Urban Subsurface Environments

Newsletter Volume 9 April 2010

The full implementation of the project "Human Impacts on Urban Subsurface Environment" continues in 2010 and the project members have conducted field experiments, surveys and data gathering in the target cities.

Summary of the group activities of the Gravity, Urban Geography and Heat groups and research results are featured in this volume of our project's newsletter. This issue also contains reports by Dr. Yasumoto and Dr. Huang

Inside this issue

Project Activities and Plans

Makoto Taniguchi, RIHN

This year is the last year of the RIHN-USE project. The domestic meeting to summarize the project results on the USE project will be held on May 26, 2010 during JpGU meeting at Makuhari, Chiba prefecture. All Japanese members of USE project will meet to discuss the results and implementation.

Another important meeting on our project is International Symposium "**Groundwater as a key of adaptation to changing climate and society**" which will be held in Kyoto on November 14 to 16, 2010. This symposium will be organized by RIHN, MEXT, Kyoto University, Nagoya University, and UNESCO-IHP. More than 50 experts on groundwater will meet at Kyoto to discuss the conclusions of the project results. The results will be published in the book from Willy and Blackwell.

In this project, integrated analyses have been made beyond the two boundaries between surface/subsurface and land/ocean in Asian coastal cities. Numerical modeling of the subsurface environment was established for Tokyo, Osaka, Bangkok, and Jakarta to evaluate the groundwater recharge rate/area, residence time, exchange of fresh/salt water.

Relationship between development stage of the city and subsurface environment problems have been also analyzed in this project with both integrated indices of changing society and environment, and natural capacity. Integrated indices, such as population and income (Driving force), groundwater pumping and dependency (Pressure), groundwater level (State), land subsidence (Impact), and regulation of pumping (Response), have been made on a yearly basis for seven cities over 100 years (1900-2000). Five development stages of the city are recognized in Tokyo based on the DPSIR, and six other cities are compared with Tokyo for (1) land subsidence, (2) groundwater contamination, and (3) subsurface thermal anomaly. Groundwater storage and groundwater recharge rate in seven cities have been compiled as integrated indices for natural capacities of changing climate and society. A five-stage model and a DPSIR model revealed that Bangkok had the following benefit (relatively small damage with same driving force/pressure), Taipei had a higher natural capacity (higher groundwater recharge rate), and Jakarta had excessive development compared to Tokyo for land subsidence issue.

Report of the Gravity Group in 2009

Yoichi Fukuda

Graduate School of Science, Kyoto University

1. Introduction

The gravity group basically aims at establishing a new method to monitor the groundwater variation by means of precise gravity measurements on land and from space as well. Regarding the in-situ gravity measurements, we introduced a field type absolute gravity meter, Micro-G LaCoste Inc. A10 in 2007. We have been conducting several test measurements in the field not only to confirm the accuracy of the instrument but also to investigate the practical and efficient measurement methods for field surveys. Some preliminary reports of the test measurements, in particular in Takigami geothermal field, are found in Newsletter No.5 (Nishijima and Fukuda, 2008). While we continue the test measurements in Takigami, we have newly set up the test areas in Osaka as an urbanized area and in Kumamoto where large groundwater variations are expected. We report the status and some outputs of these test measurements.

On the other hand, the first oversea experimental measurements have been conducted in Indonesia from August to September 2008. The outline of the measurements is found in Newsletter No. 7 (Fukuda et al., 2009). We have conducted the same measurements in Indonesia from July to August 2009, and in Thailand in September 2009. We also report the outlines of those measurements.

Regarding the satellite gravity data processing, we have employed the GRACE (Gravity Recovery and Climate Experiment) data. So far, we estimated the seasonal mass variations in four major basins of the Indochina Peninsula, and compared them with a TWS (Terrestrial Water Storage) model. The main progress in 2009 was that, using the most updated GRACE data, we have revealed not only seasonal variations but also a secular trend of the mass variations in the Chao Phraya river basin. Finally we describe the related issues briefly.

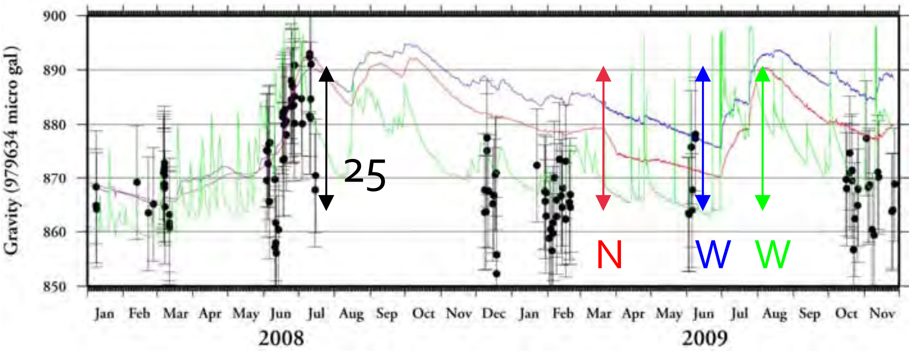
2, Status of the A10 absolute gravity measurements

2.1 Measurements in Kyushu University Ito campus

In order to check the repeatability of the measured gravity values, we have repeatedly conducted the measurements at the gravity point in Ito campus, Kyushu University, Fukuoka city, where the A10 is usually maintained. Fig. 1 shows the location of the point and Fig.2 shows all the measured values at the gravity point. There are three groundwater monitoring wells near the points as marked in Fig. 1. The groundwater levels observed at the wells are also shown in Fig. 2. It can be seen that the gravity values showed a good correlation with the groundwater levels. We can also confirm that the instrument is maintained in good condition in general, although some bad data are included in Fig. 2. Taking into account the gravity changes due to the groundwater variations, the repeatability of the A10 measurements looks better than 10 μgals.

Fig. 1. Locations of the gravity point (yellow circle) and the groundwater monitoring wells (blue rectangles) in Ito Campus, Kyushu University.

Fig. 2. Absolute gravity measurements by A10 in Ito Campus, Kyushu University.



2.2 Repeated measurements in Takigami geothermal area.

As already reported in Nishijima and Fukuda (2008), we selected Takigami geothermal area as a test field of the A10 measurements. In a geothermal plant, geothermal fluid (high temp water and vapor) is pumped up from production wells, used for the power generation, and after usage, water is finally retuned into injection wells. This cycle of the geothermal fluid was stopped in April 2008 for a regular maintenance at the Takigami geothermal plant.

We thought it was a good opportunity as a field test of the A10 because associated gravity changes should be observed. So far, the measurements have been repeated 6 times including the maintenance period.

Fig. 3 shows the gravity points and Fig. 4 shows the photo of A10 at the point T-26A (Injection zone). Fig. 5 shows the observed gravity changes at both the production zone and the injection zone as well. As we expected, the stop of the production caused a slight gravity increase in the production zone (T-27A) and rather clear gravity decreases in the injection zone (T-26A). After the restart of the production, the gravity value at T-26A was gradually returned to the steady state. On the other hand, the gravity value at T-27A decreased for a moment and increased later. Currently we are not sure whether these changes reflect any changes of the geothermal fluid or any other reasons. The next maintenance will be scheduled in May, 2010. To confirm the gravity changes due to the stop of the production, we will also plan to conduct the same measurements before and after the maintenance.

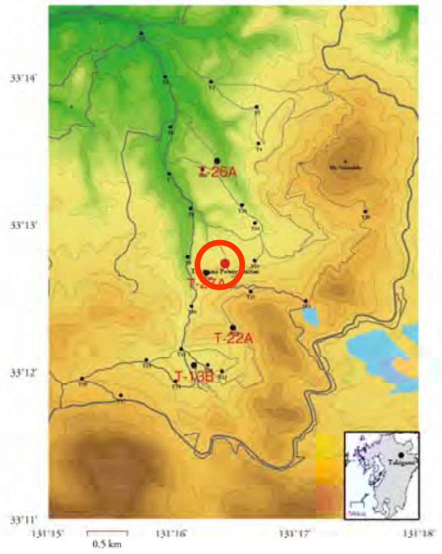


Fig. 3. Location of the gravity station in the Takigami geothermal area.

Fig. 4. A10 at the gravity point T26A.

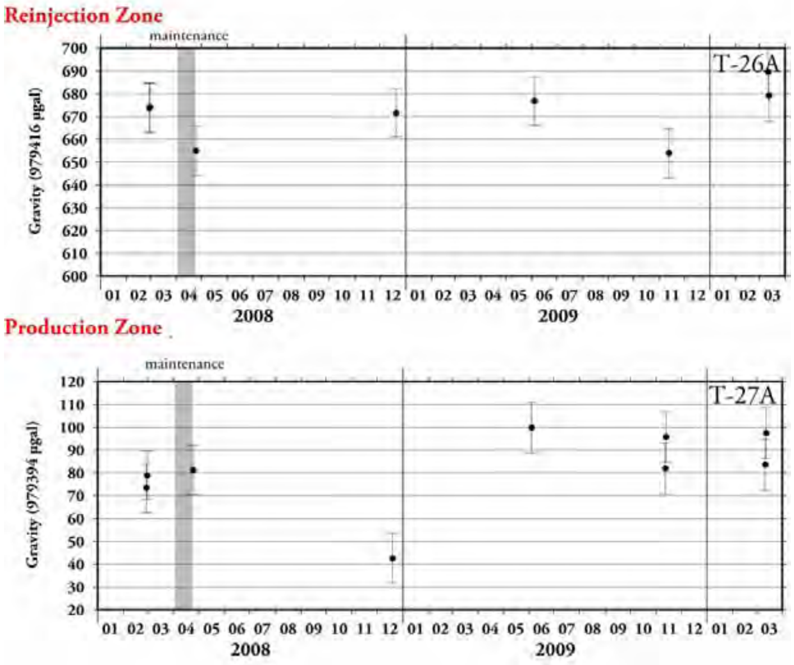


Fig. 5. Observed gravity changes in the Takigami geothermal area.

2.3 Measurements in Osaka and Kumamoto

In order to accumulate the know-hows of the A10 measurements and groundwater monitoring, we have newly set up the test sites in Osaka and in Kumamoto. Osaka is one of the most urbanized city in Japan and is located on soft sedimentary layers. Therefore the condition is very tough for gravity measurements. We established 3 gravity points in eastern part of Osaka city and in Higashi-Osaka city where relatively large seasonal groundwater variations of a few meters are expected. Fig. 6 shows the locations of the points. We conducted the measurements in December 2008, June and October 2009, so far. Fig. 7 shows the gravity values observed at these points. At some points, we occasionally repeated the measurements on the same day to confirm the repeatability. We can confirm that the observed values on the same day were fallen within 10-20 mgals in spite of the noisy circumstances. We are looking for the groundwater level data of the nearby observation wells, and will discuss the reasons of the gravity changes by comparing the groundwater level data.

Fig. 6. Gravity points in Osaka area.

Fig. 8 shows the locations of the gravity points in Kumamoto. These points are in rural areas with a quiet measurement condition. In addition, very large seasonal groundwater variations of more than several meters are expected. We conducted the measurements in June, December 2009 and March 2010. Fig. 9 shows the gravity changes observed. Unfortunately the weather of these three survey days was not good. It was rainy and windy. Thus the gravity values observed might not be so reliable. Further discussions are the future tasks because the data of groundwater levels have not been available yet.

Fig. 8. Gravity points in Kumamoto.

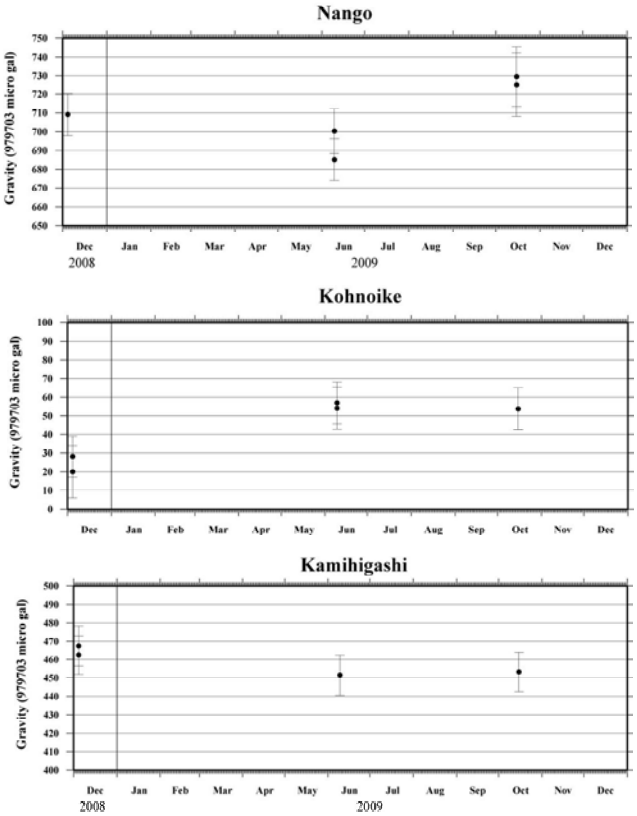


Fig. 7. Gravity changes observed at the gravity points in Osaka.

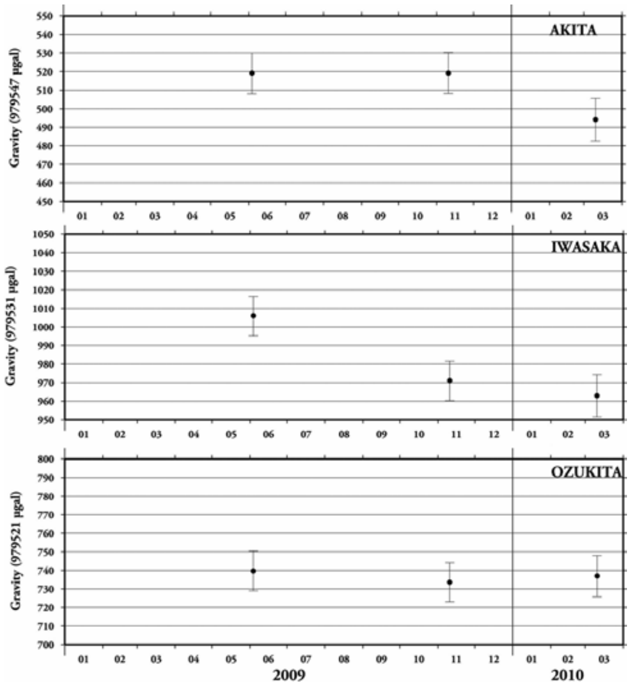


Fig. 9. Gravity changes observed at the gravity points in Kumamoto.

2.4 Surveys in Indonesia

The first gravity surveys in Indonesia have been conducted from August to September, 2008. Details of the surveys are found in Fukuda et al. (2009). Actually the surveys in 2008 were not so satisfactory mainly due to instrumental problems. We have obtained only limited number of absolute gravity values. However it was the first filed survey in Indonesia and we learned a lot in both technical and logistical viewpoints.

It was a rather tough work to conduct the measurements in high temperature and humid noisy urban circumstances. In particular the measurements in high temperature caused a problem in vacuum. In order to keep the inside of the dropping chamber in high vacuum, the A10 installs an ion vacuum pump. However the efficiency of the ion pump decreases in high temperature (about 40 °C). It occurred that the ion pump could not keep the vacuum enough in the 2008 surveys. Mainly due to the vacuum problem, we could not get enough good absolute gravity data in 2008. After the 2008 survey, the gravimeter was returned to the manufactory for overhaul, and then the 2nd ion pump was installed for upgrading the vacuum capability. In the 2009 survey, the vacuum problem has been settled. However we found another problem that the laser and other controls were unstable in high temp circumstances. Fortunately these problems were withstood by cooling down the instrument and we obtained rather good absolute gravity data of about 10 μgal accuracy.

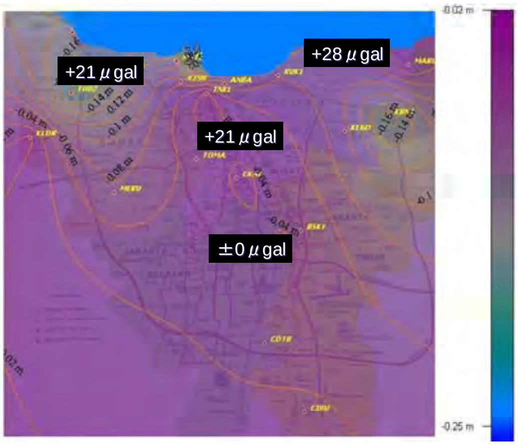
Fig. 10 shows the absolute gravity points in Jakarta. The gravity points marked LIPI and KUNI locate at the stable areas and others located at the areas with large subsidence. Fig. 11 shows a photo of the A10 which was installed on the GPS point (Bench mark) at KUNI.

Due to the luck of the absolute gravity data in 2008, we have not obtained the data of enough reliable gravity changes yet. Nevertheless the result of relative gravity measurements (Fig. 12) suggested the gravity increases in the coastal area where the large subsidence was observed by GPS. We plan to conduct the same measurements in 2010 and then we expect more quantitative interpretation will be possible with GPS and groundwater level data.

Fig. 10. Gravity points in Jakarta. The red pins show the absolute gravity points and the yellow pins show relative points.

Fig. 11. A10 at a gravity point (KUNI).

Fig. 12. Land subsidence rate (m/yr) observed by GPS and the gravity changes (2008-2009) observed by a relative gravimeter in Jakarta.



2.5 Surveys in Thailand

We have also conducted the A10 absolute gravity measurements in Thailand from September 18 to 26, 2009. Bangkok is another target city of the Project 2-4 and many kinds of field surveys have been conducted so far. It was really the first absolute gravity measurements by mean of A10, but due to the time schedule and the budget reasons, it was also expected to be the last measurements during the project period. Nevertheless we considered that it should be worthwhile to conduct the absolute gravity measurements and to establish the gravity reference points for future studies to monitor the groundwater variations and associated gravity changes. From this point of view, we selected the gravity points in Bangkok from the areas of large subsidence, and the locations as quiet as possible in the sense of urban noises. Also we expanded the survey areas to the upstream of the Chao Phraya river for aiming the comparison with the GRACE data in future. We established 9 gravity points in total, and 5 of them were indoor points. Fig. 13 shows the locations of the gravity points, and Table 1 summarized the results of the measurements. We expect these points should play the important role as the base stations in the future gravity studies in Thailand.

Fig. 13. Location map of the absolute gravity points in Thailand. Photo shows the gravity point in Suraburi.

Station	Date	Time	dg/dz	Gravity	Height	Set Scatte	Uncerta inty	Set	Latitude	Longitude
			microga l/cm	microgal	cm	microg al	microgal		deg	deg
Chula Geology	2009/9/19	13:48:29	−3.091	978298677.16	100	10.83	11.08	10	13.73518	100.52940
	2009/9/19	15:14:11	−3.091	978298658.42	100	11.61	11.16	10	13.73518	100.52940
	2009/9/20	9:34:26	−3.091	978298658.85	100	9.88	10.99	10	13.73518	100.52940
	2009/9/22	8:41:00	−3.091	978298663.61	100	9.83	11.09	8	13.73518	100.52940
	2009/9/22	17:41:50	−3.091	978298663.48	100	10.67	11.06	10	13.73518	100.52940
PD0136	2009/9/20	14:23:33	−3.086	978311222.43	100	5.23	10.85	4	13.72258	100.85298
TMD	2009/9/21	11:40:56	−2.982	978304349.65	100	10.55	11.05	10	13.66863	100.60663
DMR	2009/9/21	15:25:56	−2.898	978297184.33	100	6.09	10.71	10	13.76265	100.52712
NIMT	2009/9/22	12:22:51	−3.182	978312543.23	100	0.77	10.54	10	14.04338	100.71450
No.3	2009/9/22	15:20:23	−3.086	978309013.36	100	10.79	11.07	10	13.70568	100.78647
SARABURI	2009/9/23	12:18:38	−3.086	978331529.33	100	4.45	10.63	10	14.52247	101.03185
PHIMAI	2009/9/23	18:44:44	−3.136	978296866.83	100	1.28	10.54	10	15.18348	102.56488
	2009/9/24	8:44:08	−3.136	978296864.92	100	1.64	10.55	10	15.18348	102.56488
SRI SOMRONG	2009/9/24	19:53:31	−3.044	978422757.30	100	2.83	10.57	10	17.16147	99.86165
	2009/9/25	8:16:43	−3.044	978422751.83	100	5.21	10.68	9	17.16147	99.86165

Table 1. Gravity values measured at the gravity points in Thailand.

GRACE data processing

Regarding the GRACE data applications, we mainly estimated the seasonal variation of TWS so far (Yamamoto et al., 2007; Fukuda et al., 2009). In the Indochina Peninsula, we demonstrated that the GRACE TWS showed good agreements with Soil-Vegetation- Atmosphere Transfer Scheme (SVATS) models basically.

Recently a new GRACE dataset (GRGS gravity fields RL2) has been released from the CNES (Centre National d'Etudes Spatiales) /GRGS (Groupe de Recherche en Géodésie Spatiale) group. Using the GRGS dataset, we have detected not only seasonal mass variations but also inter-annual mass trend. Fig. 14 shows the TWS trend (mm/yr) from 2002 to 2008 estimated from the GRGS dataset. Fig. 14 shows a clear negative mass trend over the Chao Phraya river basin, while positive trend over the other river basins of Mekong, Irrawaddy and Salween. This tendency is consistent with a global TWS model (JLG model). Fig. 15 shows the comparison of the time variations of GRACE TWS and JLG model. It shows a good correlation between GRACE and the global model. However we also revealed that GRACE data can not be directly compared with unban scale groundwater flow models, because they are not usually well constrained in terms of total mass. In an ideal situation, the mass conservation in a local model would be constrained by a global model validated by GRACE. Moreover in-situ gravity measurements would be served as a validation tool of the local model. We hope that the absolute gravity measurements conducted in Thailand can serve as such references for the future studies.

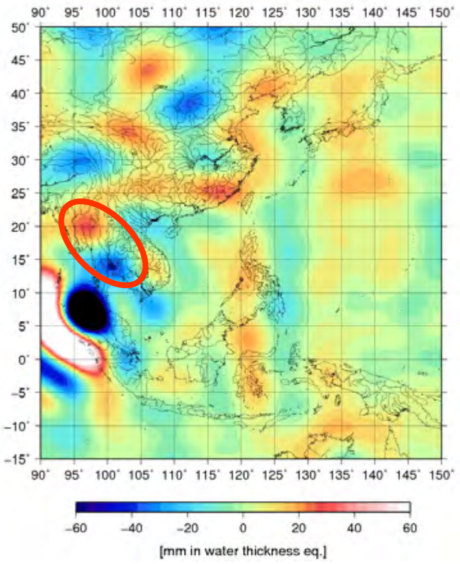


Fig. 14. TWS trend (mm/yr) from 2002 to 2008 estimated from CNS/GRGS V2 degree 50 GRACE data

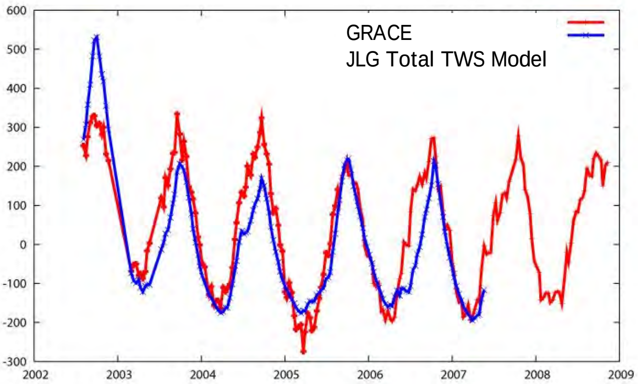


Fig. 15. Comparison of TWS variations between GRACE and JLG model.

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Contribution from Urban Geography Group

Akihisa Yoshikoshi

Department of Geography, Ritsumeikan University

I."Research on Urban Development and Water Environment Changes in Asian Megacities"

1.Objective

Since their growth into modern cities, Asian megacities have seen a change in their water environment due to such undertakings as the reclamation of their regional streams, rivers, lakes and ponds, and commencement of large-scale groundwater withdrawal projects. As a result, so-called water environment issues, i.e. lower groundwater levels, salinization of groundwater and land subsidence, emerged in many megacities. A time-series analysis of the process of their emergence reveals that the earlier a city developed, the earlier water environment issues emerged.

Accordingly, one can well expect that a city that is currently demonstrating remarkable growth might see in the near future an emergence of water environment issues similar to those in other cities that developed in earlier days. If effective steps are taken now, before it is too late, the water environment issues to emerge in Asian megacities in the future may turn out to be different from those in the past. By the way, although there are the side of water resources and environmental impacts in the water environment issues of urban area, the author will deal with the environmental impacts about groundwater, mainly.

2. Beginning and Subsequent Development of the Megacities

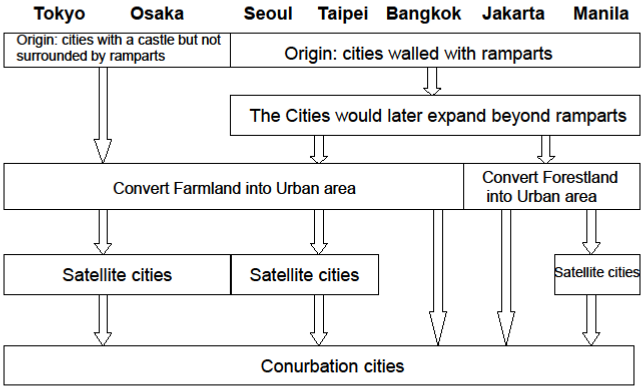


Fig. 1 The Process of Urban Development

Conceptually, the development processes of the seven megacities can be comprehended as shown in Fig. 1. To start with, the cities can be divided into two types when a focus is placed on what forms their core in terms of spatial aspects of urban development: cities walled with ramparts (Seoul, Taipei, Bangkok, Manila and Jakarta) and cities with a castle but not surrounded by ramparts(Tokyo and Osaka). In the former, the city developed in the area surrounded by clear boundary called rampart. In the latter, the city developed not in the area surrounded by clear boundary(rampart), but in the area centering on a castle. Both have the difference as shown above. The cities would later expand beyond ramparts, which would eventually be taken down in many cities (although they are preserved in Manila), with only some gates preserved up to the present time. Urban expansion would then further continue out to surrounding areas, which can also be divided into two types in terms of what kind of land was converted for development purposes: farmland and forestland. This is not as clear a distinction as the existence of ramparts, however.

Whether satellite cities have *f*ormed in surrounding areas is another factor that divides the megacities into two categories, but the timing of satellite city formation also varies from city to city. Bangkok and Jakarta have seen no obvious satellite city formation. These megacities have developed through the expansion of urban areas into their surrounding areas. Even in cities with satellite city formation, subsequent urban development and expansion eventually made it difficult to distinguish these cities from those without satellite cities in terms of landscapes, resulting in the formation of so-called conurbation cities. Fig. 1 illustrates all these aspects in chronological order, with the most recent period at the bottom.

While a description of urban development processes in this paper should revolve around Fig. 1, doing so would be a little too complicated. Alternatively, therefore, the cities are divided into the four groups below in an attempt to provide an overview and present spatial development models for each group on the basis of urban development stages.

As part of research in our project at the Research Institute for Humanity and Nature, the land use data on the subject megacities over three periods was converted into GIS data. More specifically, GIS was used to create square-grid land use maps on the basis of 1:50000-scale topographical maps from the three respective periods. In this process, roughly 500-meter square grids were drawn on topographical maps, with each grid showing the most prominent way in which the land was used in the area. Therefore, this method would preclude any comparative analysis using detailed figures, since minor land use that cannot be expressed by this approach would be ignored and because of variations in the topographical maps, on which the analysis would be based, depending on the country or the year in which they were created.

Case Study of Tokyo

The starting point of Tokyo as modern cities is set at the Meiji Revolution of 1868. Tokyo is situated on coastal plains and adjacent to rivers. And, Tokyo had vast farmland to its back consisting of rice paddies and crop fields, allowing physical room for the city to expand substantially. This city used to be castle towns in pre-modern times but was not surrounded by ramparts.

Later on, Tokyo's development began mainly from areas around the castle, as is illustrated in Fig. 2. Tokyo suffered devastation: it was utterly destroyed by the Great Kanto Earthquake in 1923 and then by air raids in the last phase of World War II, but thereafter made an astonishing recovery. Tokyo took in a large population coming from all around Japan not only in their urban areas but also by forming satellite cities in their suburbs. The inner city areas and their satellite cities were connected by railways that radiated out from the center. The cities expanded rapidly during the period of high economic growth starting in the mid-1950s, resulting in a large number of satellite cities growing in their suburbs as residential areas for those commuting to the city centers by train. Further growth that followed led to conurbation of existing medium- and small-sized cities in the vicinity and satellite cities, which entailed across-the-board urbanization that covered all those areas. Fig. 2 is a model representing these actual developments.

Fig. 3 illustrates changes in land use in Tokyo. Residential lands, which are colored red, existed only in the proximity of coastal areas around 1930. However, by roughly 2000, they were seen to extend from the areas along Tokyo Bay to the inland areas. In contrast, it is clear that farmland, the lightly shaded areas, followed a shrinking pattern.

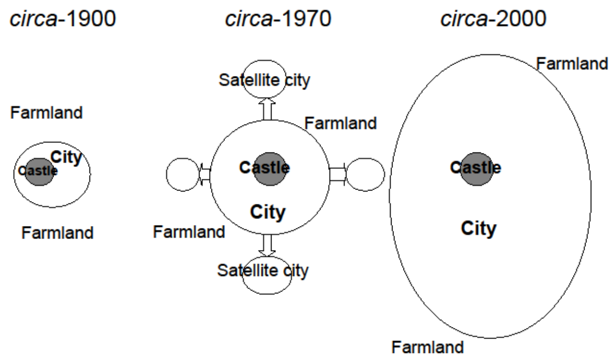


Fig. 2 Urban development model of Tokyo

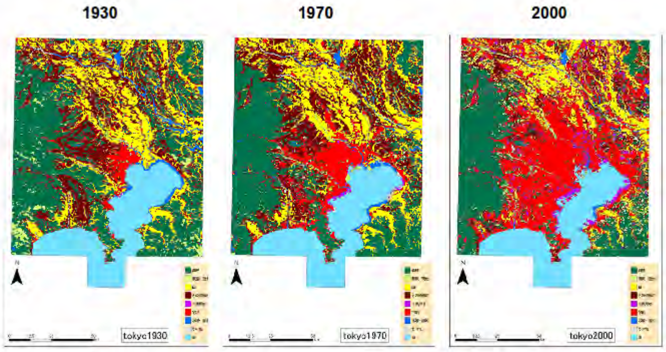


Fig.3 Land use of Tokyo

3. Water Environment Changes and Water Environment Issues

In this context, water environment changes refer to areas of water, including channels, streams, rivers, lakes, ponds, and marshlands, changing to roads or other urban-type land uses. Although it is naturally expected for water areas and marshlands to diminish with urban development, such changes in land use may not always be reflected accurately when land uses are calculated by a grid-square approach based on topographical maps as described earlier. With reference to GIS data, outcomes are relatively good in the cases of Tokyo, Seoul, Jakarta, Manila, etc., but appear to leave some issues for other cities. One way to complement this would be to use large-scale maps produced in different years to compare waters and other areas on them.

Case Study of Tokyo

1) Water Environment Changes

The area of its waters and marshlands dropped from 336 km^2 around 1930 to 173 km^2 (GIS data) by around 2000. Waters and marshlands diminished because of, among other things, their conversion to roads, etc. and culverting of streams. Since increased river flows as a result of urbanization were seen to lead to flood damage in recent years, a series of new measures have started being taken, such as stream or river improvements together with underground drain construction.

2) Groundwater Level Fluctuations

Since a restriction on groundwater pumping was put in place in 1961, groundwater levels have been on the rise. Prior to 1970, the amount of water pumped up in Tokyo per day used to be 1.5 million m^3, but has recently declined down to 400,000 m^3. This, in turn, actually caused groundwater levels to rise too high and has thus generated new issues, such as water seepage into underground structures as well as deformation and surfacing of them due to water pressure.

3) Land Subsidence

Land subsidence had already been occurring since the 1880s when monitoring was begun, but the issue was brought to light only after the 1920s. The trend ceased temporarily during World War II but again became noticeable in post-war days and continued on until around 1970, when the water pumping restriction started to be proven effective. Viewed by area, land subsidence took place mainly in areas from the Tokyo Bay coastal area to the alluvial lowland. Thanks to the groundwater pumping restriction that was subsequently applied to most areas, the land ceased to subside after 1970. On the diluvial plateau where groundwater pumping still continued, however, localized subsidence was observed. This led to the appearance of so-called “zero-meter zones,” meaning areas of which elevation is at or below sea level, on the alluvial lowland, including the proximity of the Arakawa River’s mouth where a large cumulative subsidence was recorded. It therefore became necessary to construct coastal levees, etc. to prevent tidal wave damage.

4) Water Salinization

When groundwater levels dropped sharply, coastal areas experienced groundwater salinization. This issue, however, has been put to rest in recent years because groundwater levels rose and groundwater is no longer used. Of an additional note, the problem of accidents caused by oxygen-deficient air, which had occurred frequently on underground and other construction sites between the 1950s and the 1970s, was likewise essentially solved as a result of the groundwater level rise.

5) Water Pollution

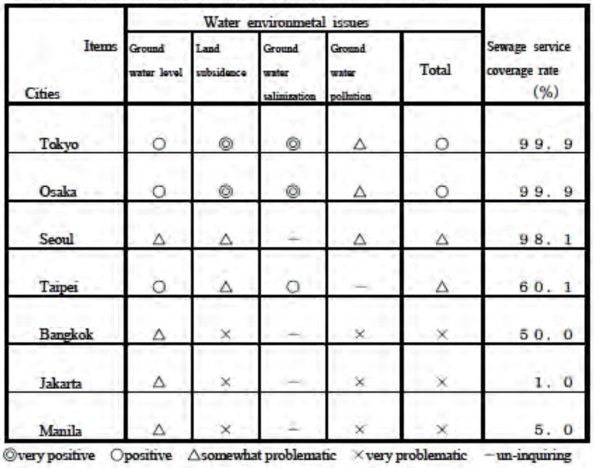
Non-point source pollution from nitrate-nitrogen and other compounds used to be found in Tokyo's groundwater, though the recent trend has shifted to point source pollution (from heavy metals and the like) from factories and other sites.

4.Connection between Urban Development and Water Environment Changes

The observations in the preceding sections have revealed that there are time lags between megacities in terms of timings of water environment issue emergence and solution. On that account, the current state of water environment issues in the respective cities was examined and sorted out for this paper. The results are as shown in Tab.1. As the data used was not necessarily prepared on the same basis, elaborate comparison becomes difficult; therefore, the approach chosen by the author was to compare the degree of water environment issues on a scale of five: ◎ indicates very positive, ○ positive, △ somewhat problematic, × very problematic and－un-inquiring. Take groundwater levels as an example. Tokyo and Osaka should really be given a score of◎, seeing that their groundwater levels are on the rise, but the score given is ○ because, as mentioned above, they are faced with new issues arising as a result of such rise.

As a next step, an attempt will now be made to gain an organized time-series view as to how water environment issues have developed(Fig.4).

Tab.1 Current state of water environmental issues



Items / Cities	Water environmetal issues					Sewage service coverage rate (%)
	Ground water level	Land subsidence	Ground water salinization	Ground water pollution	Total	
Tokyo	○	◎	◎	△	○	99.9
Osaka	○	◎	◎	△	○	99.9
Seoul	△	△	－	△	△	98.1
Taipei	○	△	○	－	△	60.1
Bangkok	△	×	－	×	×	50.0
Jakarta	△	×	－	×	×	1.0
Manila	△	×	－	×	×	5.0

◎very positive ○positive △somewhat problematic ×very problematic －un-inquiring

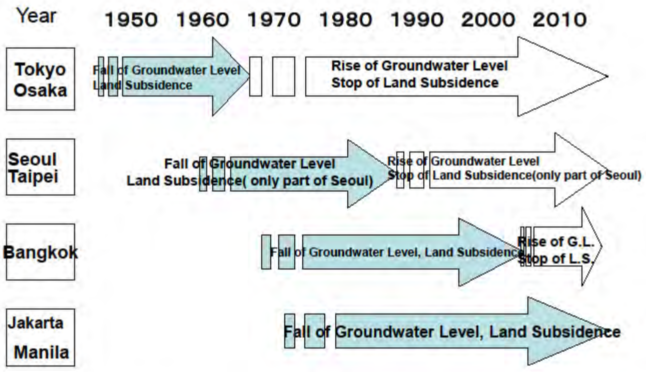


Fig.4 Change of Water Environment Issues

5.Conclusion

In this paper, the urban development processes in the Asian megacities and resulting changes in their water environment were discussed, and the water environment issues that have emerged as a consequence were sorted out. As a result, it has been brought to light that the cities that developed early also saw water environment issues emerge early, but a good part of them are now in the process of being solved. This Chapter stopped short of examining any specific actions taken to address those issues, but a remaining challenge is to apply in an effective fashion the approaches and experience of those cities to other megacities.

II. Research Progression of Urban Geography Group in 2009 Fiscal Year

1.The urban climate research group

The urban climate research group carried out the questionnaire to neighboring residents and visitors about the impression of Cheonggye River(Photo 1) in Seoul. The following results were obtained. ①The heat of summer softened near the river ②Near the river, the cold of winter became severe③Near the river, the wind became strong, etc.

On the other hand, also in the rural area in Thailand, the member of the group conducted investigation about the usage of the river (Photo 2).

Photo 1

Photo 2

2. Field survey

★Jakarta (28 Feb.2010～5Mar.2010)

Collection of data, investigation of the usage of well, river landscape survey

★Bangkok (13Mar.2010～18Mar.2010)

Location investigation of religion institution, Water use of religion institution

★Manila (24Mar.2010～26Mar.2010)

Urban landscape investigation

Photo 3 Heavy rain of Jakarta

Photo 4 Well in Bangkok

Long-term monitoring of subsurface temperature in Taiwan

Makoto Yamano[1], Akinobu Miyakoshi[2], Chung-Ho Wang[3], Rachmat Fajar Lubis[4], and In-Tian Lin[3]

[1] Earthquake Research Institute, University of Tokyo, [2] Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, [3] Institute of Earth Sciences, Academia Sinica, [4] Research Center for Geotechnology, Indonesian Institute of Sciences

The Heat Group has been conducting long-term monitoring of soil and borehole water temperatures in target cities of the project (Bangkok, Jakarta, Taipei, and Tokyo) and their surrounding areas, as briefly reported in former issues of the newsletter. Long-term temperature records at multiple depths in surface soil show penetration process of annual or shorter period variation of the ground surface temperature (GST), which gives information on heat transfer mechanism just below the ground surface (conduction and/or advection by fluid flow). It is also possible to calculate GST variation from soil temperature records at shallow depths based on the thermal diffusion equation (e.g., Smerdon et al., 2003; Bartlett et al., 2006). The estimated GST variation can be compared with surface air temperature (SAT) data.

By monitoring temperature at depths of 30 to 50 m below the ground surface, we may observe propagation of longer period components of GST variation, because influence of the annual variation must have decayed before reaching this depth range by thermal diffusion. Cermak et al. (2000) conducted long-term temperature monitoring in boreholes in the Czech Republic and showed that temperature increased at constant rates at depths of about 40 m. The steady temperature increase is interpreted as a result of propagation of GST variation.

In February 2010, we visited Taiwan for recovering soil and borehole water temperature data as well as for making repeated measurement of temperature profiles in groundwater observation wells. Long-term temperature records of good quality were successfully obtained in areas around Taipei and Chiayi (in the western part of Taiwan) in cooperation with National Cheng-Kung University and Water Resources Agency, Ministry of Economic Organization, Taiwan. We report on the temperature monitoring experiment in Taiwan and main results below.

Monitoring of soil temperature

Soil temperature monitoring was carried out just beside observation wells in which temperature profile measurement was made. Temperature sensors were buried at two depths (e.g., 50 cm and 100 cm below the surface) in slim holes drilled with a hand auger (cf. Fig. 4). Temperature was measured every hour with a resolution of 0.1 K by “Thermo Recorder” (T&D Corp., Japan).

We have obtained soil temperature records of good quality at three sites in Taiwan. The longest data, for about 2.5 years, was obtained at a site in the Chiayi area (Fig. 1). It shows typical features of thermal diffusion process: the temperature variation at 93 cm depth has smaller amplitude and lagged phase as compared to that at 43 cm. With an appropriate value of average thermal diffusivity between the two depths, the temperature variation at 93 cm calculated from the 43 cm temperature record agrees well with the observed one. It indicates that heat transfer in surface soil at this site is almost conductive. The average thermal diffusivity is estimated to be about 8×10^{-7} m^2/s.

Similar soil temperature data was obtained in the Taipei area as well (Fig. 2). Temperature variations at 54 cm and 94 cm can be well explained by downward propagation of GST variation with average thermal diffusivity of about 9×10^{-7} m^2/s. At this site, SAT was also measured about 1.6 m above the ground surface with “Thermo Recorder” installed in “Solar Radiation Shield” (Onset Computer Corp., USA) (Fig. 3). As expected, SAT is higher than soil temperature at 54 cm in the summer and lower in the winter, reflecting the heat exchange process across the ground surface. This type of air and soil temperature data will be useful for investigation of the GST and SAT relationship. We thus started soil temperature monitoring in February 2010 at two new sites in the Taipei area (Fig. 4), where SAT measurement had been conducted by the Urban Geography Group (Bai, 2009).

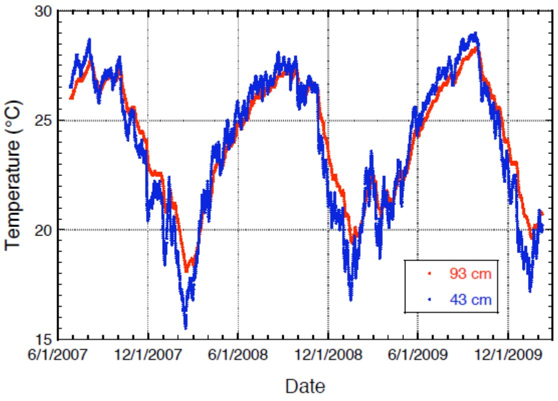


Fig. 1. Soil temperature records at depths of 43 and 93 cm below the ground surface obtained at a site in the Chiayi area.

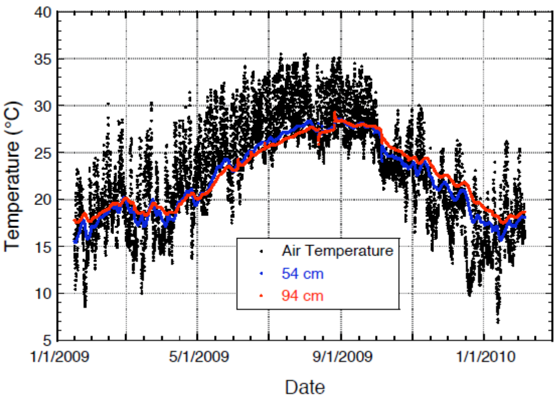


Fig. 2. Soil temperature at depths of 54 and 94 cm and air temperature measured at a site in the Taipei area.

Fig. 3. Installation of solar radiation shield for air temperature measurement.

Fig. 4. Drilling of a slim hole for installation of soil temperature sensors beside a thermal recorder for air temperature monitoring (Bai, 2009).

Monitoring of borehole water temperature

We carried out water temperature monitoring experiments in five groundwater observations wells in Taiwan. In each well, three self-contained recorders (Kaiyo Denshi Co., Japan) were hung at 30 to 50 m depths at intervals of 5 m and measured temperature every 30 min. with a resolution of 1 mK (Fig. 5). We detected peculiar short-period temperature variation with a strong one-week component in a well in the Taipei area (Yamano et al., 2009). It may be attributed to vertical movement of borehole water caused by some human activity in the vicinity of the well.

In February 2010, we recovered temperature data at three wells in the Taipei and Chiayi areas. All the obtained data (at all depths in all wells) showed temperature increase with time. The temperature record obtained in a well in the Taipei area is plotted in Fig. 6. Temperature increased monotonously at all the depths throughout the 2.5 year observation period at rates of 20 to 70 mK/year. The most probable cause of the observed increase in subsurface temperature at the three sites is propagation of influence of recent increase in GST, though the temperature distribution may have been disturbed by groundwater flow as well. We will continue temperature monitoring in boreholes in Taiwan and in other areas for further investigation of heat accumulation process in the subsurface of urban areas.

Fig. 5. Deployment of water temperature recorders in a well in the Chiayi area.

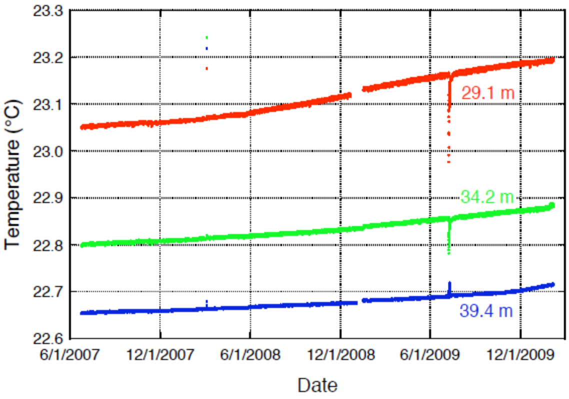


Fig. 6. Temperature records for about 2.5 years at depths of 29.1, 34.2, and 39.4 m in a well in the Taipei area.

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Estimation of the past ground surface temperature history from subsurface temperature distribution in the northern part of the Tokyo metropolitan area

Hideki Hamamoto[1], Shoichi Hachinohe[1], and Akinobu Miyakoshi[2]

[1] Center for Environmental Science in Saitama, [2] Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology

Temperature variations at the ground surface slowly penetrate into the subsurface by heat conduction and disturb the underground temperature distribution. The history of the ground surface temperature (GST) has thus been archived in the present temperature distribution in subsurface formations and can be estimated from temperature profiles measured in boreholes. GST is closely coupled with the surface air temperature and the reconstructed GST history generally reflects the global and/or local climate changes in the past.

We conducted temperature profile measurements in groundwater monitoring wells at 25 stations in July to October, 2009 (Fig. 1). The depths of the wells range from 50 to 600 m (most of the wells are 200 to 300 m deep). Temperatures were measured at 1 to 2 m intervals with a resolution of 0.01 K (Figs. 2 and 3). Many of the measured temperature profiles are distorted and appear to have been disturbed by groundwater flow. We examined the shapesof the temperature profiles and selected ones that are not significantly disturbed by groundwater flow. The profiles are convex downward in the upper part of the wells, which indicates a recent increase in GST, i.e. warming at the ground surface (Fig. 4).

We can reconstruct GST history for the last 300 hundred years using the selected temperature profiles. In the reconstruction analysis, we used a multi-layer model that takes account of variation of thermal properties with depth. The depths of layer boundaries were determined based on lithology information around the wells. Fig. 5 shows an example of the reconstructed GST history.

JMA (Japan Meteorological Agency) has been monitoring air temperature in the center of the Tokyo metropolis since 1880. The yearly mean surface air temperature at the Tokyo observatory increased by about 3 K in the last 100 years, consistent with the result of GST history reconstruction in Saitama prefecture (Fig. 5). It should be noted, however, that increase in GST does not necessarily correspond to increase in surface air temperature. GST and subsurface temperature may be affected by the land use and could be highly variable in urban areas. We should examine the history of land use at each station to discriminate the effect of local land use from the effect of regional heat island.

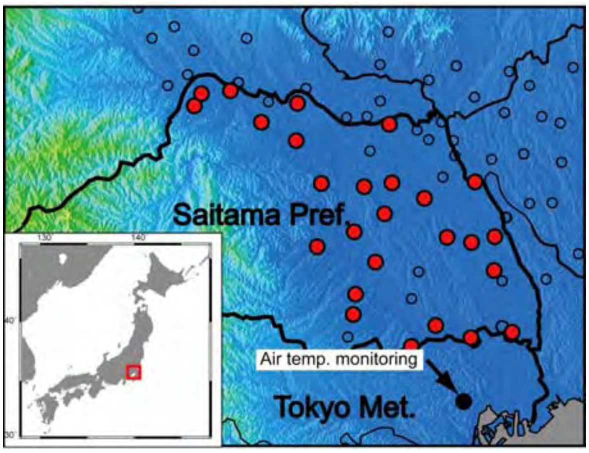

Fig. 1. Locations of groundwater monitoring stations where borehole temperature measurement was conducted.

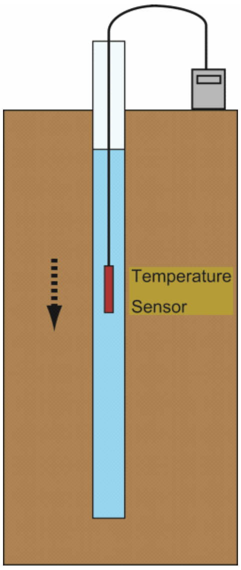

Fig. 2. Measurement of temperature profile in a borehole.

Fig. 3. Temperature measurement at a groundwater monitoring station

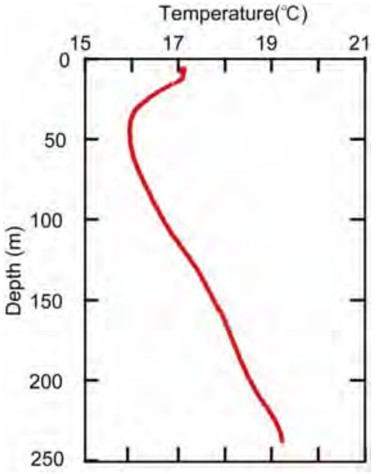

Fig. 4. Borehole temperature profile in an observation well in Saitama prefecture.

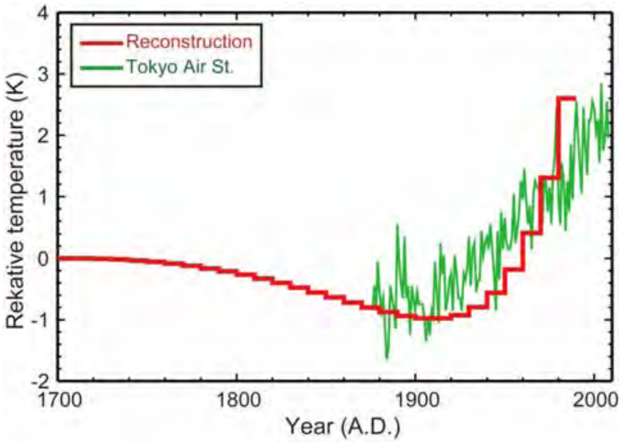

Fig. 5. GST history reconstructed from the subsurface temperature profile (Fig. 4) and surface air temperature in Tokyo.

Estimation of submarine groundwater discharge to Osaka Bay, Japan

Jun Yasumoto[1], Satoshi Nakada[2], Makoto Taniguchi[2], Shinji Nakaya[3]
& Masahiro Takahashi[4]

[1] Faculty of Agriculture, University of the Ryukyus, [2] Research Institute for Human and Nature

[3] Faculty of Engineering, Shinshu University, [4] NIPPON KOEI CO., LTD

INTRODUCTION

The coastal eutrophication from terrestrial nutrient discharge is a serious problem. This study focuses on the environmental rehabilitation of Osaka Bay, Japan, where eutrophication is occurring due to an increase in fertilizer and wastewater input through direct runoff and groundwater discharge from the residential, industrial and agricultural areas in Osaka Bay catchment. However, groundwater discharge has not yet been quantified as the pathway of nutrients input in this area.

For the study of submarine groundwater discharge to Osaka Bay, a detailed cross-sectional model of submarine groundwater discharge has been developed to evaluate the field measurements using automated seepage meter and electric resistivity survey in Omaehama beach, located in the northern part of Osaka Bay. Additionally, a three-dimensional, regional-scale model has been constructed to scale up the local-scale studies to the entire bay. The SEWAT code (Langevin, et al. 2003) was used to simulate the complex variable-density flow pattern and to estimate the rate of submarine groundwater discharge to Osaka Bay.

METHODS

Field measurements and cross-sectional groundwater flow model

The field site is located in the coastal zone of Omaehama beach, Osaka Bay, which is the only location that has remained natural coast in the northern part of Osaka Bay. Many bivalves such as oysters and clams live in this beach area.

SGD was quantified using automated seepage mater and electrical resistivity survey along the beach. As a result, the SGD and SFGD (Submarine Fresh Groundwater Discharge) in the beach were measured as will hereinafter be described in detail and the structures of fresh water and salt water that exists under sea bottom was clarified. There, a detailed cross-sectional model of submarine groundwater discharge has been developed to evaluate the field measurements in the beach. Figure 1 depicts the model geometry and boundary conditions. The density-dependent groundwater flow code, SEAWAT (Langevin, et al. 2003), is used to the simulation.

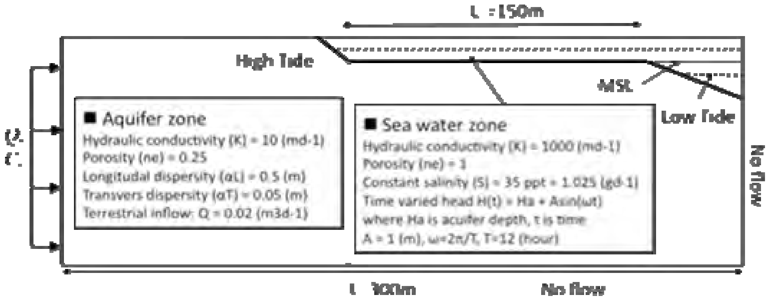

Figure 1. Model geometry and boundary conditions

Regional groundwater flow model

With the extremely rapid urbanization in the Osaka Bay region by the postwar development of Japan's economy, the natural coastal area was modified vertical engineering structures. Measuring SGD using seepage mater is impossible in such an artificial coastal area. Therefore, a three-dimensional, regional-scale model has been constructed to scale up the local-scale studies to the entire bay. The groundwater flow code, MODFLOW-2000 (Harbaugh, et al. 2000), is used in the simulation. Figure 2 depicts geological map of Osaka Bay and domain of regional scale model. The aquifer parameters of the regional scale model are depicted in Table 1.

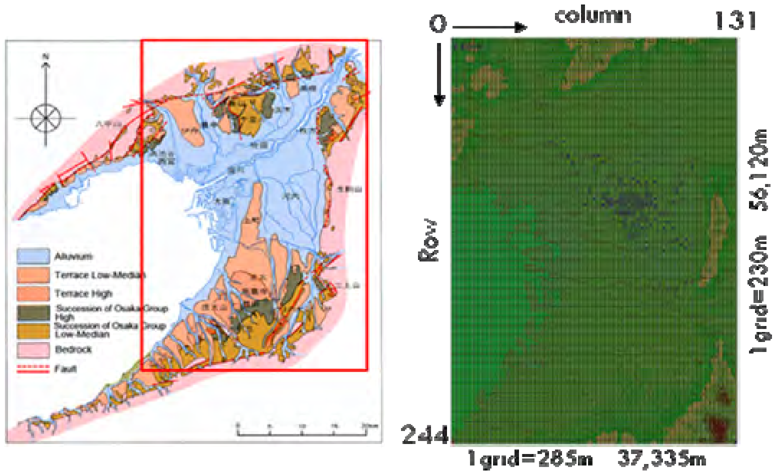

Figure 2. Geological map of Osaka Bay and domain of regional scale model

Table 1. Aquifer parameters used in the regional scale model

Stratigraphical division		Layer	Hydraulic Conductivity(cm/s) Kx, Ky	Kz	Specific storage Ss (1/cm)	Thickness	Group
Alluvium	Upper	No.1:	1.E-06	1.E-06	1.E-04		G1
	Clay (Ma13)	No.2:	2.E-07	2.E-07	1.E-03	30-50m	
	Bottom	No.3:	1.E-06	1.E-06	1.E-04		G2
Upper Diluvium	Tenman	No.4:	5.E-04	5.E-05	4.E-05	30-100m	
	Clay (Ma12)	No.5	2.E-07	2.E-07	5.E-04		
	gravel	No.6	6.E-04	6.E-05	4.E-05	50-100m	G3
Succession of Osaka Group	Clay (Ma9)	No.7	1.E-07	1.E-07	5.E-04		G4
	Ma8-Ma6	No.8	3.E-04	3.E-05	3.E-05	50-100m	
	Ma5-Ma3	No.9	2.E-04	2.E-05	3.E-05	50-100m	
	Ma2-Ma-1	No.10	2.E-04	2.E-05	2.E-05	50-100m	
		No.11	5.E-04	5.E-05	2.E-06	500-1000m	
Bedrock							

RESULTS

Field measurements and cross-sectional groundwater flow model

Field measurements using the automated seepage meter suggest that submarine groundwater discharge to Osaka Bay's relative shoreline is restricted to within 200 meters of the shoreline at Omaehama Beach. Submarine groundwater discharge rate was about 22cm/day on average in one tidal cycle. The submarine groundwater discharge consists of two components: fresh groundwater and recirculated seawater which are separated using the submarine groundwater discharge rates and electric conductivity. The estimated fresh groundwater discharge rate was about 2.4cm/day on average. The two SGD components were well-mixed and a clear boundary between fresh groundwater and seawater was not observed.

The cross-sectional simulation suggests that the flow path where the fresh groundwater passed over the mixing zone between freshwater and seawater was formed at low tide and flood tide.

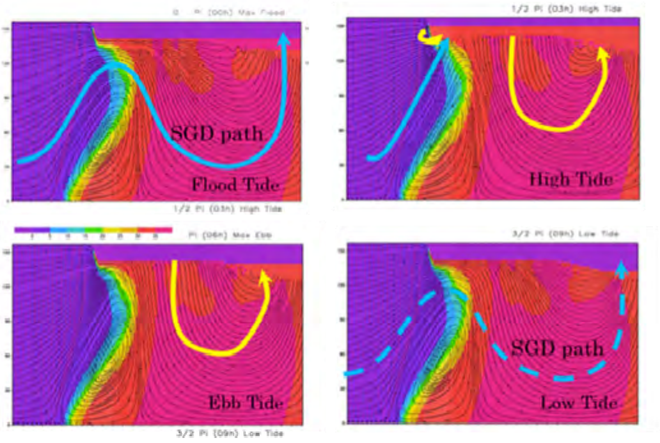

Figure 3. Salt concentrations and flow streamline at each tidal cycle (Flood Tide, High Tide, Ebb Tide & Low Tide)

Figure 4. Simulated rates of fresh groundwater discharge compared with measured rate of surface water discharge to Osaka Bay

Regional groundwater flow model

The regional-scale simulation suggests that average rate of fresh groundwater discharge to Osaka Bay for 80 years (1925-2005) is about 9.3 x 10^6 cubic meters per day. Simulated groundwater discharge was compared with measured surface-water discharge to the entire bay for 50 years (1955-2005). For the same period, groundwater discharge to Osaka Bay was about 1 percent of surface-water discharge.

DISCUSSION AND CONCLUSIONS

The results indicate that groundwater discharge to Osaka Bay is a minor component of the water budget. But, the simulated groundwater discharge will improve when an effect of recirculated seawater induced by density and tidal pumping is added. Moreover, it is possible that the ratio of groundwater discharge to surface water is larger in the northern and southern part regions, where a large amount of submarine groundwater discharge exists.

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ACKNOWLEDGMENT

Discussion with Tom Gleeson (University of British Columbia) was helpful in developing some of the ideas presented in this manuscript.

A Conjunct Position With New Research Areas

Shaopeng Huang

I am delighted to report that recently I accepted a conjunct position as a Specially Appointed Professor in the Xi'an Jiaotong University (XJTU). I will, therefore, be traveling back and forth between USA and China.

Located in the ancient capital city Xi'an, the XJTU is among the most prestigious universities in China. Traditionally, the University is famous for its national leadership in many engineering disciplines. In the wake of global climate change as well as the challenges and opportunities imposed by climate change on socioeconomic development, the XJTU has decided to embrace an ambitious earth science and engineering program, and to create the Institute of Global Environmental Change (IGEC, or in its Chinese full name, 西安交通大学全球环境变化研究院) as the base of the program. As the first principle investigator of the newly created XJTU/IGEC, I will continue to foster a better understanding of the course and causes of climate change, while extending my research effort to application research to promote low-carbon economy for climate change mitigation and adaptation. My near-term research interest with the XJTU/IGEC includes the following three major aspects. I would welcome any collaboration opportunity with the RIHN project team. Besides, if you know of anyone who might be interested in working in Xi'an on any of the aspects, please let him/her get in touch with me at shaopeng@umich.edu or shaopeng@mail.xjtu.edu.cn.

Greetings from Xi'an, an ancient Chinese capital city of 5000 year old.

1. The role of ground temperature change in climate change

The climate system is a dynamic system encompassing interactions among various components across atmosphere, oceans, and lands. In principle, all the interactions involve energy exchange accompanied by a temperature variation. Tremendous efforts have been devoted to understand the causes and consequences of temperature changes in the atmosphere and oceans. In comparison, very little has been done to address the role of ground temperature in climate change, which has become a bottleneck in the climate system research

On a regional scale, seasonal fluctuations of Tibetan Plateau ground temperature is a driving force of Eastern Asia monsoon. Several Chinese scientists have long used subsurface temperature as a key parameter in their short-term precipitation forecast with a reasonably high success rate; yet the interpretation of the empirical relationship between ground temperature and precipitation underlying their method remains controversial. On the global scale, atmospheric warming and oceanic warming make frequent headlines. Less well known is that the land is warming too. Based on world-wide meteorological and borehole temperature records, the 20th century global warming deposited about 10×10^{21} Joules of thermal energy into the continental landmasses. If the observed global warming trend over the last three decades were to continue, the continents would gain additional thermal energy more than five-fold the amount they acquired over the 20th century. Even if the global surface temperature would stabilize at the current state throughout the rest of the 21st century, the continental landmasses will continue to acquire heat from the atmosphere.

Ground temperature is a fundamental parameter controlling various physical, chemical, and biological processes that affect the climate system as a whole. For example, several recent studies show that subsurface temperature could also affect soil respiration, and hence greenhouse gas fluxes at the land-atmosphere interface. However, routine temperature monitoring in soils and rocks are not only sparse, but also made mostly for other original objectives rather than weather/climate research. A nationwide environmental drilling and monitoring network has been proposed as a key facility for science and technology in China. We intend to incorporate long-term subsurface temperature monitoring into this network to foster both fundamental science and practical application of climate system research.

2. Deep geothermal energy as an alternative clean energy source

The growing concern about global warming underscores the need for alternative primary energy resource to replace the carbon-emitting fossil fuel. An important low carbon energy source is geothermal energy, especially the enhanced geothermal systems (EGS, also known as Hot Dry Rock, or HDR).

The Earth is a giant heat engine with a total heat content of 12.6 x 10^{24} MJ. Geothermal energy is apparently one of the most abundant potential sources of clean energy. An 18-member assessment panel led by Massachusetts Institute of Technology estimated the indigenous geothermal energy extractable at the depths between 3-10 km in the United States to be 280,000 EJ, about 2,800 times the total US annual primary energy in 2005. Moreover, unlike solar radiation and wind power which fluctuate on seasonal, diurnal, and hourly time scales, EGS is one of the very few renewable energy resources capable of generating steady "baseload" power.

However, before a geothermal energy program can be implemented on a regional scale, many details of EGS must be carefully investigated. For examples, while the Basel geothermal project in Switzerland was shut down due to earthquake fears, the U.S. Department of Energy sponsored EGS demonstration project in the Geysers north of San Francisco was abandoned because of "geological anomalies" in the midway to drill to its about 4 km depth destination. Similar drilling woes were suffered by EGS projects at Paralana and Cope Basin in South Australia. The recent setbacks in EGS exploration underscore the need to enhance our understanding of geothermal environment at greater depths.

Under the common pressure to suppress carbon emission, U.S. and China recently established a 150 million USD Clean Energy Research Center to facilitate joint efforts by scientists and engineers from the two countries. Meanwhile, China has launched the SinoProbe project to advance the drilling technologies for mineral resource exploration at several kilometers below the surface.

I am involved in the site selection for the SinoProbe drilling experiment in the Tengchong Volcano-Geothermal Area in SW China. I hope that the U.S.-China joint venture and the SinoProbe project will help to enhance our ability to embrace deep geothermal energy in our pursuit of alternative clean energy.

3. Biological photosynthesis as a means of carbon sequestration

It has been well appreciated that the Keeling Curve, a time series of precise atmospheric carbon dioxide measurements, sets a stage for studying the relationship between man-made carbon dioxide emissions and global warming. It has not been recognized, though, that the Keeling Curve bears important clues to global warming mitigation.

The saw-tooth Keeling Curve carries an increasing trend and an annual oscillation as an expression of the photosynthesis-respiration rhythm of the plant-rich northern hemisphere. In a balanced atmosphere-biosphere system, the amount of the CO_2 taken-up by plants for the production of sugars via photosynthesis should be equal to the amount released from plant and soil respirations at an annual basis. However, with extra sources brought into the system by human, there is a surplus each year, and accumulatively there is an accelerated increasing trend that could soon lead to a dangerous level, according to the IPCC.

But what could shed some light in the midst of the darkness is the relatively small magnitude of each annual surplus as compared to the amplitude of the biological CO_2 oscillations. Should we have been able to suppress the upward segments by 10% of the carbon involved in the annual biological cycle from returning to the atmosphere since 1958, the 2007 atmospheric CO_2 concentrations would be at the level of 1987.

Such a suppression scenario might seem too ambitious at first glance. However, it is not out of our reach with the biological resources and technologies already available. For example, the 10% reduction scenario requires the 2007 annual increment to be reduced from 1.79 to 1.05 ppmv, or a carbon sequestration rate of 1.58 Gt C/yr, which is around 10% of human appropriation of net primary production (HANPP). Based on food and agriculture statistics from over 160 countries, the global HANPP is estimated to be 15.6 Gt C/yr, over half of which is contributed by harvest.

When the biomass of a plant is burned or decomposed, the carbon dioxide the plant absorbed from the atmosphere would be released back to the atmosphere. However, if it is heated in the absence of oxygen, most carbon would stay in the form of biochar which is the key soil amendment in the "terra preta" (dark earths). Inspired by the high carbon content, high fertility, and long-term stability of the Amazonian dark earths created by pre-Columbian Indians, there is a growing interest in promoting biochar as a novel approach to carbon sequestration

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Joint Research with RIHN

Takashi Hasegawa

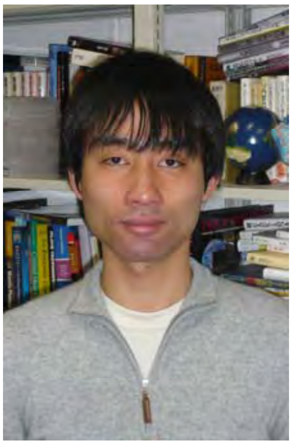
Graduate School of Science Kyoto University, Japan

My name is Takashi Hasegawa and I am a second year Ph.D. student of Department of Geophysics, Kyoto University, majoring in geodesy. In the RIHN Project Human Impacts on Urban Subsurface Environment, I am a member of the Gravity subgroup and engaging in subjects to monitor groundwater changes using data from in-situ and satellite gravity measurements.

In-site measurements can reveal local groundwater variations. We are conducting repeating gravity and GPS survey in Jakarta, Bandung and Sumarang for monitoring groundwater changes and land subsidence. Multi-year measurements will reveal groundwater changes and rate of gravity changes versus height variation will provide important importations about a mechanism of land subsidence.

On the other hand, a satellite measurement provides long wavelength gravity signals. GRACE satellite gravity mission has been providing time-varying gravity field, with a spatial resolution of several hundred kilometers. From GRACE data, I found long-term reductions in terrestrial water storages in south-east Australia. Comparison of GRACE data with in-situ climate and hydrological observations indicated multi-year rainfall deficiencies induced decrease of soil moisture and/or groundwater storage. Moreover, GRACE data showed good correlations with ground gravity measurements.

In-situ and satellite gravity measurements which have different spatial resolution should work complementary, though few study combined them effectively. Climate and hydrological data may give hits for understanding discrepancies, as well as consistencies between in-site and satellite gravity measurements. I am going to study the effective usage of recent gravity measurements for monitoring terrestrial water storage changes.



Inter-University Research Institute Corporation

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Project 2-4 Human Impacts on Urban Subsurface Environments

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

Contact:

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

Project Leader: Dr. Makoto Taniguchi

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

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.

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

・Japan Geoscience Union Meeting 2010

(Makuhari, 23-28 May)

Call for Contributions

For the tenth volume (October 2010), we would like to request all group leaders to give their articles for the newsletter: For inquiries, please send email to: **makoto@chikyu.ac.jp**

RIHN Corner

Satoshi Nakada

Project Researcher

Many megacities are located in alluvial plains or coastal regions that are a relatively flat landform created by the deposition of sediment with the global sea-level change and by one or more rivers coming from highland regions over an epoch of the Holocene. Human civilization, in its most widely used definition, dates entirely within the Holocene and was built in the vulnerable alluvial plains where floods often have occurred. Nowadays, the modern civilization can defend the human societies against many floods but have consumed a huge amount of energy every second. The word anthropocene is sometimes used to describe the time period from when humans have had a significant impact on the Earth's climate and ecosystems to the present. It can be readily said that we just are in anthropocene considering that the megacities or the human activities in the coastal regions have greatly influenced not only the global environment but also the urban subsurface environment. Therefore, I have the great interesting for the hydrological, oceanic, and atmospheric environments in the coastal regions such as the urbanized cities on vulnerable plains. In particular, the study by means of approaches of the oceanography and hydrology should be necessary to understand the interaction between the nature and human in the coastal regions. Since January 2009, my interests were extended to the megacities in the coastal areas to research the anthropogenic influence of urbanization to the subsurface environment beneath the coastal area. At first, the submarine groundwater discharge (SGD), which has often high nutrient output, is being examined to estimate the polluted groundwater discharge from the coast to ocean and to quantify the interaction between the terrestrial and oceanic water in the nearshore regions. Recently, as one of the output in this discipline, I have succeeded to reveal the hydrology including the SGD in tidal flat at one of the megacities, Osaka using the numerical modeling technique that were the main approach in doctor courses in Kyushu Univ. Japan (2005-2008) and in postdoctoral in Yonsei Univ. Korea (2009). If you have only a little interesting for them, please contact me freely.