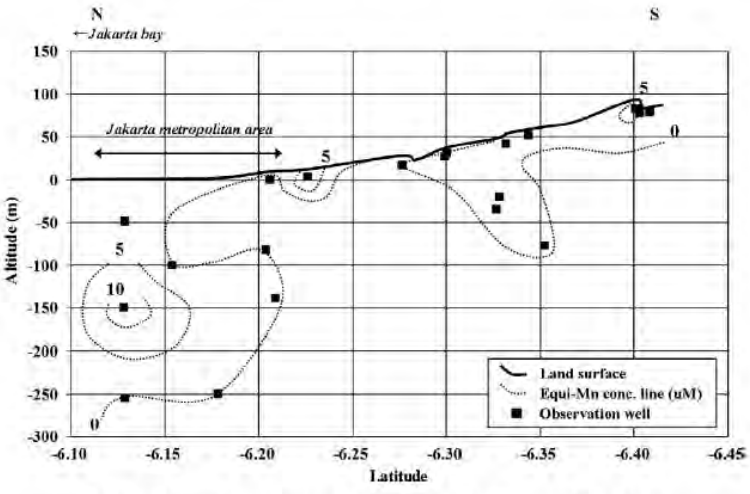


Fig. 9. Distribution of Mn concentration in groundwater on the N–S transect line in Jakarta.

Fig.5 Mn concentration of groundwater in Jakarta (Onodera et al., 2009).

Research Results

We have conducted the intensive researches in two different seasons at Bangkok, Jakarta and Manila (Fig.1) as well as research in one season at Taipei and Seoul. In addition, we have conducted the monitoring of SGD and collection of rainwater, groundwater and porewater at the coastal zone at Manila, Bangkok, and Jakarta.

The results are summarized as follows:

1) we confirmed huge accumulation amount of trace metal, dissolved nitrogen, and chloride in groundwater, especially in Jakarta and Manila(Fig.2, Fig.3, Fig.4 and Fig.5).

2) Various N sources and denitrification were confirmed by using N isotope distribution in groundwater (Fig.6).

3) We detected less terrestrial submarine groundwater discharge but huge material flux by total SGD, and spatial variation in SGD was estimated in Osaka bay, using topographic model (Shimizu et al., 2009).

4) As and NH_4^+ contamination originated by natural sources were suggested by these results (Fig.2).

5) We will reconstruct organic pollution and metal pollution histories, using marine sediments. In addition, the differences of the peak in each trace metal were confirmed.

6) We collected groundwater samples in Osaka metropolitan area and we confirmed the salinisation of groundwater have expanded since 1960.

7) We are monitoring SGD and material load in Bangkok and Jakarta as well as in Manila with automated seepage meter and piezometers of two depths for manual water collection. Unfortunately these equipments have not output reasonable data. Because marine bed materials are mud and sludge, the velocity may be very low.

8) We are also going to develop the new research methods.

a) First one is analysis system of dissolved N_2/Ar in groundwater for reconstruction of dinitrification in groundwater and nitrate content during the groundwater recharge.

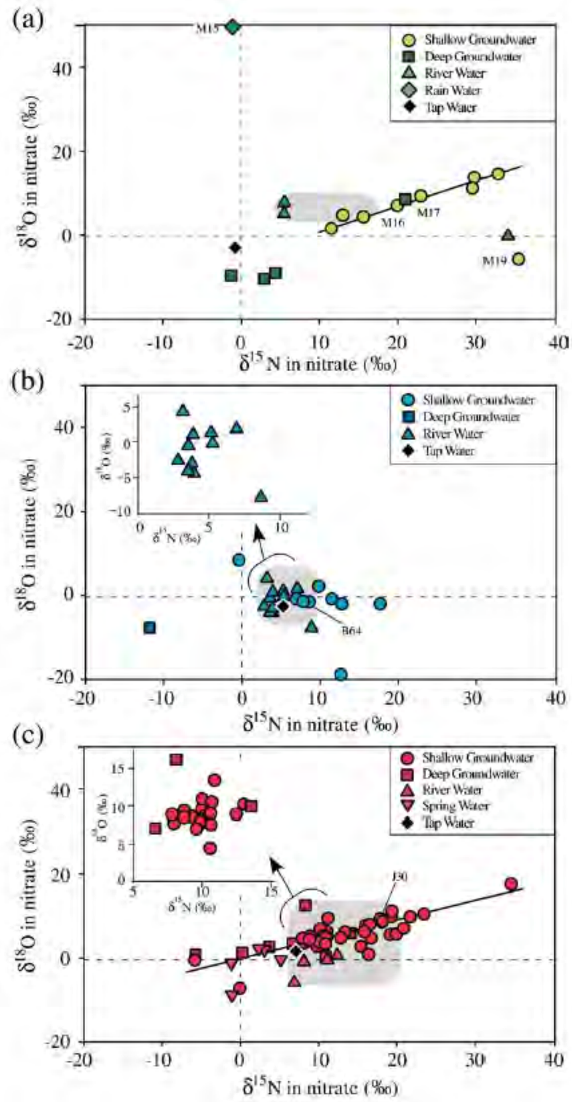


Fig.6 Nitrogen and Oxygen stable isotope in Manila, Bangkok and Jakarta (Umezawa et al., 2009).

b) Second one is Rn analysis system for the quantification of SGD and seawater intrusion.

c) Third one is the purification approach of organic pollution.

9) We had a meeting with the Social-Economic Group on last March and July. The material flow and material balance model will be produced to compare the process and mass balance at each city.

References

Umezawa et al., 2009 STOTEN

Onodera et al., 2009 STOTEN

Hosono et al., 2009 STOTEN

Saito et al., 2009 IAHS publication

Nakaya et al., 2009 Jap. J. Groundwater Scie.

Shimizu et al., 2009 Jap. J. Limnology

Groundwater in the mine used for the confirmation of CFCs aging method in Japan

Shimada, J.[1], Kagabu M. [1], Ikawa, R.[2], Tsujimura, M. [3]

1. Kumamoto University, 2. Geological survey of Japan, 3. Tsukuba University

Development of modern groundwater age tracer

In the study of environmental isotope hydrology, the representative young groundwater age tracer was the radioactive tritium. However, recent tritium concentration in precipitation has been decreased almost natural level (less than 10 T.U.) and the age resolution by using tritium has become lower year by year. In the Taniguchi Project, as for the modern young groundwater age tracer, Cloro-fluoro Carbon (CFCs) and ^{85}Kr method has developed in order to understand the groundwater system in the urban areas. The atmospheric CFCs have introduced into the groundwater through recharge process and could be useful as the shallow aquifer age tracer like tritium. The method has developed by USGS in 1990's but not introduced to Japan and Asian areas. We have learned the sampling, gas extraction, gas separation method from USGS and developed our own system in 2006-2007. Then we applied this method to the groundwater aquifer of many areas in Japan. It has confirmed that some urban area has highly contaminated by anthropogenic CFCs substances and sometimes not applicable this aging method at all. Also in the case of reduction condition in some confined aquifer, CFCs degradation has reduced the atmospheric origin CFCs content and to show apparently old groundwater age in some aquifers. In order to confirm the accuracy of CFCs groundwater aging method in Japan, groundwater age testing by conventional tritium method and new CFCs age method was conducted at the Kamaishi abandoned iron mine in Iwate Prefecture, Japan in July 2008. This is because Kamaishi mine has the long term tritium record in their groundwater and it is possible to confirm the precise groundwater age including its flow system in the bed rock.

Location of Kamaishi iron mine and its tritium history

Kamaishi mine is located in the eastern coast of Iwate prefecture and one of the old iron mine in Japan. Iron ore itself has abandoned in 1970's, but it has long drift tunnel excavated into granitic puluton and grano-diorite, these drift itself has been used for the ideal in-situ rock mechanical study site and the groundwater study in the crystalline bed rock aquifers. There were several horizontal drift tunnels for the iron mining, only the 550 m above sea level horizontal drift tunnel has been left open to use for the underground experimental purposes. Fig.1 shows the location of Kamaishi mine and the expansion of the 550 m level horizontal drift tunnel. The groundwater study was done the most end of this horizontal tunnel from late 1980's. Fig. 2 shows the tritium record of some groundwater sampling points in the drift tunnel from 1980's to 2008.

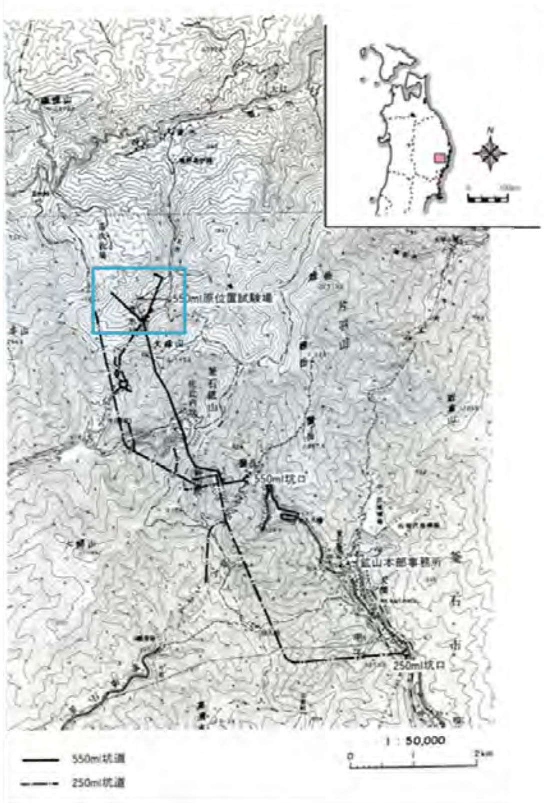


Fig.1 Location of Kamaishi mine and the expansion of the 550 m level horizontal drift tunnel.

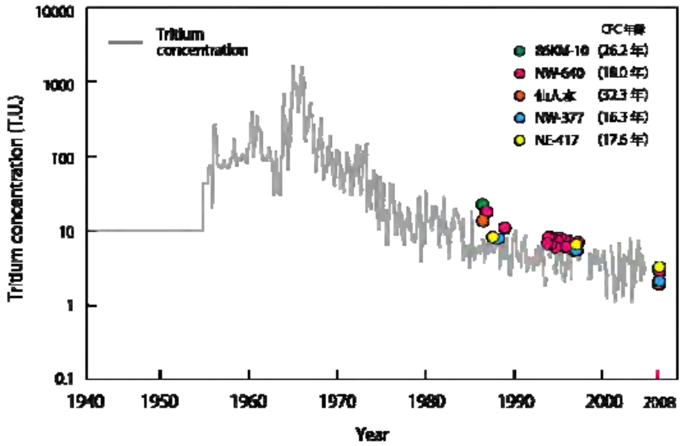


Fig. 2 The tritium record of some groundwater sampling points in the drift tunnel from 1980's to 2008.

Groundwater sampling campaign in 2008

In the year 2008, we have visited twice for the Kamaishi mine to sample the representative groundwater age sample from this mine in order to compare with the precise groundwater age confirmed by the long term tritium record of this drift tunnel.

Fig.3 Battery rail car of the drift tunnel, its tunnel entrance and conveying sub-vehicle for the sampling tools.

4km rail car drive in the dark mine drift tunnel takes nearly 30 minutes from the tunnel entrance in the Figure 3 to the sampling location which is almost the end of the drift tunnel. The drift wall is mostly composed by Granite and Grano-diorite with some drip seepage and self-flowing boreholes. Because of low flow rate of groundwater sampling points and needs as much as less contact with present air, it is very time consuming and tuff work for the CFCs groundwater sampling (Fig. 4). Sometimes it takes more than one hour to collect 2 L of groundwater. The air temperature in the tunnel is around 14 to 17 ℃ all the year round, which is affected by the groundwater temperature at that depth. This is bit cool in short time period, but it gradually becomes really cold during the long term sampling work at one location with not much moving action. You can understand to wear the thick winter cold jacket during sampling shown in the Fig.4.

Fig.4 CFCs groundwater sampling in the Kamaishi drift tunnel.

Good results to confirm CFCs groundwater aging method in Japan

Table 1 shows the results of our comparison for tritium method and CFCs method. It shows very good results for the CFCs aging method which is very comparable with conventional tritium method. This is because Kamaishi mine is quite remote area from anthropogenic CFCs origin and quite representative CFCs input concentration, which is almost similar to Northern hemisphere average by USGS, can be applicable at this location. The results show CFCs aging method is effective in the Japanese aquifer which has not been much affected by the anthropogenic CFCs origin.

For Taniguchi Project, this result is somehow not happy because it will be a problem for the groundwater age confirmation in the urban aquifer. However, CFCs itself can be an anthropogenic contamination factor in the urban area and this can be used as an urbanization indicator instead of groundwater aging tracer. As for the other young groundwater age tracer, ^{85}Kr method has also developed in our project. We will expect ^{85}Kr method as the young age tracer in urban area. We are planning to precede the similar age confirmation test at Kamaishi mine for ^{85}Kr method late of 2009.

Sampling point	Residence time (Piston flow)				LUMPED Model
	Tririum	CFC-11	CFC-12	CFC-113	(Piston+Bypass flow)
86KM10	16 or 28	28	22	23	26.3
NW640	17	—	18	22	16.4
NW377	14	14	8	18	11.7
NE417	14	—	—	5 or 17	9.1
Senninsui	31	46	32	55	33.5

Table.1 The comparison of tritium age method and CFCs age method.

Radon, Groundwater, and Oysters: Chokai, Japan

Bill Burnett

Florida State University , USA

I recently spent an interesting 3 months at RIHN working on the urban subsurface environments project. During this period I teamed with colleagues at RIHN to investigate groundwater discharge into the Sea of Japan off the coast of northwestern Honshu. This region is primarily volcanic with considerable relief (Mt. Chokai, at 2236 m, is one of Japan's highest peaks). During the week of July 20-24, 2009, Makoto Taniguchi, Takahiro Hosono, Masa Ono, Akinori Murata and myself surveyed a portion of this coastline and deployed moorings for preliminary evaluation of the sites and magnitudes of submarine groundwater discharge (SGD) into the coastal zone.

This area is known to have an abundance of springs, a result of heavy rainfall, high relief, and a volcanic terrain conducive to groundwater flow and storage. Undocumented reports suggest rainfall amounts approaching 20 meters per year near the summit of the volcano. Springs are plentiful along the coastline as well as offshore. The local economy is based on tourism and fishing with oysters being one of the prized commodities. Interestingly, we have been told that the "best" oysters originate from the bays along the coast that do not have any surface drainage but are characterized by brackish water because of SGD.

We based our survey mainly on ^{222}Rn, a naturally-occurring radioactive gas that is typically 2-3 orders of magnitude higher in groundwaters than surface waters. In the Chokai area, the radon in the coastal waters was very high indeed. Concentrations over 25 dpm/L (disintegrations per minute per liter) were measured in surface seawater during the survey (~200 m offshore) and near-shore moorings showed concentrations up to over 500 dpm/L, perhaps the highest yet measured in a coastal marine environment. On our first day of surveying, we found two areas with higher radon than adjacent areas, both signals emanating from small river-free embayments with known springs and plentiful oysters (Fig. 1).

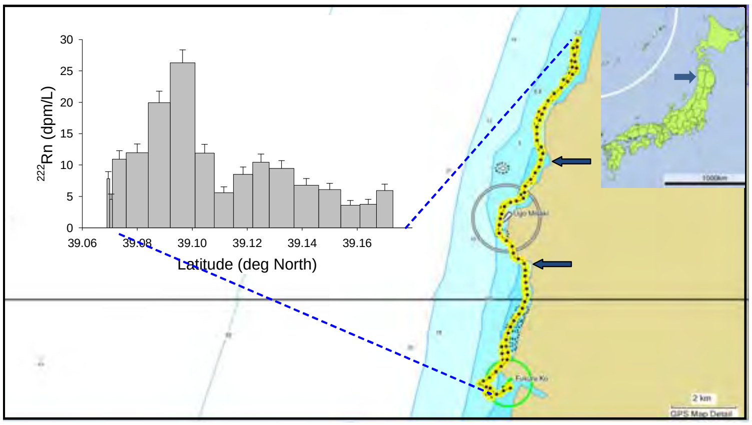


Figure 1. Over-lapping survey lines along the Chokai coastline. The bar graph shown represents results from the return path from north to south. Subsequent surveys showed the same pattern. The two arrows pointing left indicate the approximate locations of the two high areas in groundwater discharge as indicated by the radon.

One of our moorings was deployed in the small embayment of Kaimaiso, just to the south of the southernmost hot spot noted from the survey, a bay known as Mega. Both of these areas are characterized by clearly visible submarine springs, cool water, and some of the most sought after and expensive oysters found in Japan. Based on the radon inventory versus time plot (Fig. 2) we can estimate the flux of groundwater-derived radon into the coast at the site of this deployment. Using measurements of radon in groundwater made in the area and assumptions about the area of seepage around the embayment, we estimate that the groundwater flow must be at least 5,000 m^3/day just inside Kaimaiso Bay, only a few hundred meters in length.

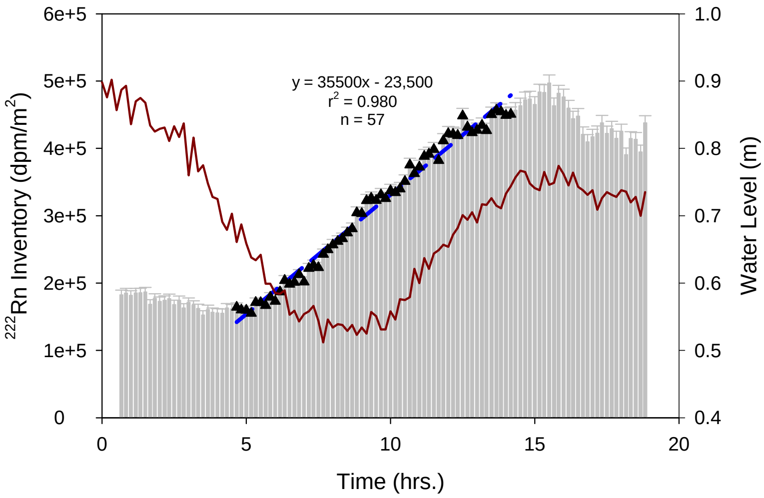
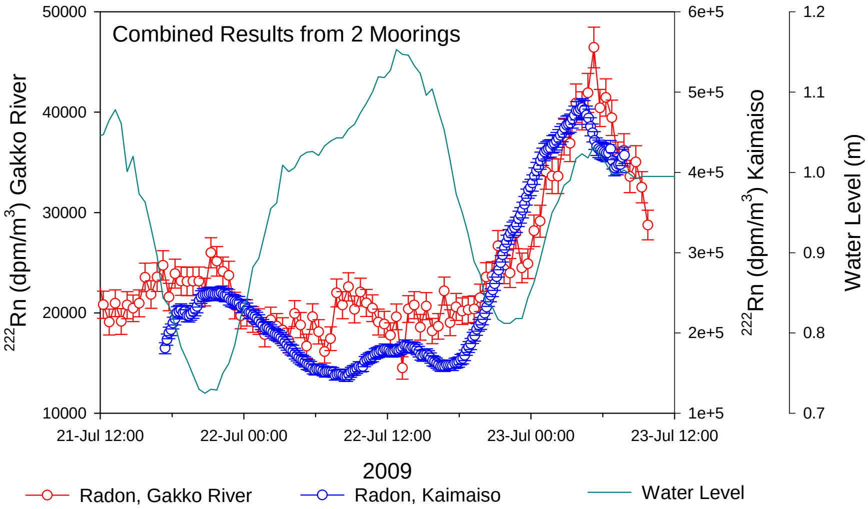


Figure 2. Radon inventory (bars) and water level (solid line) at a near-shore site in Kaimaiso Bay July 22-23, 2009. The regression of inventory versus time is performed over the linear segment shown by triangles.

An interesting aspect of the moorings was the strong coherence between the radon distributions from two stations ~1 km apart (Kaimaiso and the mouth of the Gakko River; Fig. 3). Note that while the radon concentrations are almost an order of magnitude different, with the station at Kaimaiso showing the higher concentrations, the trends are very similar with a sharp increase in radon shortly before midnight, July 23. In addition, we note that there was little response to tidal fluctuations during most of the approximately 48-hour deployment period. This is unusual for coastal settings as tidal pumping typically drives water into the sub-bottom during high tide and out of the sub-bottom at low tide. Because radon is acquired underground, this process is reflected in higher radon activities in the discharged waters. One possibility that may explain the unusual record from the Chokai area moorings is that groundwater discharge here is dominated by terrestrial, rather than marine forces. This is consistent with the dramatic relief and high rainfall in this area.

Figure 3. Radon time-series results from deployments at the mouth of the Gakko River and at Kaimaiso. Note that the radon concentrations are much higher at Kaimaiso. The water level curve is from the Gakko River station.



The oysters are good. The ones seen most commonly in the market (Fig 4) are from the Sakata area and are river-fed. These each sell for 600-700 JPY (~US $7-8 each!). Those from Mega and Kaimaiso, SGD embayments, will cost you about 1,000 JPY a piece if you are lucky enough to be in the area. Order one in a high-end Tokyo restaurant and you may need your platinum Visa credit card.

Why are there these differences between oysters? Does the source of the fresh water really make such a difference? Is it the radon? Perhaps a little polonium (radioactive daughter of radon) helps. Is it possible that SGD/river water variations result in dissimilar phytoplankton numbers and/or compositions that affect oyster growth and quality? We are now pursuing discussions with David Kimbo, an oyster expert at Florida State University, in hopes of developing a project to investigate these terrestrial-marine linkages further. The study would be in collaboration with personnel at RIHN, and Kimberly Burnett (University of Hawaii) would add an economic component by designing a methodology to value ecosystem services.

Figure 4. During our visit, Sakata oysters were selling for 600 JY each. The ice chest next to the cooler shows which port the oyster originated from, providing clues about the relationship between price and location.

Currently the Sakata area uses only surface water for domestic and irrigation purposes, therefore there is no "price" for their groundwater resources. However, this does not mean the groundwater is without economic value, especially if the higher priced oysters (Fig. 5) are indeed correlated with SGD prevalence. Any premium paid for "SGD oysters" over oysters from river fed systems may be able to be attributed to the water resource itself. Using oyster price and consumption data, one can estimate the value of the groundwater ecosystem service to the Sakata region.
It will be interesting to see where our investigations of possible linkages between groundwater discharges and ecological services lead us.

Figure 5. Oysters mean big business for this fish market in Sakata.

Joint Research with RIHN

Yuta Shimizu

Graduate school of Integrated Arts and Sciences, Hiroshima University, Japan

My name is Yuta Shimizu and I am a second year Ph.D. student of Integrated Arts and Sciences at Hiroshima University. My major is environmental hydrology and numerical modeling of material transport in river basin scale.

In the RIHN Project Human Impacts on Urban Subsurface Environment, I am a member of the Material subgroup and I am engaging in two subjects to understand nitrate contamination at the Asian mega-cities.

One is to confirm past nitrate contamination in groundwater with each developing stage by analyzing dissolved gases such as Nitrogen gas (N_2), Argon gas (Ar) and Oxygen gas (O_2) in groundwater. Analysis of nitrogen gas and argon gas in groundwater is also useful to confirm denitrification and to determine recharge temperature of groundwater. We have corrected groundwater samples at Jakarta, Bangkok, Manila and Osaka in 2008 and 2009. Now, I am analyzing dissolved gases of groundwater, and the results are coming out.

The other is to estimate nitrate loading at each cities. I am estimating of nitrogen load of 1930, 1970 and 2000, using land-use data which were created by urban geography subgroup. The estimating model is based on previous study. The results are also coming out. Finally, I will combine these results to restore a past nitrate contamination.

I have been able to make the acquaintance of many researchers including foreign country through this project. It will become a big property for my research in the future.

Poster presentation at IAHS2009

ANNOUNCEMENTS

・The 4th RIHN International Symposium "The Dilemma of Boundaries: Toward a New Concept of Catchment " (Kyoto, October 20-22)

・USE Project General Meeting (Otsu, October 28-30)

・The 3rd International Symposium on "Human Impacts on urban subsurface environment" (Taipei, November 17-20)

Call for Contributions

For the ninth volume (April 2010), we would like to request the following Groups/individuals to give their articles for the newsletter: Prof. Yoshikoshi's Group, Prof. Fukdua's Group, Prof. Yamano's Group, Dr. Yasumoto, Dr. Huang, Mr. Hasegawa, Dr. Nakada. To allow ample time for editing and layouting, we hope to receive your articles on or before March 31, 2010. For inquiries, please send email to: **makoto@chikyu.ac.jp**

Inter-University Research Institute Corporation
National Institutes for Humanities, Japan
Research Institute for Humanity and Nature

Project 2-4 Human Impacts on Urban Subsurface Environments

http://www.chikyu.ac.jp/USE/

Contact:

457-4 Motoyama Kamigamo, Kita-Ku, Kyoto
603-8047 JAPAN
Phone: + 81– 75– 707-2261
Fax: +81-75-707-2506

Project Leader: Dr. Makoto Taniguchi

Newsletter Editor: Keiko Yamamoto
Email: yamamoto@chikyu.ac.jp

ACKNOWLEDGMENT We wish to thank all project members who have contributed to our newsletter. Your articles and reports are very valuable and informative. We hope for your continued support and cooperation in the succeeding issues of our newsletter.

Human Impacts on Urban Subsurface Environments

This project will assess the effects of human activities on the urban subsurface environment, an important aspect of human life in the present and future but not yet evaluated. This is especially true in Asian coastal cities where population and density have expanded rapidly and uses of subsurface environmental have increased. The primary goal of this project is to evaluate the relationships between the development stage of cities and various subsurface environmental problems, including extreme subsidence, groundwater contamination, and subsurface thermal anomalies. We will address the sustainable use of groundwater and subsurface environments to provide for better future development and human being.

RIHN Corner

Tomoyo Toyota

Project Researcher

Since April 2009, I have joined this project as a project researcher of social economic group. I entered to the University of Shimane in 2000 I concerned about poverty reduction and income-gap in the developing countries, I majored the economic development. After graduation of the university, I entered Graduate School for Development and Cooperation, Hiroshima University in 2004, and I started to conduct study about agricultural modernization and environmental problem.

Environmental problem is externality in the market economy. When we make the environmental decision-making, we have to evaluate this externality. However, it is difficult to show the situation or scale of environmental problem because environmental issue mixed multiple problems. So I tried to visualize of the various environmental impacts as one indicator by using ecological footprint (EF) approach.

Capital intensive agriculture contributes to improvements in land productivity, as lesser land input and more production, while production and use of the capital causes environmental pollution and burden. EF is an accounting framework of the land which is required for assimilating environmental burden. For measuring ecological footprint as required indirect lands, one might consider environmental pollutions discharged from production processes of agricultural machinery and chemical fertilizer and pesticide, carbon dioxide emissions in use of agricultural machinery, water catchments for irrigation water and etc. The EF enables to translate the impacts of various different environmental burdens into the area of land, as a size of environmental externalities. In the process of agricultural modernization, the trade-off between increases in land productivity and ecological footprint can be observed in such a way that harvested land to produce one unit of agricultural product (land input) is declining, whereas the EF is increasing.

Environmental problem in the city is also externality. Especially city generates the intensive environmental problems by the human activity. The urbanization of Asia is rapidly increased, and there is growing concern about the worsening environmental problems in the city. I would like to evaluate the externality in cities by developing stage, for sustainable development.