Urban Subsurface Environments

Newsletter Volume 5 April 2008

Project Activities and Plans

Makoto Taniguchi, RIHN

The full implementation of the project "Human Impacts on Urban Subsurface Environment" continues in 2008 and the project members have conducted field experiments, surveys and data gathering in the target cities.

Summary of the group activities of the Urban Geography, Water, and Gravity groups and research results are featured in this volume of our project's newsletter. This issue also contains overview and comments on the research of Bangkok, Manila and Taipei.

Inside this issue

The Project FR2-4 "**Human impacts on urban subsurface environment**" started at 2003 as Incubation Study, followed by Feasibility Study (2004), Preliminary Research (2005), and Full Research (2006). The **interim external evaluation** of the project had been made on Feb. 28, 2008.

In order to integrate the results of this project, the **2nd International Symposium and Workshop** was held in Bali, Indonesia on Dec 4-8, 2007, which was also authorized as one of the side events of COP13. The number of symposium participants was 157 and they came from 9 countries (Indonesia, Japan, Thailand, Philippines, USA, Germany, Australia, Korea and Taiwan). The progress report which shows the summary of the interim results of the project and results from each subgroup was published on Feb 2008 as "**Progress Report 2007**".

The interim results of the project are also planned to be published in a special issue of **STOTEN** (**Science of Total Environment,** Elsevier) Journal in 2008. New methods for evaluating the changes in groundwater storage by Satellite GRACE, and residence time by ^{85}Kr and CFCs, have been developed in this project. The results of submarine groundwater discharge and dissolved material transports through groundwater into the ocean by using stable isotopes (C, N, O, Sr) revealed the origin of groundwater in each city. The study on subsurface temperature in Asian cities showed the magnitude and timing of urbanization, and the results published in the peer reviewed paper were also introduced in the open scientific news "Scitizen".

Cross cutting themes, such as groundwater and religion, laws and change in reliable water resources between groundwater and surface water, development of integrated indicators based on GIS for understanding the relationship between human activities and subsurface environment, and combining subsurface environmental problems into socio-economic model, have been considered as additional insights for the project. The results of the project were featured in some newspapers (Yomiuri and Mainichi), radio show (Kyoto Broadcasting System), and open lectures.

Visiting Research Fellow

Dr. Robert Mohammad Delinom, Senior Research Scientist of the Research Center for Geotechnology of Indonesian Institute of Sciences (LIPI) arrived in RIHN on 6th April 2008 and will stay here for three months as a Visiting Research Fellow.

By education and training, Robert is a geologist, specializing in hydrogeology. His current research interest include groundwater flow model based on sub-surface temperature and stable isotope, the evidence of global climate change, geological structure features on groundwater flow patterns, and submarine groundwater discharge (SGD).

Research of Urban Geography (2007)

Akihisa Yoshikosihi

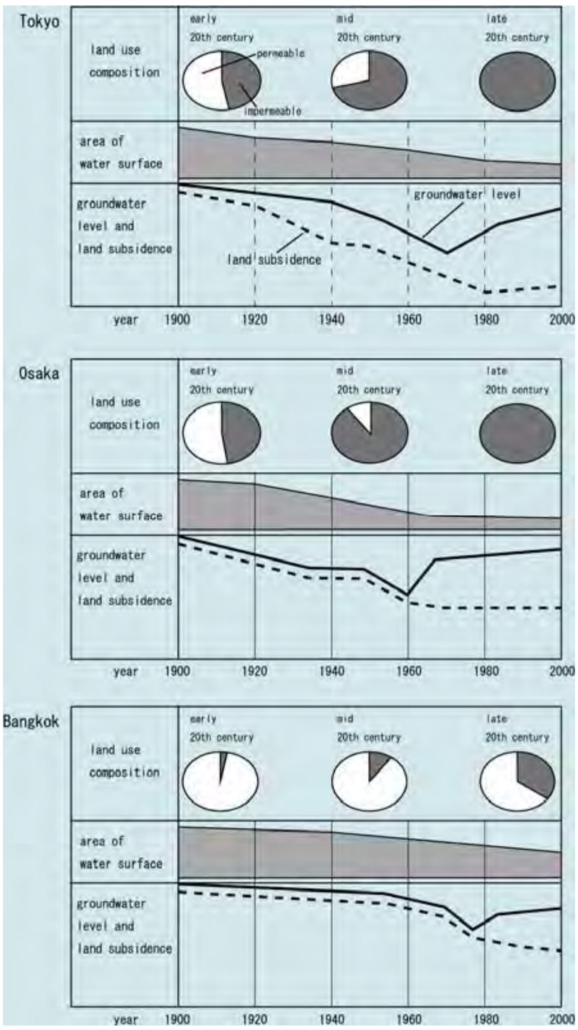
Ritsumeikan University

Research title

"Hydro-environmental changes and their influence on the subsurface environment in the context of urban development"

Purpose of the research

First purpose of the research is to qualitatively analyze (finally quantitatively analyze) the relationship between urban development and hydro-environmental changes and to examine the influence of these factors on the subsurface. Second purpose of the research is to provide the urban geographical data for other groups. Third purpose of the research is to explore the new possibility of research by joint research with other groups. Among these, about the first and the second purpose, we are getting the considerable result.



Changes of "land use composition", "area of water surface", " groundwater level" and "land subsidence" in Tokyo, Osaka and Bangkok in 20th century

Research members

Akihisa YOSHIKOSHI, Ritsumeikan Univ.

Itsu ADACHI, JICA

Kazuya SUZUKI, JICA

Tomomasa TANIGUCHI, Rissho Univ.

Yuichi KAGAWA, Univ. of Shiga Prefecture

Masahiro KATO , Ritsumeikan Univ.

Akio YAMASHITA , Rakuno Gakuen Univ.

Manabu INOUE, Ritsumeikan Univ.

Taiko TODOKORO, Ritsumeikan Univ. Graduate School

Toshiaki ICHINOSE, National Institute for Environmental Studies

Kumi KATAOKA, Univ. of Tsukuba

Yingjiu BAI,Tohoku Univ. of Community Service and Science

Takahiro ENDO, RIHN

Result of the research

1.Research Paper: [Science of Total Environment, Elsevier]

"Hydro-Environmental Changes and their Influence on the Subsurface Environment in the Context of Urban Development"

A.Yoshikoshi,I.Adachi,T.Taniguchi,Y.Kagawa,M.Kato,A.Yamashita,

T.Todokoro,,M.Taniguchi

2. Urban Seminar: 19 Oct. 2007 at RIHN

"Urban Seminar(Bangkok)"

5 Presentaions and 1 Comment

3. Session of Inter-University Research Activities in Japan:

1-2 Nov.2007 at CSIS, Kashiwa

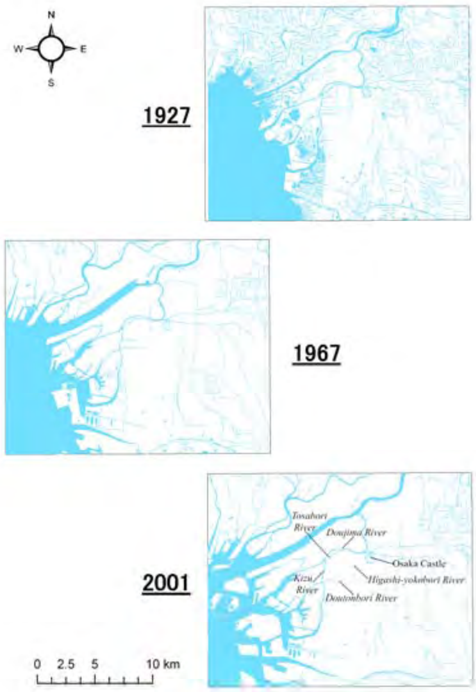
"Urban Structural and Historical Changes of Hydrological Environment in Tokyo and Osaka"

A.Yoshikoshi, S.Kaneko, I.Adachi, Y.Kagawa, M.Kato, H.Tanikawa, T.Taniguchi, A.Yamashita,T.Todokoro, Y.Umezawa, J.Nishijima, A.Miyakoshi, T.Yamanaka

4. International Symposium and Workshop on Current Problem in Groundwater Management and Related Water Resources Issues: 3-8 Dec.2007 at Bali

"Hydro-Environmental Changes and their Influence on the Subsurface Environment in the Context of Urban Development"

A.Yoshikoshi, I.Adachi, T.Taniguchi, Y.Kagawa, M.Kato, A.Yamashita, T.Todokoro, M.Taniguchi



Change of Water Area in Osaka Plain

5.Symposium of Japanese Association of Geography:

29 Mar.2008 at Souka

"Urban Development and Water and Heat Environment of Asian Mega Cities"

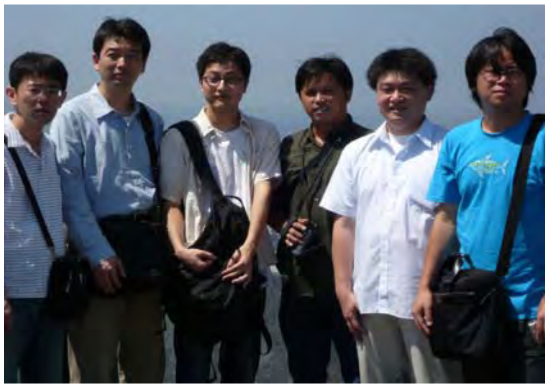
7 Presentations and 3 Comments

6. Field Survey:

Manila (15-19 Mar.2008)

Taipei(1-5Sept.2007)

Tokyo and Osaka

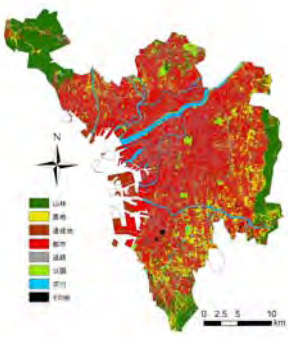


Manila 1

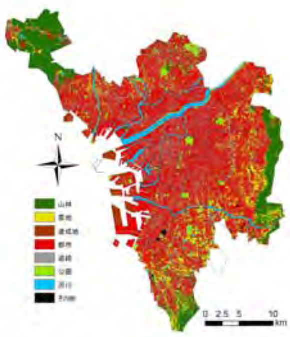
Danshuei, nearTaipei

Manila 2

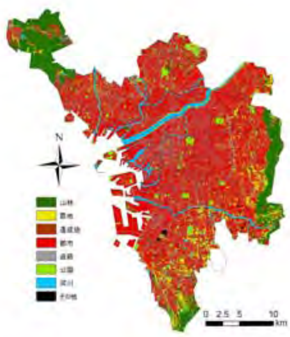
7. GIS Method, Result of GIS Group



1974



1985



1996

Land Use Map of Osaka

The urban heat island phenomenon and its mitigation through planning (1)

Toshiaki Ichinose, Futoshi Matsumoto, Kumi Kataoka

National Institute for Environmental Studies

1.Summer heat problems in urban settings

Increasing urbanization is generally associated with heat islands—a phenomenon of rising temperatures in urban settings. As a result, more people are affected by higher temperatures for longer periods. Heat islands not only make life uncomfortable for urban residents, the increased temperatures adversely affect people's health (e.g. accelerating air pollution by less ventilation) and the natural ecosystems (e.g. changing flora and fauna) in cities.

With increasing urbanization, ground surfaces have been converted from natural soil or green tracts of land, which function to lower the surrounding air temperature through the cooling effect of *evapotranspiration*, to materials such as asphalt or concrete, which lack any water content and tend to heat the atmosphere. Moreover, in major urban regions, although work is ongoing to develop parks and similar amenities, there has been a substantial decrease in greenery and "productive green land" in residential areas. Land for roads, public facilities, offices, and high-rise residential blocks is increasingly surfaced with water-impermeable substances such as asphalt paving. Asphalt or concrete ground surfaces reach relatively high temperatures—in the region of 50–60 deg C—during the daytime on clear summer days, and this daytime heat builds up and is still present during the night.

Exhaust heat from urban energy consumption, such as air conditioners or vehicle traffic, is also a major factor in atmospheric heating (e.g. Ichinose *et al.*, 1999). The warmed atmosphere moves according to meteorological or geographic conditions such that the heat not only affects the region where it originated but also produces downwind effects.

Urban environments create a complex set of factors, such as (1) the blocking of heat dispersal through natural wind flows, because of the formation of conurbations; (2) the location of factories and other major heat sources at coastal sites (windward) in seaside cities; and (3) the formation of low-wind areas where the atmosphere tends to stagnate because of the shape of the ground surface, including urban topography and the presence of large buildings.

Japan's Ministry of the Environment (MoE) has recently investigated these issues through various committees (e.g. MoE, 2001a; MoE, 2001b), concluding that heat islands are domains of thermal atmospheric pollution, caused by human activities. The Ministry of Land, Infrastructure and Transport (MLIT) and local municipal authorities have also started to debate various measures, while the general public is also increasingly interested in this topic as an environmental problem (Ichinose, 2005). We start this chapter with a discussion of the impact of heat islands using actual examples of their assessment as well as measures to mitigate and adapt to summer heat. We then discuss the potential for developing user and environmentally friendly cities that take into account the atmospheric and thermal environments.

2. Impact of urban heat islands

It has recently been suggested that urban warming, as symbolized by heat islands (e.g. Landsberg, 1981), is affecting ecosystems, including our environment. The impact on ecosystems was pointed out some time ago (Numata, 1987), but unusually almost no research has been undertaken to evaluate this effect. Impact assessments are important in terms of providing warnings concerning the issues involved and educating urban residents and as basic information or evaluation tools for use in social policies and to estimate the costs involved (Matsumoto *et al.*, 2006). As such, impact assessments can be thought of as barometers or indices for changing climatic environments.

2.1 Impact on human activities

Heatstroke and other health issues are the main risks from higher urban temperatures. Fig. 1 shows Tokyo Fire Department figures for the number of individuals transported to hospital with heatstroke during the summer. Heatstroke often occurs when individuals are working or exercising outdoors, but this figure also includes some examples of individuals requiring emergency transport after being indoors. The results shown illustrate the harsh environment during the summer heat in cities.

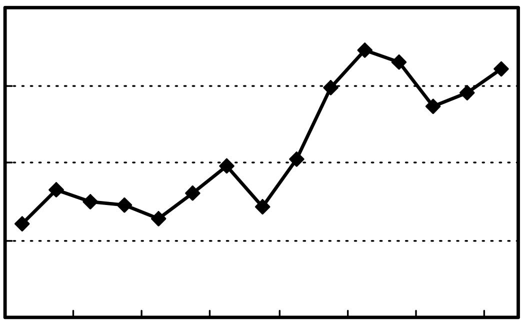


Fig.1 Transported to hospital with heatstroke in Tokyo (Running average in 3 years)

(Tokyo Metropolitan Government, 2006)

<http://www2.kankyo.metro.tokyo.jp/heat/heat1.htm>

Another problem that is becoming more prevalent is the increase in the number of summer "tropical nights" in urban settings when daily minimum temperatures exceed 25 deg C (Fig. 2). This is attributed to heat storage by artificial ground surfaces and its release during the night, which prevents temperatures from falling. Such temperatures produce discomfort, including sleep difficulties, physical fatigue due to inadequate sleep, additional burdens on cardiac function, and psychological stress. There also appears to be an increasing number of heatstroke cases occurring at night. Fatigue due to inadequate sleep affects the individuals concerned the following day and this should not be overlooked as a risk factor associated with the onset of heatstroke during the day.

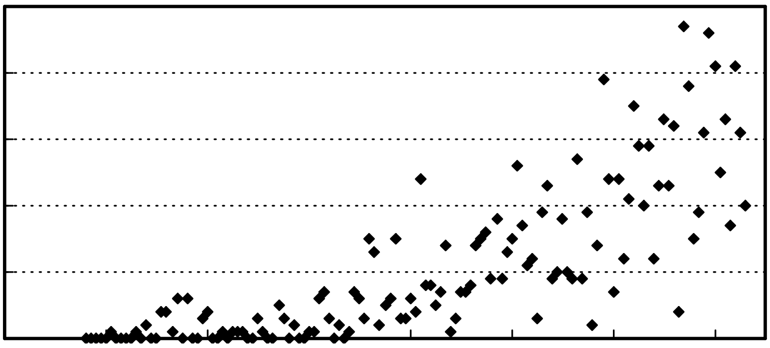


Fig.2 Numbers of “Tropical Nights (minimum temperature is exceeding 25 deg C)”in Tokyo

Other factors behind such hot summer environments involve urban living infrastructure, including the widespread use of air conditioners. The lifestyle of urban residents has become dependent on air conditioning, and this promotes health problems resulting from summer heat. Air conditioning use superficially appears to be a way of preventing or coping with summer heat, but it actually creates a vicious circle whereby the air conditioner is switched on because it is hot, and this then consumes energy and the exhaust heat makes the outside temperatures even hotter. Another recently recognized problem is summer colds caused by air conditioning use.

Of course, such high temperatures are caused not only by urbanization, but can also occur as a result of extreme weather phenomena, such as heat waves, not directly related to urbanization. References such as the report by the Intergovernmental Panel on Climate Change (IPCC) highlight the possibility of increasingly fierce summers due to global warming. However, urbanization itself definitely plays a role in exposure to high temperatures. When conducting impact assessments of rising temperatures in urban settings, we may need to consider comparisons with the impact from global warming as well as synergistic effects with global warming.

2.2 Impact on urban ecosystems

We have recently started to see changes in the vegetation season, with flowers blooming earlier in the spring and leaves changing color later in the fall (Yoshino and Park, 1996; Momose, 1998).

Fig. 3 shows inter-annual changes in average March temperatures and the date of Somei Yoshino cherry tree blossoming in the Tokyo District Meteorological Observatory. The figure demonstrates that the cherry blossoms have recently bloomed earlier each year in line with rising temperatures.

Fig. 4 shows an assessment of the impact of heat islands in the Tokyo wards on the date of Somei Yoshino cherry tree blossoming. In heat islands in the heart of Tokyo, the cherry trees are blossoming some 5–6 days earlier than in the suburbs (Matsumoto *et al.*,

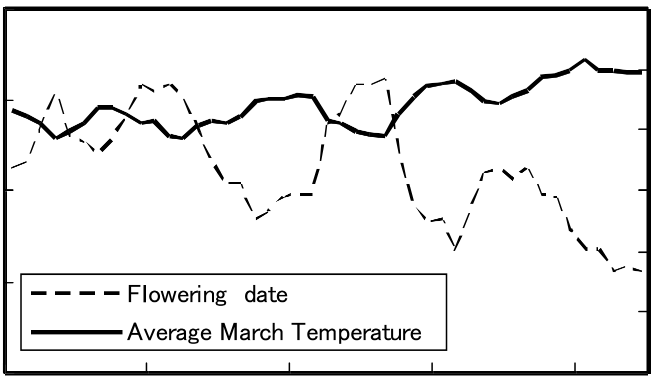


Fig.3 Inter-annual changes in average March temperatures and the date of Somei Yoshino (cherry tree) blossoming in the Tokyo District Meteorological Observatory. (Running average in 5 years, during 1960 - 2004)

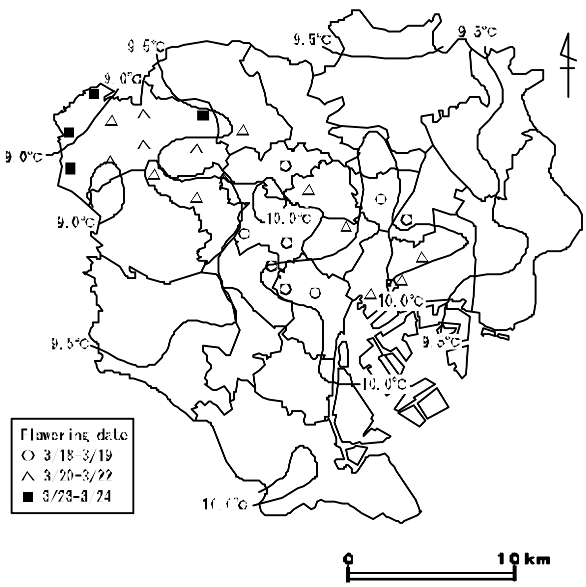


Fig.4 Distribution of flowering dates of Somei Yoshino (cherry tree) and mean temperature in March in the Wards Area in Tokyo in 2004 (Based on Matsumoto *et al.*, 2006)

2006). Moreover, there have been reports that in Kumagaya City, a small-to-medium sized city in Saitama Prefecture (population: approximately 160,000), cherry trees located in heat islands in the city center are blossoming around 2 days earlier than those in the suburbs (Matsumoto and Fukuoka, 2003). This suggests that the earlier blossoming is not simply a result of global warming, but may be associated with rising urban temperatures as symbolized by the heat islands. There have also been reports of the leaves on gingko and Japanese maple trees changing color later in the fall in city centers (Matsumoto and Fukuoka, 2002; Matsumoto, 2004).

In addition to these effects on vegetation seasons, heat islands are also thought to impact other organisms in various ways. For example, there have been reports of the successful open-field cultivation of tropical aloe plants in the Tokyo city center (Nemoto *et al.*, 2001), as well as reports of the disappearance of dragonflies (Shinada *et al.*, 1987) and a fall in black-spotted pond frog numbers (Momose, 1998).

Of course, we do not know enough about the mechanisms behind the relationship between heat islands and early cherry blossom blooming or tropical plant cultivation, so these examples do not necessarily prove a direct causal relationship. Moreover, we have the impression that these phenomena do not appear to be particularly relevant to urban living. However, ecosystems consist of complex relationships between organisms, one example being the food chain, so a breakdown in the balance of the ecosystem could eventually result in the extinction or, indeed, a plague of a particular organism. We also run the risk that the natural environment in which we live, including the atmosphere, water, or soil that have long been cleaned by other organisms, will no longer function normally. This could also bring about changes in sanitary conditions, such as the emergence of pests or changes to agricultural production in city suburbs. From this perspective, it is becoming increasingly important to evaluate changes not only in the summer, but also in the winter, spring, and fall.

In conclusion, it is necessary to conduct careful monitoring and study-based assessments of the impact on natural ecosystems in urban climates. Such assessments need to take a multidisciplinary approach to comprehensive analyses, drawing on expertise from various fields, including meteorology, medicine, ecology, geography, agriculture, and anthropology.

Observations of bio-ecosystems within cities are inexpensive and easily understood methods of understanding local environmental change and can also be used in observation networks or for monitoring environmental impacts on the citizen level. Moreover, they can act as learning tools for real-life environmental education when schools and other educational establishments are involved.

An understanding of the actual impact of urban warming, as symbolized by heat islands, can play an important role in helping to work out necessary measures (e.g. improving the social environment and preventive measures).

References

Ichinose, T. 1999, Klimaanalyse: Climate Analysis for the Urban Planning in Germany. *Tenki*, 46: 709-715 (*in Japanese*)

Ichinose, T. 2005, Recent counteractions for urban heat island in regional autonomies in Japan. *Urban Dimensions of Environmental Change: Science, Exposures, Policies and Technologies*, Science Press, 161-167

Landsberg, H.E. 1981, *The urban climate*, New York: Academic Press

Matsumoto, F. and Y. Fukuoka 2002, The Relationship between Urban Climate and Plant Phenology in Kumagaya City (1) - In the Case of Leaf-Color-Change Date of Gingko Biloba and Acer Palmatum -. *Japanese Journal of Biometeorology*, 39: 3-16 (*in Japanese with English abstract*)

Matsumoto, F. and Y. Fukuoka 2003, Effects of Urban Warming on Plant Phenology: The Prunus yedoensis Flowering Date in Kumagaya City. *Geographical Review of Japan*, 76: 1-18 (*in Japanese with English abstract*)

Matsumoto, F., T. Mikami and Y. Fukuoka 2006, Effects of Heat Island on the Flowing Dates of Prunus yedoensis: Case Study in the Wards of Tokyo. *Geographical Review of Japan*, 79: 322-334 (*in Japanese with English abstract*)

MoE.(Japan's Ministry of the Environment) 2001a, *Report of UHI council on analyses* (author's translation), Tokyo: MoE (*in Japanese*)

MoE. 2001b, *Report of UHI council on methods for counteractions* (author's translation), Tokyo: MoE (*in Japanese*)

Momose, N. 1998, *The Four Seasons - Animals and Plants Seasonal Behavior* (author's translation), Gihodo Shuppan (*in Japanese*)

Numata, M. 1987, *Urban Ecology* (author's translation), Iwanami Shoten (*in Japanese*)

Shinada, Y., N. Tachibana and K. Sugiyama 1987, *Human Environment of Urban Area* (author's translation), Kyoritsu Shuppan (*in Japanese*)

First field campaign of the in-situ ^{85}Kr gas extraction in Kumamoto, Japan

Shimada, J.[1], Mahara, Y.[2], Momoshima, N.[3], Ono, M.[1] and Taniguchi, M.[4]

[1] Kumamoto University, [2] Kyoto University, [3] Kyushu University, [4] RIHN

Needs for the modern groundwater age tracer technique

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. After 1990's, the development of the new young groundwater age tracer technique has been appreciated. The Cloro-fluoro Carbon (CFCs), the refrigerant liquid that has been widely used in 1980's and stopped to use because of the global ozone-hole problem, is one of this target age tracer. The atmospheric CFCs have introduced into the groundwater through recharge process and could be useful as the shallow aquifer age tracer like tritium. ^{85}Kr, another anthropogenic substance, which is the artificial production through nuclear reactor or reprocessing plant of used nuclear fuel, is also thought to be the useful young age tracer after tritium. Fig. 1 shows the recent trend of these age tracers.

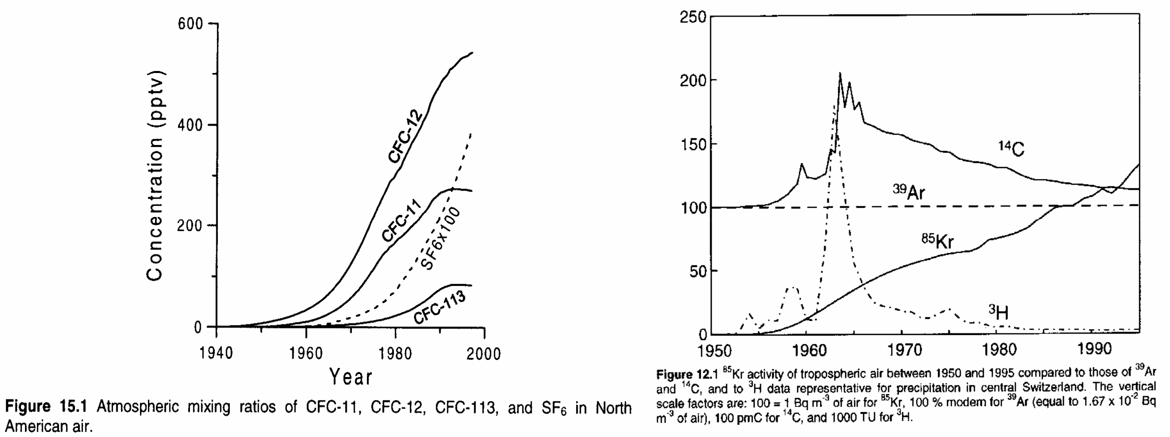


Fig. 1 The recent concentration trend of CFCs and Kr-85 for groundwater age tracers.

As the use of those young age tracers has not been recognized in the hydrological study in Japan, we would like to introduce or develop those young age tracer techniques within the framework of Taniguchi Project to detect the groundwater age in the induced groundwater flow caused by the over-pumping in the urban area. This should contribute not only for the urban groundwater research, but also for the potential development of new groundwater age tracer in Japan. As Tsujimura M. *et al.* (2007) have introduced CFCs method already in the previous newsletter; we would like to show you the present progress status of ^{85}Kr method this time.

^{85}Kr gas extraction and radioactive measurement

Since the activity of ^{85}Kr is very low (1×10^{-4} Bq/L) in the present young groundwater, we have to collect 0.5~1.0 cc STP of Kr from an approximate 10,000 L groundwater sample. We have developed the proto-type on-site dissolved gas extraction system by assembling the hollow-fiber membranes, which is made of poly-4-methyl-1-pentene (Fig. 2).

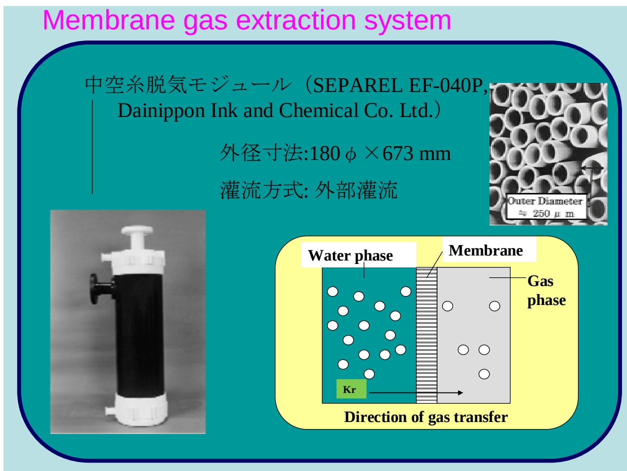


Fig. 2 Hollw-fiber membranes for dissolved gas extraction from groundwater.

We checked the Kr extraction performance by comparing the dissolved Kr concentration in water at an inlet of the degassing system with that at an outlet of it. Simultaneously, we measured concentrations of the dissolved oxygen and chloride ion in water at the inlet and the outlet. After degassing, the concentrations of Kr and oxygen at the outlet decreased to 1 % of that at the inlet in a few minutes (see Fig.3). However, the dissolved chloride ion concentration did not show any change at the inlet and the outlet after degassing. Although the dissolved chloride ion could not extract from water at all, all dissolved gases was degassed with a high efficiency. We had succeeded continuously extracting the dissolved oxygen at the 99.8 % degassing efficiency from 2000L water inletting into the system during 6 hours. Consequently, results of performance tests suggest that more than 99 % of dissolved gases were continuously collected from groundwater by using the assembled prototype degassing system (Fig.4).

Fig.3 Dissolved Oxygen (DO) check after the gas extraction.

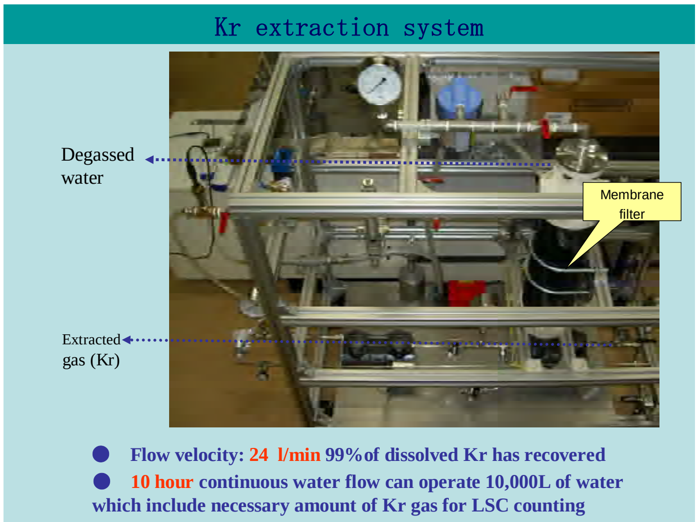


Fig.4 Overview of proto-type Kr gas extraction system

Another target of this research is to establish a radioactivity measurement of ^{85}Kr that has extracted from groundwater. ^{85}Kr is rare gas with half-life of 10.7 y and emits beta ray of maximum energy of 0.687 MeV, therefore, gas chromatography and liquid scintillation counting (LSC) with low background counter were applied. We develop the analytical method similar to that for ^{85}Kr in air; separation of N_2 and O_2 from Kr and complete isolation of Kr by gas chromatography. The material of a counting vial for ^{85}Kr was determined to use synthesized quart with very low background and no leakage of Kr from the vial wall. The method for Kr transfer to organic solution based scintillator cocktail in the synthesized quart vial has also developed. The precise report on this radioactivity measurement of ^{85}Kr by liquid scintillation counting method has already reported by Momoshima N. *et al.*(2007).

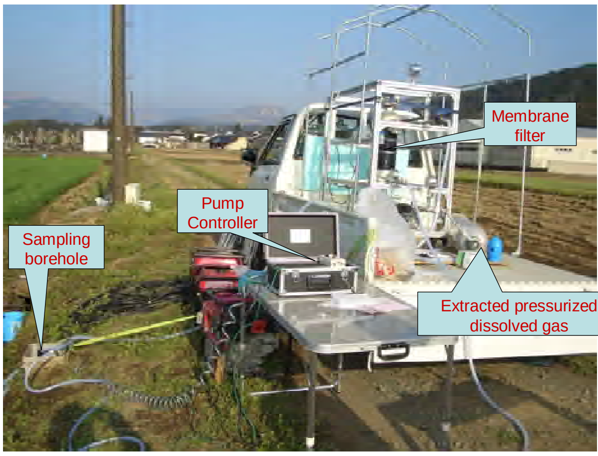
In February 2008, Prof. Y. Mahara had performed the dissolved gas extraction from the groundwater of Kyoto University in his laboratory, and sent that gas to Prof. N. Momoshima at Kyushu University to separate the Kr gas to analyze the low level ^{85}Kr radioactivity by LSC measurement. This has succeeded to detect the sampled groundwater age, which showed ^{85}Kr content around the recharge of 1970's.

Fig. 5 Sampling at Lake Ezu site

First field sampling campaign at Kumamoto area

From 13 to 16th of March 2008, the first field sampling campaign for ^{85}Kr groundwater age measurement has done at Kumamoto area. This is because that there are many existing groundwater observation wells, the well understood hydrogeological setting and the flow system of the local aquifer. The selected sampling sites are two; one at the discharge area near lake Etzu which is flowing artesian condition as shown in Fig.5, and another at the recharge area of Ohzu which is the mid-stream low land area of Shira river and has very deep water level below 65 m from ground surface (Fig.6).

As shown in Fig.6, all the extraction system has been equipped on a small truck and three parallel AC generators and groundwater-sampling pump (MP-1 by Grundfos Co.) has used to sample the water. Extracted dissolved gas has pressurized into the gas container tank (47 L with 0.5MPa) with 8.8 – 13.5 L/min water-sampling pump flow rate. It was continuous water sampling for about 7 to 13 hours and mostly an overnight work because the preparation before the sampling will takes nearly half day. The sampled gas has transferred to Kyushu University to separate the Kr gas and to count the radioactivity of ^{85}Kr. We are expecting the exciting age results analyzed soon. This must be the first ^{85}Kr groundwater age in Japan.



References

Tsujimura, M., Asai, K., Ohta, K., Hasegawa, K., Shimada, J., and Taniguchi, M. (2007): Age dating of Groundwater using CFCs as a tracer. *Urban Subsurface Environment Newsletter Vol.3, April 2007*, 12-15.

Momoshima, N., Mahara, Y., Shimada, J. and Taniguchi, M. (2007): Development of dating method for groundwater using Kr-85. *Urban Subsurface Environment Newsletter Vol.3, October 2007*, 8-12.

Fig.6 Sampling at Ohzu site

Preliminary gravity measurement using the A10 absolute gravimeter

Jun Nishijima[1] and Yoichi Fukuda[2]

[1] Kyushu University, [2] Kyoto University

Introduction

We carried out the preliminary gravity and GPS survey at Jakarta and Bangkok in order to detect the gravity changes caused by groundwater level changes. There are two methods to measure the gravity. We will combine the Absolute gravity measurement and the relative gravity measurement. We will use the instruments for the relative gravity measurement (CG-3M gravimeter: Scintrex Ltd. and LaCoste and Romberg gravimeter: Micro-g LaCoste, Inc.) and the absolute gravity measurement (A-10 gravimeter: Micro-g LaCoste, Inc.). The A-10 absolute gravimeter (A10 -#017) was introduced on Dec. 10 2007, and we got the training for the operation, theory, data processing at the same time (Fig. 1, 2). In this issue, we will report the preliminary gravity measurement using the new absolute gravimeter at Takigami and Otake geothermal power plant.

Fig.1 A picture of the A10 training with Dr. Derek van Westrum (Micro-g LaCoste Inc.).

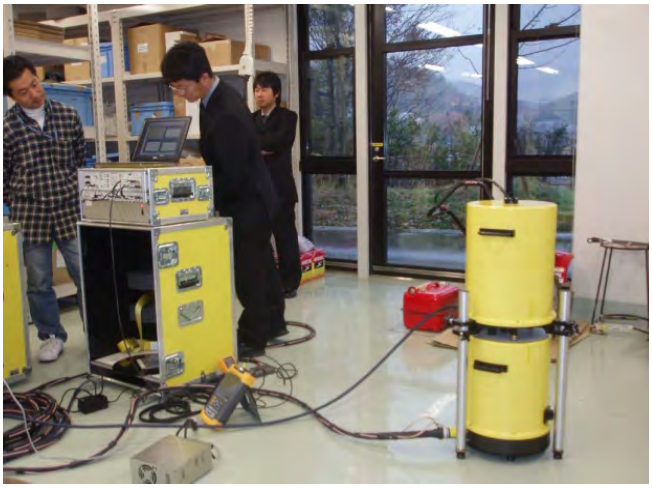


Fig. 2 A10 #017 gravimeter.

The A10 absolute gravimeter

The A10 absolute gravimeter is a portable absolute gravimeter produced by Micro-g LaCoste Inc. It operates on a 12V DC power supply (i.e. vehicle battery). We can measure the absolute gravity using the vehicle battery at the field. The principle of this instrument is simple. A test mass is dropped vertically in a vacuum chamber, and then allowed to fall an average distance 7cm. The A10 uses a laser, interferometer, long period inertial isolation device and an atomic clock to measure the position of the test mass very accurately. Fig. 3 (Micro-g LaCoste Inc., 2006) shows the concept of the absolute gravity measurement. A test mass, containing a corner cube retro-reflector, is dropped from the top of the vacuum camber. A laser is split to reflect off the falling the test object and a fixed reference which serves as a reference. The test object accelerates to the bottom of the vacuum chamber under the influence of gravity. The raw fringe signal is detected by the photodiode as the dropped object falls. The obtained gravity data is combined into a set which usually consist of 100-150 drops. Our typical setup parameters are listed below:

- ●Drop interval: 1 second
- ●Number of drops/ 1 set: 100
- ●Set interval: 3 minutes
- ●Number of set: 10

The raw gravity data are processed with the software 'g' version 7. This software is designed to work with Micro-g LaCoste absolute gravimeter to acquire and process the gravity data. And this software needs the input of some parameters, including the location of the site (Latitude, Longitude and Altitude), geophysical corrections, and so on. We can correct the effect of the earth tide, ocean load, barometric pressure and polar motion in acquiring the gravity data.

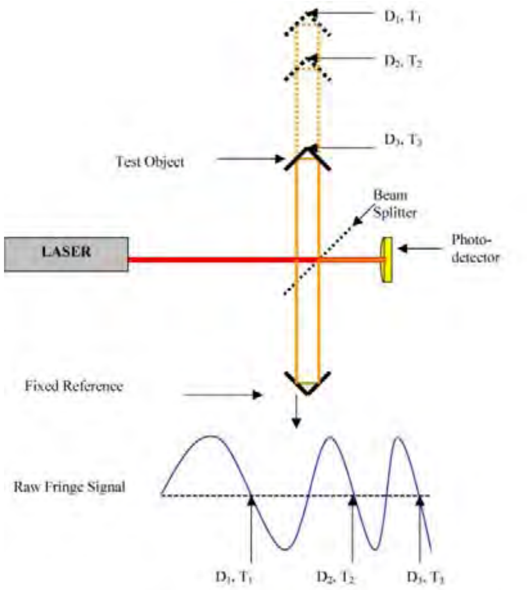


Fig. 3 The concept of the A10 absolute gravity measurement (Micro-g LaCoste Inc., 2006).

Laboratory measurement

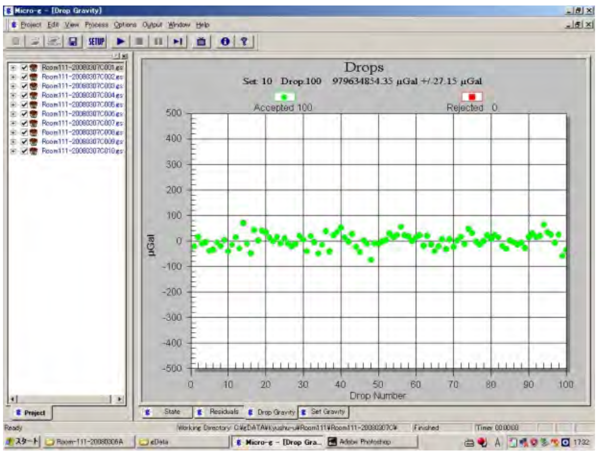


Fig. 4 Example of the good data (Set window).

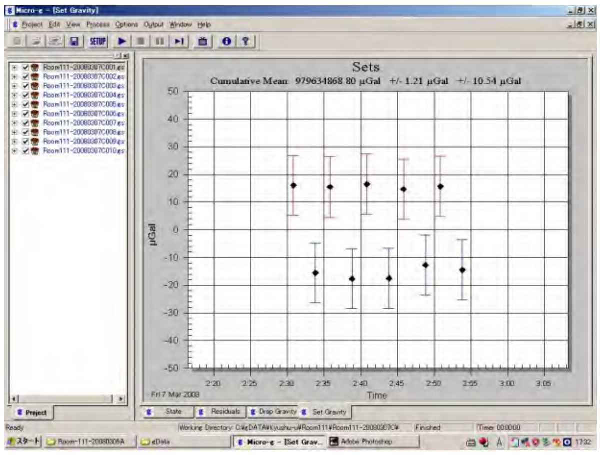


Fig. 5 Example of the good data (Drop window).

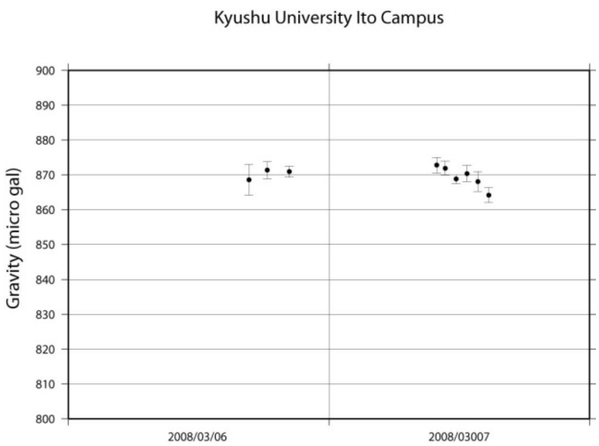


Fig. 6 Result of the absolute gravity measurement at Kyushu University. This gravity value are subtracted the reference value gr=979634000 microgal.

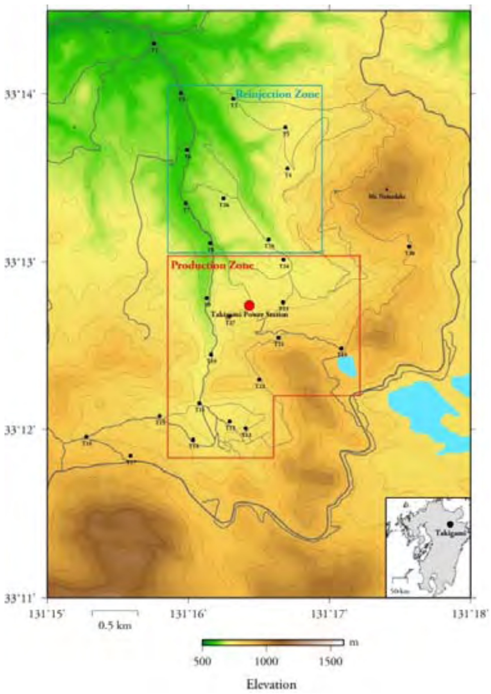


Fig. 7 Distribution of observation points around Takigami geothermal power plant.

Fig. 8 Absolute gravity measurement at Takigami geothermal power plant.

First, we measured in the laboratory using AC power supply. The measurement was conducted from January to March 2008 to assess the accuracy and repeatability. We measured 10 sets at each measurement (Fig. 4), and 1 set consists of 100 drops (Fig.5). Fig. 6 shows the result of gravity measurement at Ito campus of Kyushu University (Fukuoka city) from Mar. 6 to Mar. 7 2008. The scatter of each data is very small (less than 5 micro gal). And we got the absolute gravity 979634869.67±2.60 micro gal.

Field measurement

Takigami geothermal field is located in the southwestern part of Oita prefecture, central Kyushu, Japan. The Takigami power plant (25MW) was completed in November 1996. We conducted repeat gravity measurement in May 1991, at 26 observation points (Fig. 7). The production depth is about 2500m and the reinjection depth from 1000m to 1500m. The amount of production is about 12Mt/year, and about the 85% of production is reinjected to the underground not to cause the ground subsidence.

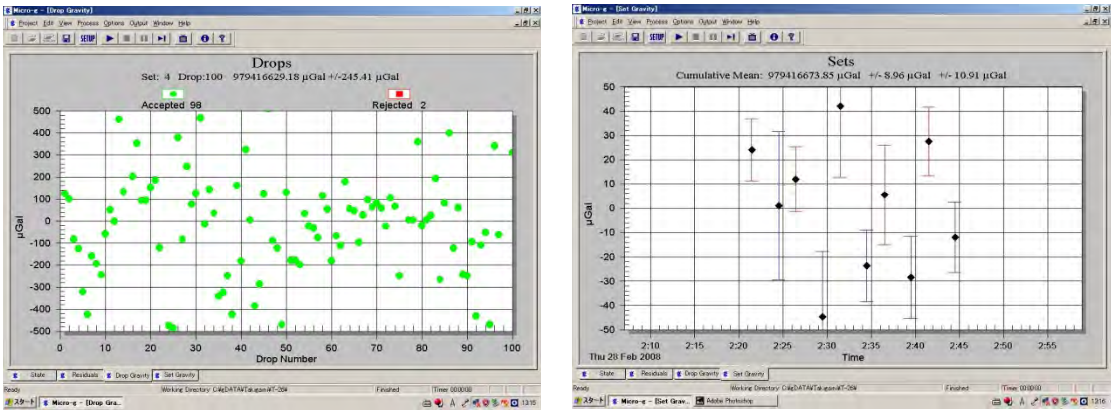


Fig. 9 Result of gravity measurement at T26 without the wind protection. (a) Drops window, (b) Set window

We chose the 4 stations (T13, T19, T26 and T27) to conduct the repeat gravity measurement using the vehicle battery. And we also conducted the gravity measurement at the Otake geothermal power plant (Kuju geothermal and volcanological research station, Kyushu University) in order check the accuracy of the A10. These measurements were conducted from 27 Feb. to 1 Mar. 2008 (Fig. 8). It took about 50 minutes for 1 site measurement. At first, the scatter of gravity is very large because of the effect of the wind (Fig. 9). So we prepared a wind protection (Fig. 10). After that the scatter of gravity is getting smaller (Fig. 11). We could not get the good data at T19, because the foundation of T19 is not so solid. Fig. 12 shows the result of gravity measurement at Otake geothermal power plant. We obtained the absolute gravity 979354909.07±10.75 micro gal.

Fig. 10 The wind protection of the A10 absolute gravimeter.

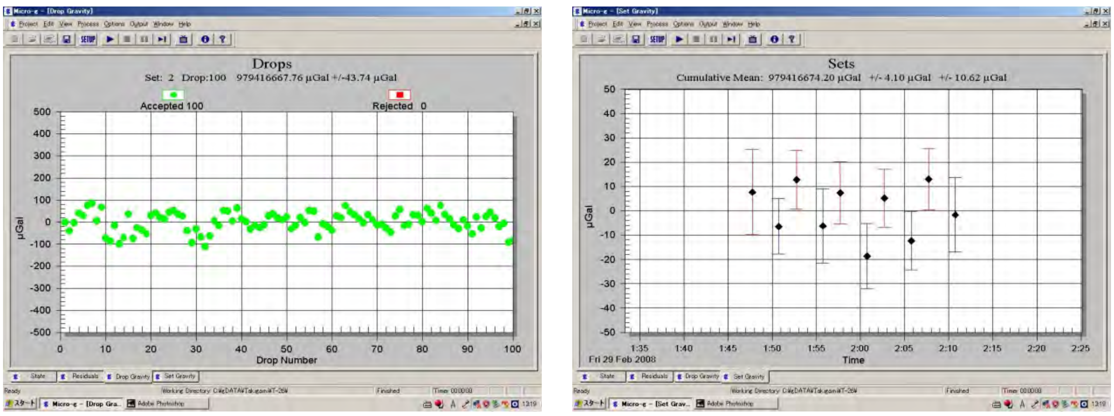


Fig. 10 Result of gravity measurement at T26 with the wind protection. (a) Drops window, (b) Set window

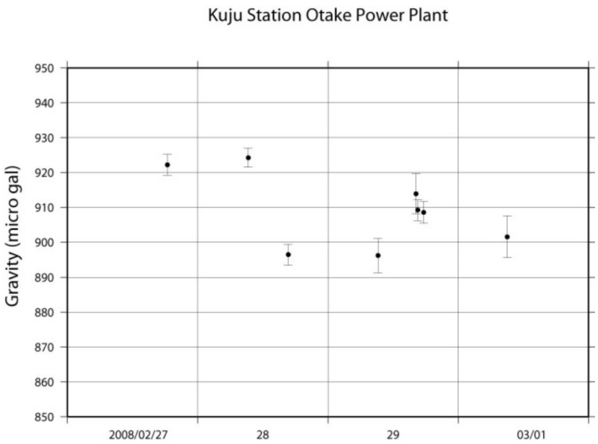


Fig. 12 Result of the absolute gravity measurement at Otake geothermal power plant. This gravity value are subtracted the reference value gr=979354000 microgal.

Future plan

We will conduct the absolute and the relative gravity measurement several times at Jakarta from this summer. And we will assess the gravity changes caused by the groundwater level changes and the ground subsidence.

Reference

Micro-g LaCoste Inc. (2006) A10 Portable Gravimeter User's Manual, pp. 7.

Overview and Comment for the Research Studies in Bangkok Metropolitan Areas

Somkid Buapeng

Department of Groundwater Recourses, Bangkok

The progress report of RIHN Project 2-4 "Human impacts on subsurface environments" shows the results of the surveys and studies in Bangkok areas. There are 6 groups of studies namely Water Group, Material Group, Heat Group, Gravity Group, Socioeconomic Group and Urban Geography Group. The study aims to investigate groundwater flow, pollutant contamination, material transports, temperature profile in sediments, land subsidence and statistics data.

The results of survey and studies are in well progress and in good results. Each team conducted their good field surveys and interpretation except some topics need to be interpreted in more details. In Bangkok Metropolitan areas subsurface environments have impacts from human activities such as over pumping of groundwater, construction of underground train and land used. Land subsidence was occurred and can be observed in many areas of heavy pumping of groundwater for more than 20 years. The results from the research project will be useful for future development and management of groundwater resources in Bangkok City.

The results from Urban Group on the religion and groundwater management in Bangkok, it is not clear from the study witch has been found that conductivity of canal water was high in front of the temple. It is also concluded that, there is relationship between conductivity and the location of the temple. The fresh of water in dug well was also found in the area of temple near the canal and from the radon study indicated that the source of water is from groundwater. The general comment on this study: the detail study is needed to confirm because the shallow groundwater in Bangkok are generally is brackish to salty water due to marine deposits in the ancient time. The relationship between the temple and canal have been found in everywhere in Thailand. This is due to in the ancient time the villagers have to utilize water from the canal

For Urban Group, groundwater resources management in Bangkok have been conducted since 1977. Groundwater Act B.E. 2520 was implemented in 1978 and Groundwater Development Fund was established in 2003 to collect groundwater conservation fee in the critical areas. Groundwater Management in Bangkok is also used the technical information such as safe yield and water level decline. So more detail information on groundwater development and management in Bangkok are recommended for the research in order to have a better results in comparing the management of groundwater between each cities.

For Water Group and Material Group, most of the results of study are good and useful for groundwater management in the future. Only the term "Saltwater intrusion" used in the study should be careful considered due to complex conditions of saltwater in Bangkok Aquifers system. The term of saltwater encroachment may be appropriate to use for saltwater movement in mainland. The groundwater quality and the study of seawater level rising due to global warming related to land subsidence are also recommended for future study. Contamination sources in Bangkok especially As, NH_3 /NH_4 and NO_3 are needed to study more details in concentration, original (source) and distribution of the contaminants.

General comments for future work of the project :

1) Coordination and planning for the study should be informed and consult with the counterpart in advance, both for field survey and data collection

2) Meeting and discussion between technical group from RIHN and counter part should be conducted after/ during the filed survey.

3) Close collaboration between RIHN and counterpart is necessary for successful of the project.

4) Public relations of the project should be carried out to publish the result of the project and to be used for sus tainable groundwater management.

Overview and Comments on the Studies in Metro Manila

Fernando Siringan

Marine Science Institute University of the Philippines

Two groups within RIHN Project 2-4 have conducted fieldworks in Metro Manila - the Material and the Socio-Economic. The Material Group has thus far conducted two fieldworks – in May 2006 and September 2007. The May 2006 fieldwork, which was at the end of the dry season, involved sampling of surface and groundwater in various sites of the city. Measurements of SGD using automated seepage meters, stationary RAD 7 and resistivity were performed in the southern fringe of Metro Manila. RAD 7 survey along the coast of Metro Manila and river landward of the SGD survey site was also conducted. Sediment cores were acquired in Manila Bay.

In September 2007, an automated seepage meter and piezometers for long-term, continuous monitoring were installed inside the Manila Yacht Club in Malate, Manila. This site, based on 2004 piezometric maps and the 2006 RAD 7 measurements, is a potential site of high SGD. Together with personnel from Manila Water Inc., one of the two water concessionaires in Metro Manila, vertical temperature profiling and deployment of TD loggers for continuous monitoring were attempted in several wells across the metropolis. Deployment was not possible because of an incompatibility between the diameters of the TD loggers and monitoring pipes.

Other activities performed by the Material Group is the reconstruction of the pollution history from sediment cores acquired in three water bodies receiving effluents from Metro Manila. A TD logger was also deployed in June 2006 in a well in Makati for long-term monitoring. Rain, river and piezometer water sampling is also conducted at a regular interval or when possible

The Socio-Economic Group went to Manila in December 2006. Several government and non-government offices were visited to acquire secondary data ranging from land use plans to demographics Though data is scattered, with the help of personal contacts, a considerable collection was gathered. These have been made available to all the groups of the projects.

Results of the processing and analysis of samples and data acquired in 2006 were presented by both Material and Socio-Economic Groups in the Bali Workshop last December 2007. The results were very informative. Some are pleasantly surprising such as the lower nitrate content of groundwater than what was expected. Some though are alarming like the occurrence of high concentrations of As in the coastal area of Metro Manila. It is hoped that these results can be relayed to Filipino end users at the soonest. A seminar dove-tailed with fieldwork in 2008 can accomplish not only the passing of information but also the drumming up of support from other locals for the conduct of future work and more importantly, it may lead to action to address the deterioration of Metro Manila's subsurface environment.

Future fieldworks should consider the highly seasonal precipitation in Metro Manila although the continuous monitoring at the Manila Yacht Club may already partly address this. Also. the 2006 fieldwork site is in a relatively young part of the metropolis and is mostly residential. Measurement in an older and more industrial or commercial portion of the city, such as north of Pasig River, may provide interesting variation. For proper interpretation of data, some attention may also have to be given to the nature of Metro Manila's groundwater system, which is still poorly understood.

Overview and Comments on the studies in Taipei area

Chung-Ho Wang

Institute of Earth Sciences, Academa Sinica, Taipei

General

Group members had visited the Taipei for their respective study objectives in the past two years (November, 2005; September and October, 2006; June and October, 2007). They have carried out many good measurements and data collection for the project in Taipei area (for example, presentations of Toshiaki Ichinose, Shinji Kaneko, Takahiro Hosono; Makoto Yamano, and others).

The physical and social aspects of the impacts caused by nature and anthropogenic factors both in the global and local scales have been evaluated and documented in their studies; these records are invaluable in our future work. Some further interactions among group members and host scientists are encouraged in order to generate more insightful results and publish in international journals.

Data and Methodology

A standard method should be adopted by all participants of this research for similar topics (for example, UHI parameter, borehole temperatures, groundwater hydrology etc.)

Basic data collection is the main part of this research, fully interaction among group members are desired and do not hesitate to ask help and assistances to the host respective countries. We are very pleased to collect relevant data for all members to use. In this respect, the data archive center is very vital and should be well maintained for all members to access freely in this project.

A metropolitan view on the studied cities is important in our project. In this aspect, Taipei site comprises of Taipei city and part of Taipei County. Many data only cover the Taipei city but not the Taipei County, thus we should bear in mind the difference due to municipal boundaries. The Taipei partner will do the best effort to compile relevant data both for Taipei city and Taipei County for our studies.

Inter-comparisons among seven mega-cities are possible and desirable in the further phase of our project. Parts of the endeavor have been already done by our group members and preliminary results do show some promising and encouraging comparisons. We should pursue along this line in the following years.

Field work can be costly and time consuming. It is suggested that Japan colleagues can leave some spares of sampling tools and vessels in the Institute of Earth Sciences, when the right chance comes, Taipei partner can do the sampling work for most studied items and send the samples to Japan colleagues for a further analyses. I think this is an efficient and economic way for our project.

Workshop and Symposium

A regularly workshop is essential for the promotion of data integration and calibration in this project; we should regularly hold small workshops to enhance the interactions among our group members.

Institute of Earth Sciences is very welcome all project members to come to Taipei for the proposed symposium in the fall of 2009. In addition to that, we also welcome small scale workshops or meetings held in Institute of Earth Sciences at any time if desired. We have conference rooms (two, 100-person and 60-person capacity), as well as discussion rooms (three, <30 persons) with no charge. The accommodation fee is also relatively low at our guest house.

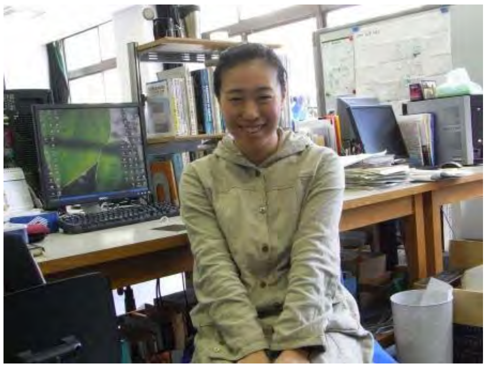
Missing part

Global warming and sea-level rising will be unavoidable threats to the world and pose increasing threats to our environments, including our studied areas. We need to include these impacts and mitigation strategy in our research.

Joint Research with RIHN

Taiko Todokoro

Ritsumeikan University



I'm Taiko TODOKORO from Ritsumeikan University in Kyoto. I'm in the doctoral program in human geography. My research subject is exploring features the urban landscape in colors and its formation process after World War 2, and present study area is Kyoto, Japan.

I have discussed this topic focusing on appearances of buildings and on efforts based on the local government and on residents, who are the agents responsible for urban landscape development. Recently, the number of traditional townhouses in Kyoto, Machiya, has decreased rapidly, and visible historical urban landscape also has changed quickly. The sequence of landscape in the physical form of buildings has been disappearing in the course of urban renewal after WW2; however, it is possible even for areas lacking physical sequence to keep some visible sequence and regional characteristics to a certain degree when traditional local colors, which are frequently used in traditional buildings such as Machiya, is used on exterior colors and color harmony is maintained. The use of traditional local colors in urban landscape formation makes it possible to create, reconstruct and enhance regional characteristics of urban landscape based on the situation in each area.

In RIHN project, I'm a member of the urban geography subgroup; the group leader is Prof. Yoshikoshi. One of our roles in this RIHN project is providing urban geographical data for other subgroups to analyze the relationship between urban development and hydro-environmental change. This is first experience I try to research relationship between hydro-environment and human activities.

My main job in this subgroup is management of collected topographical maps and digitalizing them in connection with figuring out the process of urbanization in 7 study areas. At this stage, members of the urban geography subgroup are engaged on making land-use data from old-edition topographical maps. The years covered by this work are around the year 1930, 1970 and 2000 in consideration of comparative studies on Tokyo and Osaka with other 5 Asian mega-cities in different stages of urban development. Those data are scheduled to be finished within the fiscal year 2008. By overlaying these land-use, socio-economic and hydro-environmental data, we will discuss that hydro-environment has been fully influenced and changed by the socio-economic human activities under the each developmental stage of the cities.

At this point, those paper-based maps and digitalized ones are stored in Research Center for Disaster Mitigation of Urban Cultural Heritage at Ritsumeikan University. If you would like to access these data, please contact me.

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.

ANNOUNCEMENTS

AOGS 2008 in Busan, Korea June 16-20, 2008

Session IWG06 (June 20)

"Material transport in a watershed; from headwater to coastal zone"

Convener: Dr. Shin-ichi Onodera

http://www.asiaoceania.org/aogs2008/index.asp

Project 2-4 FR General Meeting

Kasumigaura, Japan

November 10-12, 2008

HydroChange 2008 in Kyoto, Japan

"Hydrological changes and management from head water to the ocean"

October 1-3, 2008

http://www.chikyu.ac.jp/HC_2008

Call for Contributions

For the sixth volume (October 2008), we would like to request the following Groups/individuals to give their articles for the newsletter:

Prof. Kaneko's Group, Prof. Shimada's Group,

Prof. Onodera's Group, Prof. Nakano's Group,

Dr. Backjin Lee, Dr. Kagabu

Dr. Yamamoto

To allow ample time for editing and layouting, we hope to receive your articles on or before September 30, 2008. 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/

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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.

New Members

Four new members have joined in Project 2-4 Secretariat since April 2008.

Dr. Jun Yasumoto (Groundwater Engineering)

Dr. Yohei Shiraki (Urban Climatology)

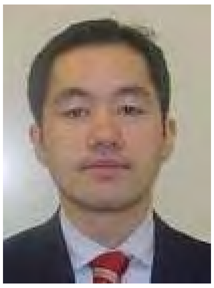
Dr. Keiko Yamamoto (Satellite Geodesy)

Ms. Takako Okamoto (secretary)

RIHN Corner

Takahiro Endo

Assistant Professor



Groundwater and Social Science

Water is shapeless. It can flow into even a tiny space. This applies to study on water. Water is such vital thing not only to nature but also to society that it seeps into various branch of knowledge.

It is often said water is a shared resource. In other words, water connects a lot of people. So somebody's water use may influence somebody else's welfare both in positive way and negative way. Especially in the latter case, a conflict will take place. That's why we need rules on water. What the rules deal with is not *the relationship between human being and water*, but *the relationship between human beings who are connected with each other via water*. This is where social science can play a role in study on water.

My concern lies in the structures of groundwater law. In many countries including Japan, groundwater is regarded as a part of the overlying land and therefore, as a property of the landowner. This causes a lot of groundwater problems such as over-exploitation, subsidence and contamination. What kind of measures can we take against these problems? Do we have to modify the groundwater law or can we solve those problems within the framework of the existing law? In this project, I am tackling this question by making a comparative study on Japanese and foreign countries' cases.