Urban Subsurface Environments

Newsletter Volume 2 October 2006

Full-scale implementation of the project “Human Impacts on Urban Subsurface Environment” started in April 2006 and the project members have conducted field experiments, surveys and data gathering in the target cities.

Summary of the field activities of the groups and initial research results are featured in this volume of our project's newsletter. This issue also contains contributions from our counterpart in Taipei and graduate research student.

Inside this issue

Project 2-4 FR Meeting in Hiroshima 2006

Makoto Taniguchi (RIHN)

A domestic project meeting will be held in Hiroshima on Nov. 27-29, 2006 to discuss the current status of the RIHN Project 2-4 "Human Impacts on Urban Subsurface Environments". Forty five project members will join the three-day meeting.

Full implementation of Project 2-4 FR “Human Impacts on Urban Subsurface Environment”, started in April 2006. Field experiments on subsurface environment in target cities of this project have been made by the Water, Material and Heat groups, and their results will be shown in the meeting. Data collection in the field has also been done by Urban and Heat groups. Some members have also begun to use new methods for evaluating the change of groundwater storage by using satellite GRACE and gravity measurements in the field, and by using CFC and Kr as indicators of human activities. These methods will be introduced in the Hiroshima meeting. The project members have also started monitoring of groundwater level, quality (conductivity) and temperature in Bangkok and Jakarta. MOUs between RIHN and Churalongkorn University and MNRE (Thailand), as well as RCGIIS (Indonesia) and IESAS (Taiwan) become effective. The UNESCO-GRAPHIC symposium was held at RIHN in April 2006, and this project has been selected as a pilot study of the GRAPHC project (http://www.chikyu.ac.jp/USE/GRAPHIC/graphic.htm).

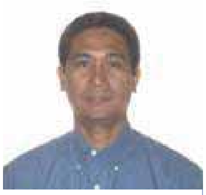
The following are the issues which will be discussed in the project meeting at Hiroshima: (1) difference between main city and sub city, (2) integration effect with different discipline groups, (3) methods of data/information management, and (4) review of eight research groups. We plan to publish the proceedings of the Hiroshima meeting in Japanese with English abstract and some pictures.

Visiting Professor and Research Fellow

Dr. William C. Burnett, Carl Henry Oppenheimer Professor of Oceanography at Florida State University, has stayed in RIHN as Visiting Professor from April to July 2006. Research studies of Dr. Burnett involve two main topics: (1) applications of naturally occurring radio isotopes to address earth and marine environmental problems; and (2) environmental radioactivity. During his stay, he has joined project members in their research and field surveys in Osaka and Kumamoto, Japan as well as in their fieldworks in Bangkok and Metro Manila.

Dr. William “Bill” Burnett

On the other hand, Dr. Fernando Siringan, Professor at the the Marine Science Institute of the University of the Philippines-Diliman is our Visiting Research Fellow from October 2006 to April 2007. His research deals with landscape transformations particularly of the coastal environments. His work requires the reconstruction of sea level and climate fluctuations, oceanographic events and identification of human activities and their consequent impacts to the environment.



Dr. Fernando Siringan

Field sampling at Seoul area reveals evidences of stages of city development stored in groundwater

Jun Shimada and Reo Ikawa
Kumamoto University

The aquifer system of Seoul area is composed of precambrian granite rock. People in the city use water from the Han river through tap water system. The groundwater is not utilized for everyday use but only for emergency purposes in case the tap water system fails accidentally. In the summer of 2005, we visited Seoul City to survey the groundwater with the help of Prof. K. Lee of Seoul National University and his students. We used the observation well which is mostly equipped with emergency pumping system (Fig. 1).

Fig. 1. Groundwater observation well for emergency

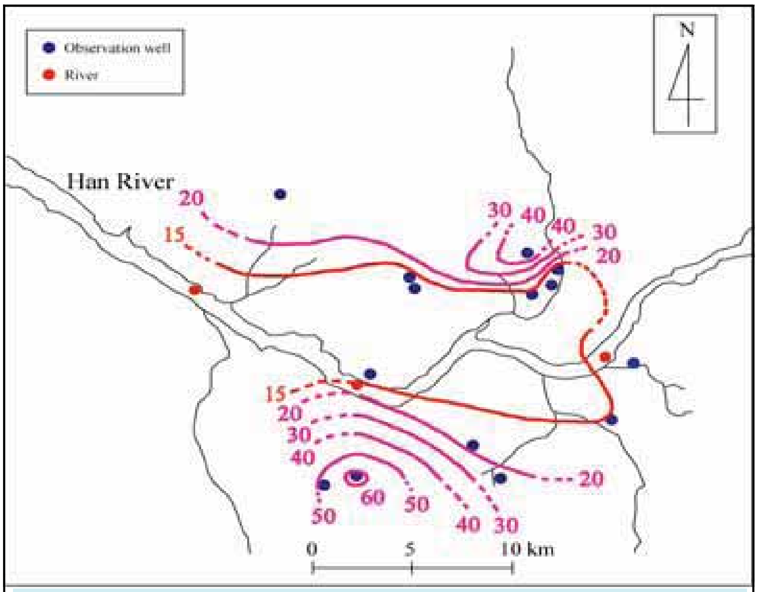


Fig. 2. Groundwater potential distribution in Seoul city area

Figure 2 shows the observed groundwater potentiometric map of the granite aquifer. Although this is the fracture system aquifer, it shows clear groundwater flow regime concentrated toward the northern half of the central city area. According to Prof. Lee (Kim, 2001), this groundwater drawdown was caused by the subway tunnel pumping (Fig.3).

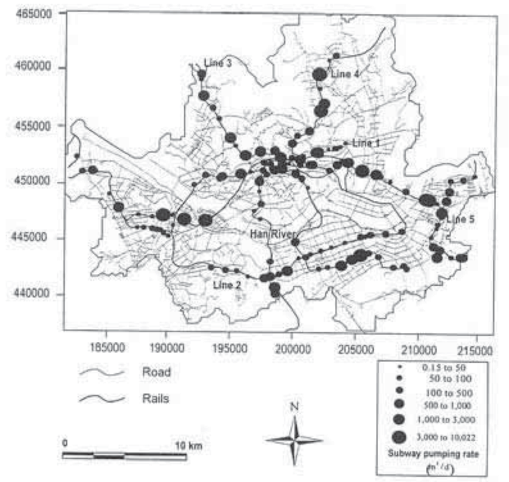


Fig.3. Pumping rates along the subway line in central Seoul (Kim, 2001)

Fig.4 shows the stable hydrogen isotope content distribution in the studied Seoul groundwater. The groundwater depression area by subway tunnel pumping shows relatively high isotopic content than the surrounding area. As shown in Fig.5, the isotopic content in the Han River water which is also used for the city tap water has relatively high isotopic content than that of Seoul city area. We also confirmed that the water chemistry in the groundwater depression area caused by the subway tunnel pumping shows relatively high nitrate content. By those evidences, we believe that those are the induced groundwater pollution caused by the leakage from the sewage system of the Seoul city because the sewage water mostly intake the Han River water through tap water system (schematically illustrated in Fig.6).

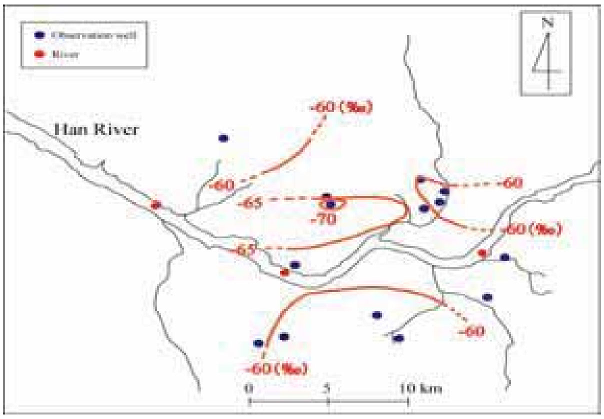


Fig.4. Stable oxygen content distribution

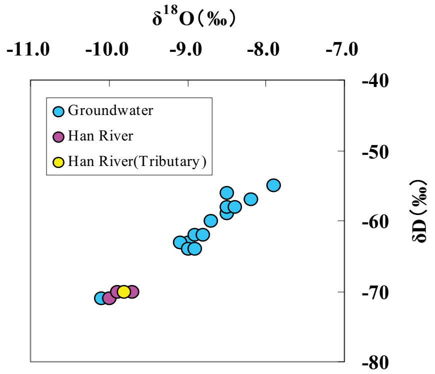


Fig. 5.δ diagram of stable oxygen

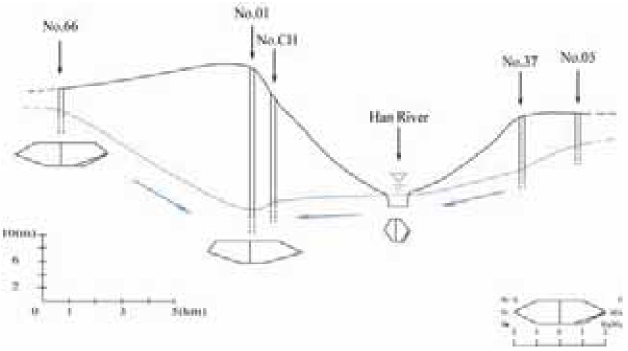


Fig. 6. Schematic cross sectional view of Seoul city's groundwater flow regime

Fig. 7. Concentrated gathering of sea fish toward the river mouth caused by the warm groundwater drainage from the underground railway tunnel system

This is an example of the indirect effect of the urban development to the local groundwater system where the artificial groundwater drawdown by subway tunneling has emerged firstly and then sewage leakage groundwater pollution has created later.

In Tokyo metropolitan area, the groundwater drawdown has almost recovered through effective pumping regulations in the last 30 years. However, the present Tokyo area has another problem caused by groundwater rise. One example is shown in Fig. 7. The photo shows the sea water fish comes from Tokyo Bay to enjoy the warm temperature caused by the groundwater drainage from the railway tunnel passing through Tokyo area as shown in Figure 8. Everyday 4,500 tons of fresh warm groundwater is freely supplied to this river mouth not for those fishes but for the trains. Japan Railway Company must spend a lot of money for this dumping/ drainage forever.

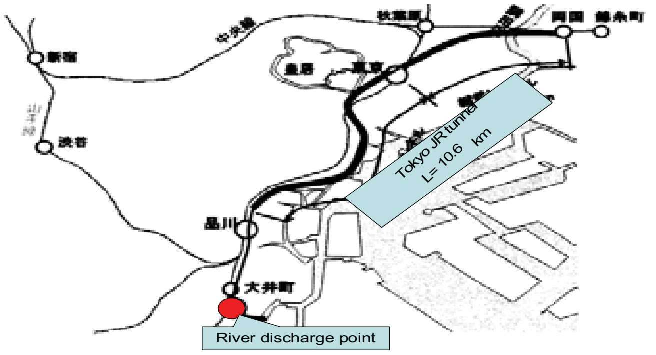


Fig. 8. Warm groundwater discharge from underground railway tunnel at Tokyo.

Reference:

Kim, Y., Lee, K. and Sung, I. (2001), Urbanization and the groundwater budget, metropolitan Seoul area, Korea. Hydrogeology Journal 9, 401-402

Urban Group conducts field research in Seoul and Taipei

Shinji Kaneko[1] and Karen Ann Jago-on[2]
[1]Hiroshima University, [2]RIHN

The objective of the study of the Urban Group is to identify the socio-economic factors that have caused environmental stresses on the groundwater situation during the different stages of development in urban areas. These causal relationships of environmental issues affecting groundwater will be analyzed in a DPSIR (Driving force- Pressure-State-Impact-Response) framework. Urban population growth and change will be described in a city-specific demographic model that will cover a period of fifty years. Along with this is the analysis of selected economic growth indicators. Spatial analysis as well as a review of planning policies will also be conducted in order to understand land use patterns and land cover changes during the selected years. Assessment of technology and infrastructure changes will focus on water supply and wastewater treatment facilities. Individual characteristics and conditions of cities will be highlighted in the case studies for Bangkok, Jakarta, Manila, Seoul, Taipei and Tokyo. These different aspects of research are being handled by different members of the group.

In 2006, the group has conducted field surveys in Seoul and Taipei. These surveys involve data gathering from secondary sources such as official demographic and socio-economic statistics of the country, region and city; interviews and discussions with experts from the government, academe and other research institutes; and actual site visits in water supply, sewerage and other sanitation facilities.

Fig. 1. Dr. Young-Duk Kwon (SDI) explaining the map of Seoul City.

Field Survey participants:

Seoul, South Korea (May 23-26, 2006)

Shinji Kaneko (IDEC, Hiroshima University)

Akimasa Fujiwara (IDEC, Hiroshima University)

Ryo Fujikura (Faculty of Humanity and Environment, Hosei University)

Backjin Lee (IDEC, Hiroshima University)

Karen Ann Jago-on (RIHN)

Taipei, Taiwan (September 11-15, 2006)

Shinji Kaneko (IDEC, Hiroshima University)

Toru Matsumoto (Faculty of Environmental Engineering, University of Kitakyushu)

Zhang Junyi (IDEC, Hiroshima University)

Xue Yonghai (Faculty of Environmental Engineering, University of Kitakyushu)

Karen Ann Jago-on (RIHN)

The survey in Seoul was done from May 23-26 and in Taipei it was conducted from September 11-15. Information collected were focused on demography and population changes, economic structures and industrial transformation, land use and cover changes, water supply and facilities, sewage and waste treatment facilities, and historical evolution of environmental and land use policies, especially those related to groundwater management.

Most of the basic data on demography and the socio-economic profiles as well as land use planning in Seoul and Korea were obtained from the Seoul Development Institute (SDI), Gyoenggi Research Institute (GRI), Korea Research Institute for Human Settlements (KRIHS) and the University of Seoul. Environmental and water related policies were also discussed during the presentations and discussions in these institutes and our visit to Seoul National University has provided us with the basic background on the evolution of environmental laws affecting groundwater and the environmental agencies administering these laws. Basic situation on surface water and issues on groundwater supply and quality have also been discussed at SDI.

Fig. 2. Model of the built-up areas in Seoul City.

Fig. 3. Discussion on Korea's national land use plan and water management with KRIHS Research Fellows.

Our field survey also included a visit to Cheonggyecheon, the famous restoration project of a buried stream in Seoul.

Mr. Soo Hak Kong of the Cheonggyecheon Restoration Project explains the plan and structures of the stream.

One of the most important functions of Cheonggyecheon was to collect sewage and transport it to the Hangang River. After several process of digging, dredging and filling to avoid flooding, Chenggyecheon was buried in 1978. An overpass was built above it to deal with the increasing traffic. The restoration started in 2003 and covering structures including the overpass were removed. This project included establishment of waterways, sewage, roads, bridges and environmental landscape architecture.

Fig. 4. Cheonggyecheon area—in front of the Metropolitan Facilities Management Corporation.

In Taipei we have visited government offices such as the Ministry of Interior and the Council of Agriculture for basic demographic statistics and food supply and consumption data. We also have discussions on land use changes and urban land use planning in Taipei with the National Taiwan University and National Taipei University of Technology. Urban water management issues were discussed at the Water Environment Research Center in the National Taipei University of Technology. Our meeting at the Society of Urban Planning helped us understand the industrialization process in Taiwan and the establishments of industrial parks in Taipei. Our understanding of the waste management practices and the sewerage systems were enhanced by visiting the Pei-tou Refuse incineration plant, the Nankang landfill and the Pa-li Sewerage treatment plant.

Fig. 5. Discussion with the faculty of National Taiwan University on land use changes in Taipei.

Fig. 6. Meeting with Dr. Chih-Hong Huang of the National Taipei University of Technology on Taipei city planning.

Fig. 7. Discussion on water resources management in Taipei with Dr. Jen-Yang Lin from the Water Environment Research Center.

Fig. 8. Nankang Landfill facilities in Taipei.

Fig. 9. Dr. Chung-Ho Wang explains the sewerage systems in Pa-li sewerage treatment plant.

Results and summaries of the data gathering will hopefully be presented in the project's general meeting in Hiroshima in November 2006. Our field surveys have greatly helped us in acquiring information on the historical changes in population, land use, water use and waste management in these cities. In addition, we have developed networks among the institutes, universities and offices that we visited.

Research Aspects and Progress of Material Group in the First Year of the Project: Developing stage of cities and environmental pollution

Shin-ichi Onodera
Hiroshima University

Introduction

The large quantity of mass generally converge in mega-cities (World Bank, 1997; Tsunekawa, 1998). As a result, a part of the consumed material had been leached into river, groundwater and ocean. Many of the mega-cities in the world exist in Asia, and most of them are located in coastal areas (Jiang et al., 2001). Growing Asian mega-cities have the some severe pollution problems experienced by Tokyo or London 30 years ago. To prevent the expansion of these problems, it is necessary to find the relationship between water pollution characteristics and the stages of growth of mega-cities, and to discuss possible problems and necessary measures in the future.

This research has two main objectives. The first objective is to confirm the subsurface accumulation and transportation of contaminants during the period of growth of mega-cities. In addition, we need to confirm the effects of groundwater flow change by intensive pumping on contaminant transport. The second objective is to reconstruct and predict the transport of subsurface contamination. During the first year and second year of this project, we will mainly focus on the first objective.

Research Method

We have two parts in our field research. One is the urban part for the confirmation of contaminant accumulation and transport, and the other is the coastal part for the confirmation of contaminant discharge (Fig.1).

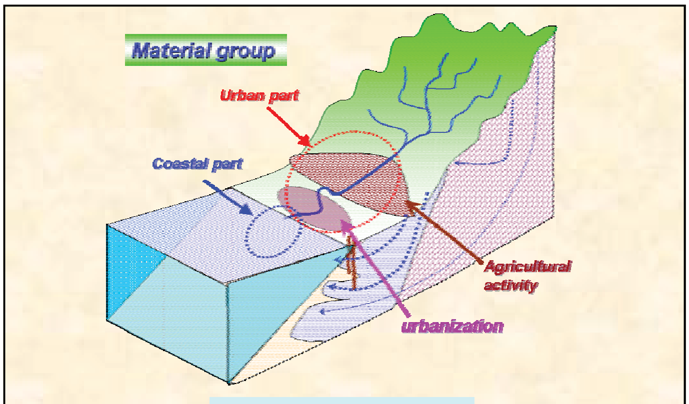


Fig.1. Research Plan

In the urban part, we have measured the water level at dug well and boreholes with multi-depths. In addition, we collected more than 50 groundwater samples in the each city with collecting river, spring and sea water. Water samples will be analyzed for main anion by ion chromatography, for main cation and trace metal by ICP spectrometer, for P, Si, and N by spectrophotometry, for stable isotope of N, S and Sr by mass spectrometer.

In the coastal part, we have measured the submarine groundwater discharge by seepagemeter and piezometer. In addition, we collected water samples by piezometer and core sampling. The water samples will also be analyzed. The sediment of core sampling will be analyzed for Pb dating and stable isotope of Pb by mass spectrometer.

Research Members

Our group is composed of Japanese core and student members, and field counterpart members in Korea, Taiwan, Philippines, Thailand, and Indonesia. Eight Japanese members participated in field surveys conducted during the pre-research period and in the first year of this project.

Core members:

Shin-ichi Onodera (Hiroshima Univ.), Takanori Nakano (RIHN), Takahiro Hosono (RIHN), Yu Umezawa (RIHN), and Tomotoshi Ishitobi (RIHN).

Student members:

Mitsuyo Saito, Misa Sawano, and Masaki Hayashi (Hiroshima Univ.)

In addition, Dr. Kazuhiko Takeda of Hiroshima University supports the chemical analysis in the laboratory.

Our group has conducted researches in all mega-cities of 5 countries for two years. Three young researchers in RIHN, Dr. Hosono, Dr. Umezawa and Mr. Ishitobi have already been in all cities.

Research Progress

Aside from Japan, we have conducted field researches in the following areas:

(i) Bangkok, in July 2004 with Gravity Group

(ii) Seoul, in August 2005 with Water and Heat Group

(iii) Taipei, in November 2005

(iv) Manila, in May 2006

(v) Bangkok, in June 2006 with Water and Heat Group

(vi) Jakarta, in September 2006 with Water, Gravity and Heat Group

(vii) Taipei, in October 2006

Fig.2a and Fig.2b below show the site maps of water collection for this year in Bangkok and Jakarta.

In addition, we have also conducted field research in Japan. The main city for our research is Osaka. This year, we have conducted coastal research at Osaka Bay in August. The distribution of instruments in the coastal research is shown in Figure 3.

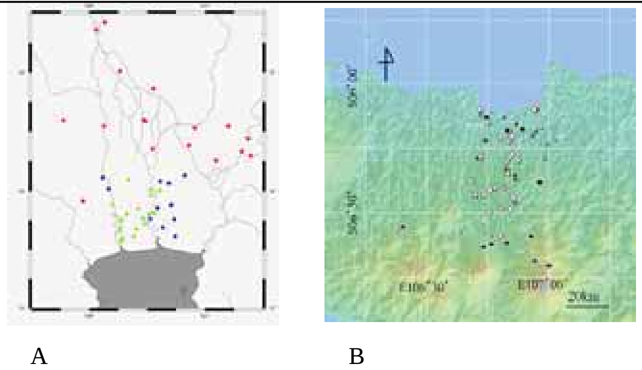

A
B

Fig.2. Site map of water collection in Bangkok (A) and Jakarta (B) in 2006

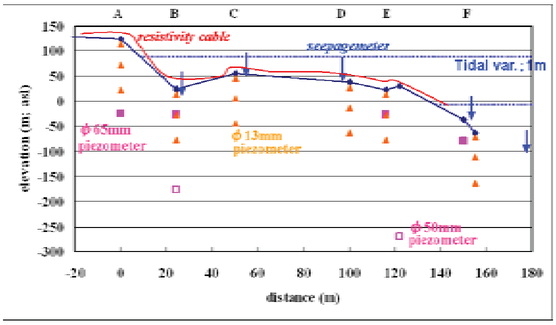


Fig.3. Distribution of instruments in coastal research at Osaka Bay

The aspects of research are shown in Figures 4 to 7.

Fig. 4. Water level measurements in a borehole in Bangkok with land subsidence in 2006

Fig.5. Water sampling at a dug well in Jakarta in 2006

Fig.6. Bench mark for monitoring of land subsidence adjacent to a flowing well in Jakarta

Fig.7. Distribution of instruments in coastal sites at Osaka bay in 2006

Report from the Heat Sub-group

Makoto Yamano
Earthquake Research Institute, University of Tokyo

As reported in the first issue of the newsletter, the major goal of our sub-group is the reconstruction of the evolution of ground surface thermal environment in large cities in Asia. For this purpose, we measure vertical temperature distribution in boreholes and estimate the history of ground surface temperature (GST) in the last several hundred years from obtained temperature profiles. Monitoring of the temperature in boreholes, soil temperature and air temperature is also planned for studies of downward propagation of the GST variation and coupling between the GST and the air temperature.

Here we report the progress of borehole temperature measurements conducted in 2005 and 2006 and long-term temperature monitoring experiments in a borehole in SW Japan.

Progress report of temperature measurements in 2005 and 2006

In 2005 and 2006, we visited Seoul, Taipei, Tungkang (small city in southern Taiwan) Bangkok, Jakarta and their surrounding areas for temperature profile measurements in boreholes (Figs. 1 and 2). The number of the measured boreholes is 78 in total (14, 6, 8, 20 and 33 in Seoul, Taipei, Tungkang, Bangkok, and Jakarta areas respectively). Most of the holes are observation wells for groundwater level monitoring and the depths are generally 100 to 200 m, though the maximum depth reaches 400 m.

Many of the measured profiles show negative (or nearly zero) temperature gradients in the upper part of the holes, indicating recent increase in the GST due to the global warming and/or the "heat island" effect. On the other hand, some of the profiles seem to have been affected by groundwater flow and should be discarded. We will select boreholes suitable for GST reconstruction analyses after examining the stability of temperature profiles, information on the lithology around the holes, and so forth.

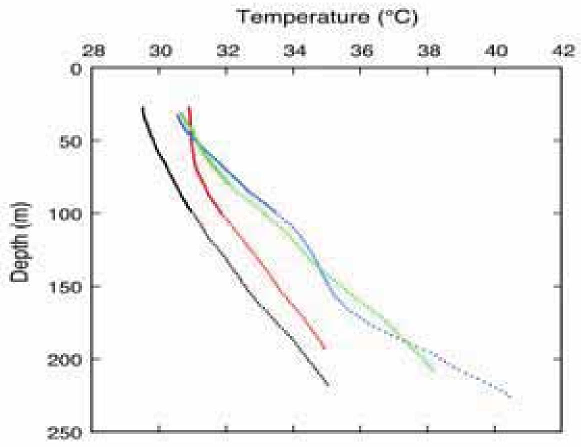


Fig.2. Examples of borehole temperature profiles measured in Bangkok area

We started monitoring of borehole temperature and soil temperature at eight stations (one in Taipei, one in Tungkang, three in Bangkok, and three in Jakarta areas; Fig. 3 and 4). At each station, three water temperature recorders were hung in the upper part of the borehole at intervals of five (or ten) meters.

meters. The temperature resolution is 0.001 K and the measurement interval is 10 or 30 minutes. If the temperature profiles in these holes are stable, penetration of the GST variation by thermal diffusion will be detected. If not, temperature variation records will give information on groundwater flow around the hole or water movement inside the hole.

Fig.3. Installation of water temperature recorders in a borehole in Tungkang area.

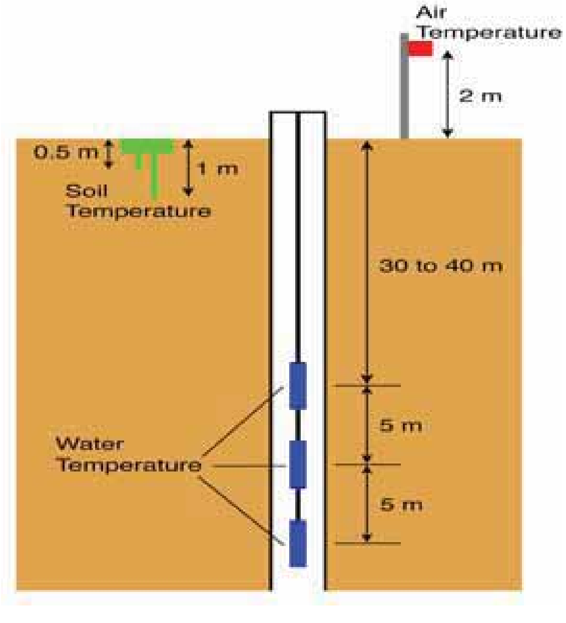


Fig.4. Typical configuration of temperature monitoring in and around a borehole. Air temperature recorders were installed only at the stations in Jakarta area.

Soil temperature is measured with recorders buried under the ground surface just beside the borehole. The depths of the sensors are 0.5 and 1.0 m in most stations. Soil temperature records will be used to determine the present GST, which can be compared with air temperature data at meteorological stations. At three stations in Jakarta area, air temperature recorders were also installed 2.0 m above the ground surface in order to determine the relation between the GST and air temperature more accurately.

These temperature recorders will be recovered 1 to 1.5 years after installation. In stations where good quality data have been obtained, monitoring will be continued for another couple of years.

Temperature monitoring at multiple depths in a borehole

For the reconstruction of GST history from the vertical temperature profile measured in a borehole, we assume that the past GST variation has been propagated downward by thermal diffusion. If we monitor temporal variation of temperature at multiple depths for a long period, the obtained data will show how the temperature signals are actually transferred through formations. There is a borehole ideal for such temperature monitoring experiments on the southeastern coast of Lake Biwa, southwest Japan. The hole, about 900 m deep, was drilled in 1992. Casing pipes were inserted down to 670 m to prevent the borehole wall from collapsing. The hole is owned by the Lake Biwa Museum and has been well maintained. The top of the hole is located inside of the museum building, providing us with an environment favorable for installing monitoring instruments.

The first temperature logging in this hole was conducted in September 1993, one year after the completion of drilling. We revisited the hole in April 2002 to obtain new temperature profile data and found that the temperature above 75 m increased significantly (by up to 1 K) in 8.5 years. It indicates that the temperature structure above 75 m was disturbed by some recent event(s) near the ground surface. To study this interesting phenomenon, we have made temperature logging repeatedly, which revealed that the temperature increase is still in progress with a slower rate (Fig. 5).

We have also made continuous measurements of temperature at depths of 30 m (since October 2002) and 40 m (since April 2004). The obtained temperature records show slow but steady increases at both depths (Fig. 6). Probable causes of these temperature variations are: 1) sudden rise in the average ground surface temperature due to construction of the building of the Lake Biwa Museum in 1996, which covered the top of the borehole, 2) increase in the depth from the surface due to fill-up of artificial sediment (6.7 m thick) on the original ground surface between 1982 and 1991.

A simple combination of these two factors, however, cannot explain the observation that the temperature increase at 30 m is much larger than that at 40 m.

In obtaining more information on the nature of heat transfer and the causes of temperature variations, we installed a temperature sensor cable in the borehole in August 2006. The cable has 10 thermistor sensors at depths of 15, 20, 25, 30, 40, 50, 60, 75, 100, and 130 m. It is connected to the temperature measurement unit controlled by a PC and the temperature data are stored in the PC. Long-term temperature records with this new system will allow us to make more quantitative and detailed analyses of the heat transfer process at this site. Similar temperature monitoring experiments and data analyses will be attempted in selected boreholes in the target areas.

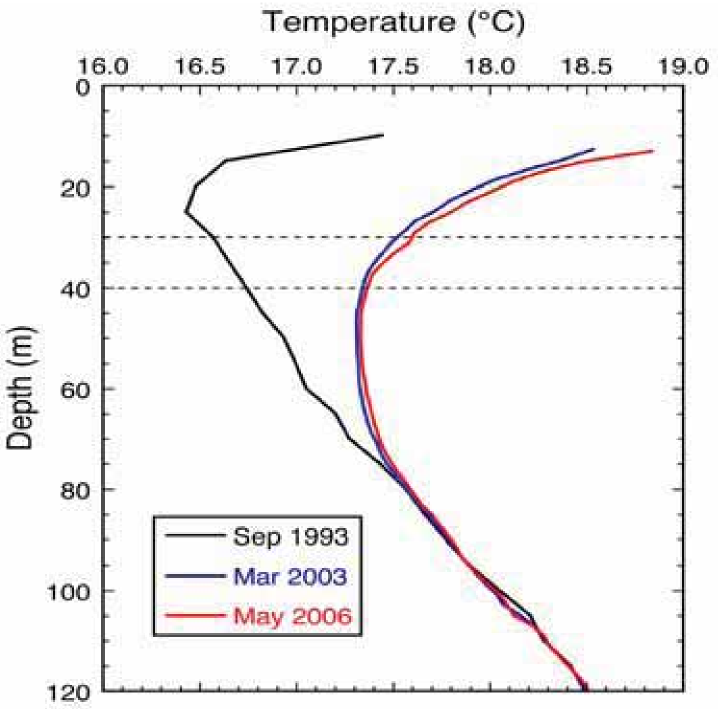


Fig.5. Temperature profiles in the upper part of a borehole in Lake Biwa museum measured in September 1993, March 2003 and May 2006. Dashed lines indicate the depths at which long-term temperature records in Fig.6 were obtained.

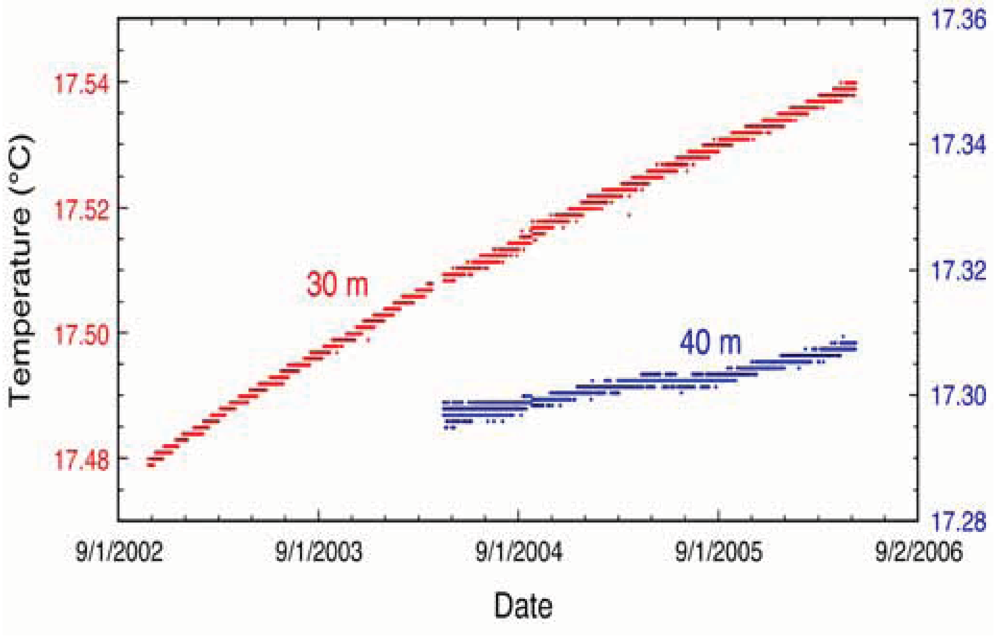


Fig.6. Temperature records obtained at depths of 30 m and 40 m in the Lake Biwa Museum

Temperature and hydrological changes of the subsurface environment

Chung-Ho Wang

Institute of Earth Sciences, Academia Sinica, Taipei

1. Introduction

Taipei is the capital city and serve as political, economic, educational, cultural, transportation, information and technology hub of Taiwan. Surrounded by mountains on all sides, Taipei city and neighboring areas shape as a distinctive basin in the northern Taiwan (25.03° N, 121.31° E; Fig. 1) with an area of 380 sq. km and approximately 5 million inhabitants. Its climate is hot and relative low humidity in summer, cool and relative high humidity in winter. Three rivers that come from east (Keelung), southeast (Hsintien) and south (Tahan) catchments, respectively, merge into one major stream (Tanshui) in the middle of Taipei Basin and flow northwesterly toward the Taiwan Strait.

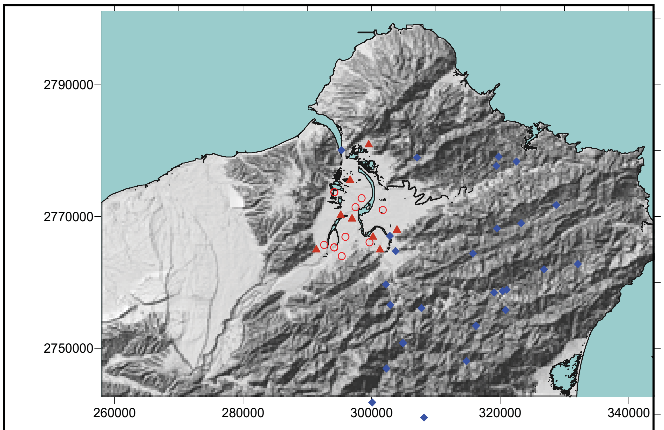


Fig. 1 Location of Taipei Basin. Red and triangle circles are groundwater level monitoring sites; blue squares are sampling sites for surface waters in previous studies.

Along with the continuous city expansion during the past decades, global warming has generated perceivable effects on the Taipei Basin. The impacts of the urban heat island phenomenon and air pollution in this subtropical basin are alarming, as many metropolitans show elsewhere. Many research topics related to basic geology and earthquakes have been proposed and conducted in the Taipei Basin. However, very few studies have focused on the subsurface environmental changes resulting from nature and anthropogenic impacts in the Taipei Basin. This important topic is now collaborated with scientists of this RIHN project for a detailed pursuit.

2. Air Temperature records

As elsewhere in the world, Taipei has experienced a steady increasing tendency in air temperature due to both global warming and urban heat island effects. Figure 2 displays the annual temperature variations from 1897 to 2004 of Taipei station. The annual temperatures are expressed as anomalies relative to the long-term average (22.2°C) which serves as the base line. The general feature of the temperature change agrees well with the global average trend. It is evident that Taipei has a linear rising rate of 0.15°C per decade. Before 1940, only one year (1915) had an annual temperature higher than the long-term average. There were some minor fluctuations between 1940 to 1975 for the temperature rising slope(0.03°C/10 years). After 1975, all annual temperatures were higher than the long-term average except years of 1976, 1979 and 1984. The rising rate after 1980 (0.38°C/10 years) is more than two times faster than the linear rate for the past century, indicating the recent acceleration of climate warming in the Taipei Basin.

The Urban Heat Island effect (UHI) can be better represented by a comparison between the temperature differences of city center with those of a rural site.

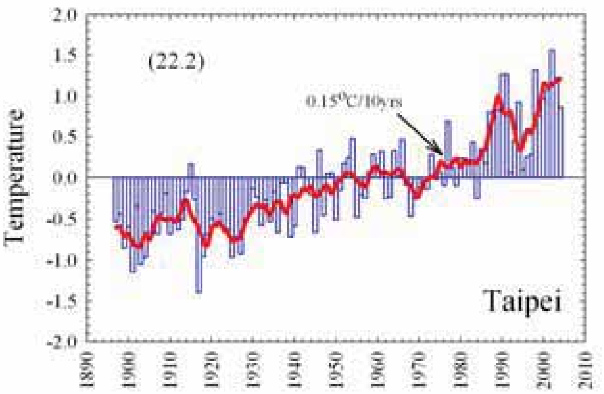


Fig. 2. Long-term annual temperature trend in Taipei. Long-term temperature average served as reference line and its value is shown in parenthesis. Five-year moving trend is illustrated as red lines.

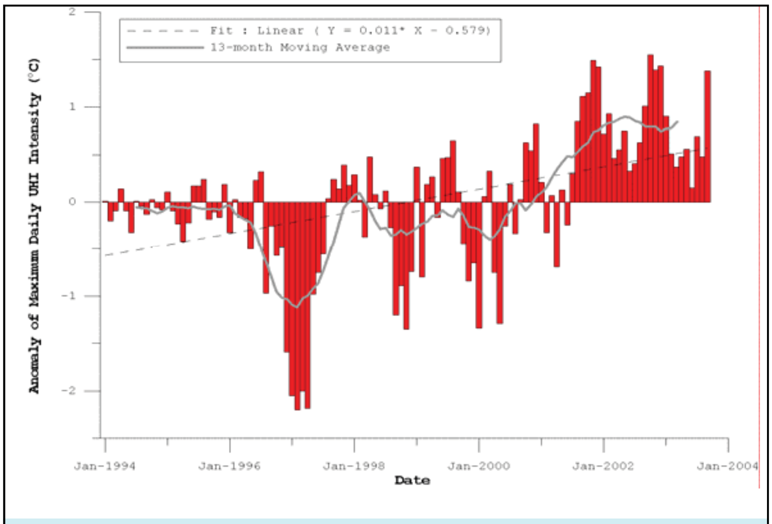


Fig. 3. Anomaly and linear trend of monthly mean daily maximum UHI between Taipei station (urban) and Wen-Shan site (rural) from 1994-2003, the latest two years show significantly positive increasing trend.

The monthly mean daily maximum UHI of city center (Taipei meteorological station) relative to the rural site (Wen-Shan station) is shown in Fig. 3. Solid line represents running average in 13 months and dash line is linear fitting. The UHI intensity revealed an increasing trend with 0.011°C in monthly average from 1994-2003. The Student's t-test shows that the trend has a value of t=4.45 which is significantly higher than that of the criterion (t=1.98) at 95% confidence level. In the latest two years (2001-2003), the UHI anomaly showed the most significantly increasing in positive mode. This observation clearly demonstrates that the Taipei city center has experienced more temperature warming than the surrounding rural or foothill regions at least for the last decade.

3. Precipitation records

The long-term trend for rainy-day in Taipei shows a clearly and steady decline during the latter half of the 20th century (middle plot). Before 1950, the average annual rainy-day is about 185 days; but this value drops to about 170 days after 1950. During the latest decade (1995-2004) the average annual rainy-day even falls to a value of 163 days, a significant reduction (12%) relative to that before 1950s. The recent increase of aerosol concentrations in Taiwan and East Asia due to anthropogenic contribution is regarded as one of the main factors causing the decrease of rainy days island-wide.

The precipitation intensity (defined as the ratio of amount over time (day)) represents an index of rainfall extremity. The intensity variations of Taipei from 1897 to 2004 are shown in the lower plot of Figure 4. On average, Taipei has a mean value of 11.9mm/day with high fluctuations since 1980; the highest is observed in 1998 (21.78) and the lowest in 1945 (7.4). The precipitation intensity of Taipei is gradually increasing (slope = 0.02) due to opposite trends for precipitation amount and rainy-day in the past 100 years.

The growing trends observed in the precipitation intensity of Taipei also pose greater risks for flooding in this metropolitan area (Figure 5). On the whole, hydrological extremes seem to become more and more common in Taipei. In the past decade, Taipei has experienced repeated occurrences of flood and drought. For instance, the ultra-high monthly precipitation records in October 1998 (caused by typhoons Zeb and Babs) and September 2001 (caused by Typhoon Nari), all broke the historical accounts of the past century. These events may be the dreadful signs for the coming of hydrological extreme periods in Taipei.

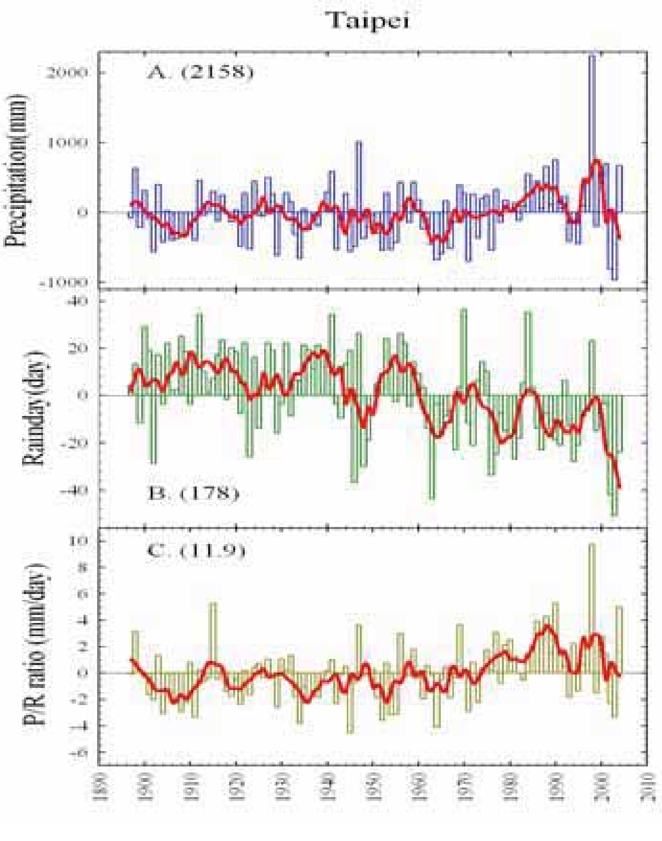


Fig. 4. Long-term annual precipitation trends of Taipei. Top: annual in mm; middle: annual raindays; bottom: annual intensity expressed by amount against rainy day in mm/day. Long-term averages for each plots served as reference line and their respective values are shown in parentheses. Five-year moving trends are illustrated as red lines.

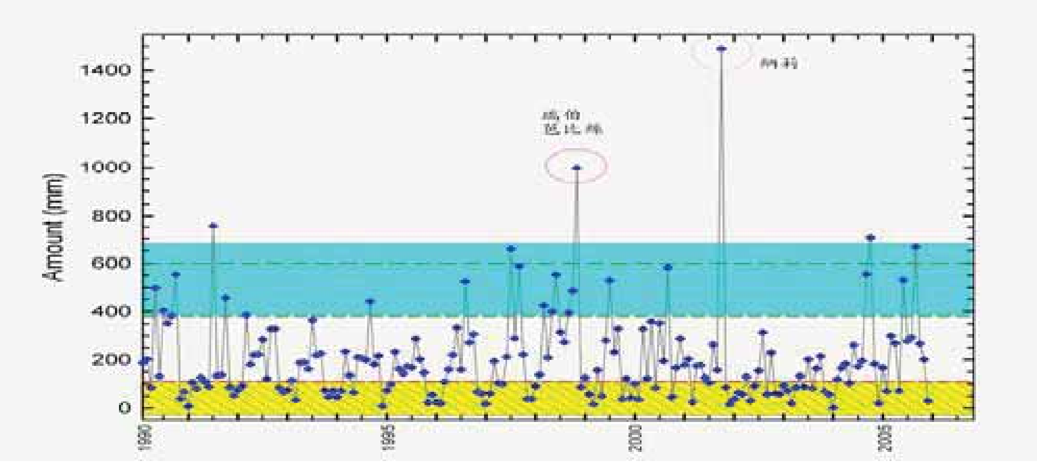


Fig. 5. Recent hydrological extreme occurrences in Taipei since 1990. The y-axis represents monthly precipitation amount (mm) of Taipei. The blue section represents flooding period and yellow belt signifies drought period.

4. Groundwater level variations

The subsurface environment of Taipei Basin has experienced substantial changes paralleling with the city development. The most prominent feature is the fall and rise of groundwater level. Due to overdraft of groundwater for domestic and industrial needs, groundwater level of Taipei Basin dropped to about 40 m below sea-level in the late 1960s to early 1970s. Consequently, land subsidence resulted and affected an area of 252 sq. km with a total vertical settlement of 2.1 m, greatly elevating the flooding risk along the river banks of Taipei Basin. Owing to the strict regulation on groundwater pumping and completion of the Feitsui Dam in 1986 for sufficiently supplying the surface water, the groundwater level has gradually recovered up to a height of about 4 meters below sea-level in early 2004. The average rising rate is about 1.3 m/year for the past three decades (Figure 6). Thus, groundwater level evolution of the Taipei Basin for the past three decades serves as a successful example of groundwater remediation.

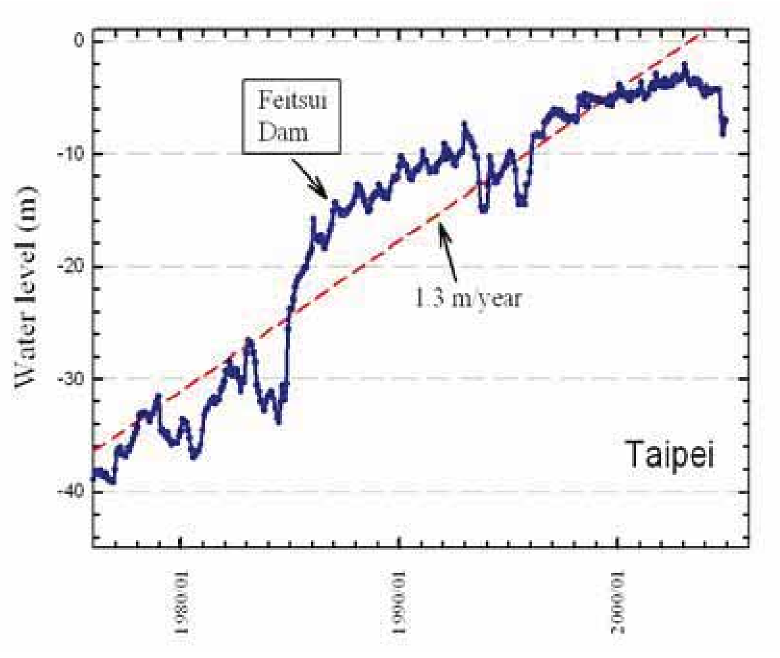


Fig. 6. Long-term monthly trend of groundwater level in Taipei station from January 1976 to December 2004. The red dashed line is the linear rising trend. Fetsui Dam began its operation in May 1986 and accelerated the rising rate of groundwater level.

5. Prospects

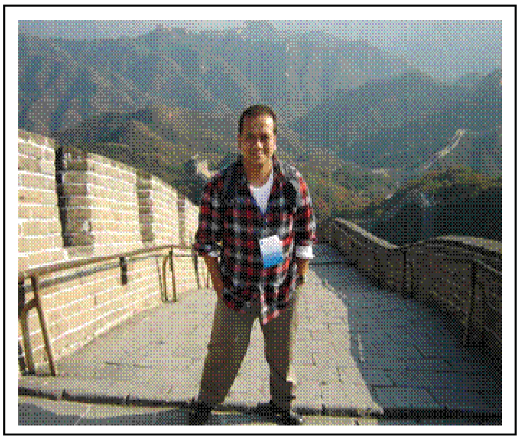
In the previous section, observations for the temperature, precipitation and groundwater level records of Taipei Basin for the past century are presented. Certain unfavorable phenomena and trends are very evident and become the major factors in generating the recent environmental problems in Taipei metropolitan area. In particular, the recent hydrological extremity and groundwater level rising should produce perceivable impacts to the subsurface environment, though very few realistic data have been observed.

A multidisciplinary effort such as our RIHN project is certainly needed to decipher the complicating relationships among possible parameters that are apparently induced from nature and human disturbances on the subsurface environment. In addition, an appropriate strategy for the effective management of natural resources and living environment in Taipei metropolitan area is urgently needed in perceiving these persistent and gloomy trends in the future.

Joint research with RIHN

Fajar Lubis

Groundwater is an important resource. It has been utilized for many centuries, particularly shallow groundwater for domestic purposes. Deep groundwater, however, has been developed since the middle of the last century. In line with the development of the country, the rate of groundwater exploitation also increased rapidly.



In Indonesia, use of groundwater has greatly accelerated with the increase in population and the development of the industrial sector, which consume a relatively huge amount of water. However, increase in groundwater exploitation has also caused negative impact on this resource both in quantity and quality. Therefore, it is necessary to protect groundwater based on the resources management model in relation with regional planning and land use planning based on environmental geology aspects, is indispensable

Groundwater studies has been my interest since my undergraduate years at Geology Dept, Bandung Institute of Technology (ITB) in Indonesia. Recognizing the importance of this field, I decided to pursue my graduate degree in a place where hydrogeology is a well established field of study. My main interest is in the application of geophysics in groundwater exploration.

While working on my PhD under the supervision of Prof. Yasuo Sakura at Chiba University, Dr. Makoto Taniguchi invited me to join the RIHN project together with Indonesia Institute of Science (LIPI). Now, I am looking at the subsurface thermal regime and will reconstruct the thermal environment evolution from underground temperature profiles. It is a great opportunity for me to be a part of this project.

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

RIHN 1st International Symposium

Theme: “Water and Better Human Life in the Future”

Kyoto International Conference Hall

Kyoto, Japan

November 6-8, 2006

Project 2-4 FR General Meeting

Hiroshima, Japan

November 27-29, 2006

Call for Contributions

For the next issue, we would like to request article contribution again from each Group. It may be in the form of a summary report of the Group’s activities or individual contribution from a member of the Group. We also encourage project members to discuss new methodologies or the use of new equipment in our research project. The newsletter will also provide special columns for our foreign counterparts, graduate students and the RIHN-based project researchers to share research updates and opinion on their involvement in the project.

For the third volume (April 2007), we would like to request the following Groups/individuals to give their articles for the newsletter:

1. Dr.. Yoshikoshi’s Group
2. Dr. Fukuda’s Group
3. Dr. Nakano’s Group
4. Dr. Tsujimura
5. Dr. Siringan
6. Dr. Umezawa

To allow ample time for editing and layouting, we hope to receive your articles on or before March 31, 2007.

For inquiries, please send email to:

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National Institutes for Humanities, Japan

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Project 2-4 Human Impacts on Urban Subsurface Environments

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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.

RIHN Corner

Profile of a Research Associate

Karen Ann Bianet Jago-on

The past six months have been a very good learning experience for me. I came here as part of the Urban Group of the Project on Urban Subsurface Environment. One of my tasks is to assist in data gathering on the socio-economic dimensions of urbanization and subsurface environmental changes. I also take charge of the publication of this project's newsletter. Aside from being a staff, I am also enrolled as a PhD student at the Graduate School for International Development and Cooperation under the supervision of Dr. Shinji Kaneko.

My initial study is to describe the process of urbanization in selected mega-cities in Asia in the last 50 years and determine the factors affecting changes in water supply and consumption of the growing population. This is part of an on-going research on the major causalities between urban development and changes in groundwater quality and quantity. The methodology will include history of urbanization, identification of patterns of urban growth and analysis of factors affecting changes in domestic water supply and consumption, including population increase, income growth, water use patterns and technological improvements in the last five decades. Case study cities include Osaka, Seoul, Taipei and Tokyo, however, these will be extended to include Manila, Jakarta and Bangkok to provide a good comparison of experiences of cities in different income levels and stages of growth. Lessons from the review of these experiences can provide insights for long-term projections and planning on water demand and supply in the growing cities in Asia.

Together with the members of the Urban Group, I went to Seoul in May and Taipei in September, to conduct research on city demographics, land use changes, economic structural change, and to visit sewerage and sanitation facilities in these cities. In December, I will do a similar survey in Metro Manila. During that time, I will present in a seminar at the School of Environmental Science and Management, University of the Philippines in Los Banos, Laguna.

I have attended the 2nd Global Water Resource Management Project Workshop in Guangzhou, China last June. In the workshop, several scientist and experts from the field of water resources management have gathered to discuss the effects/ impacts of dams and megacities on water resources. It was a good opportunity for me to enhance my understanding of the dynamics of water resources and the changes that occur due to increasing human activities.