Evolutions of spatial structures in hydrology through the interactuions between water, soil, and forest

*Makoto Tani[1]

1.Graduate School of Agriculture, Kyoto University (Former affiliation)

Hydrological processes depend on the geographical differences on the earth. In a huge continent like Eurasia, the water recycle between land and the atmosphere governs the local precipitation amount (Numaguti, JGR,1999), and constantly large evapotranspiration from forest contributes to a sustainable humid climate in the inland area (Yasunari, JMSJ, 2007; Kumagai et al., HP, 2013). In an tectonically active region, heavy rainfall works as a trigger of landslide (Tsukamoto and Ohta, JoH, 1988), and a close relationship exists between water and soil movements by strong erosional forces. The root-system mediation of forest contributes to the soil stability on a steep hillslope (Abe and Ziemer, USDA, 1991).
Although the geographical conditions are different, it should be noted that a spatial structure engaging each of the hydrological processes is created by the evolution at a long timescale based on matryoshka (nesting) doll interactions between the inherent earth activities and terrestrial ecosystems. A pollen analysis in Lake Baikal (Shichi et al., Palaeogeogr. Palaeoclimatol. Palaeoecol., 2013) demonstrated that forests covering Siberia had a dynamic glacial-interglacial spatial cycle, suggesting the spatial expansion/shrinkage fluctuation of water recycle system there has been accompanied with the vapor supply from the boreal forest. Therefore, we should pay a special attention to anthropogenic impacts on the destruction of interaction system between forest and the atmosphere. The deforestation at a huge spatial scale as well as the climate change may cause unexpected environmental devastations in the Anthropocene.
In an tectonically active region, the spatial structure of rainwater flow processes is created by geomorphological and soil-layer evolutions, and the heterogeneities including preferential pathways composed of connected macropores are developed with them (Tani, HESS, 2013). Such long timescale co-evolutions may account for a contrast between the complexity of flow processes and the simplicity involved in rainfall-runoff responses (Sivapalan, HP, 2003). The nonlinearity shown in the responses that hydrologists have studied for several decades (Takagi and Matsubayashi, 1979; Harman and Sivapalan, WRR, 2009) may also be produced by the co-evolutions.
My presentation here will focus on how the long timescale co-evolutions play roles in the flow processes and rainfall-runoff responses. A remarkable contrast in the hydrogeomorphological process between forested and denuded hillslopes will provide clear evidences not only for the role of co-evolutions but also the mitigation effect of forest on the stormflow responses.

Keywords: Hydrogeomorphological evolution, Interactions between Earth and Ecosystems, Water recycle system

Investigation of geotechnical properties and erosion characteristic of reservoir bed sediments

*Yu Jyun Su[1], Chieh Yung Wang[1], Min Ching Chen[1]

1.National Chung Hsing University

In recent years, capacities of reservoirs in Taiwan have decreased due to the input of sediments from upstream watersheds, caused by the soil loss of slopeland under construction and during flood events. The lifetime of reservoirs is therefore reducing rapidly; thus dredging of reservoir bed sediments has become one of the major issues relating to soil conservation, water resources, and human society. Hydraulic desilting is one of the commonly applied measures for dredging of reservoir bed sediments in Taiwan. Accordingly, the hydraulic condition at which desilting of sediments initiates becomes a key factor for maintaining the features of targets and extending the lifetime of a reservoir.
This study focus on the fundamental geotechnical properties and erosion characteristic of bed sediments in Agongdian Reservoir, which locates in Kaohsiung City, Taiwan. First, we carried out geotechnical experiments to identify physical properties of the bed sediments. Then erosion experiments were carried out using a recirculating hydraulic flume under different flow conditions, created by adjusting different flow rates and slopes. Afterwards, we applied the modified Shields diagram to analyze the experimental data and determined the critical condition that the erosion of bed sediments initiates. With these results, we are expected to find out the appropriate hydraulic conditions for the bed sediments to be agitated and re-suspend, and provide operating strategies that promotes the efficiency of hydraulic desilting, in order to extend the lifetime of Agongdian Reservoir.

Keywords: geotechnical properties, hydraulic desilting, Shields parameter

Natural and Human-induced Changes in Terrestrial Water Storage over the Indian Subcontinent

*Yadu N Pokhrel[1]

1.Michigan State University

Terrestrial Water Storage (TWS), which is composed of water stored above and underneath the land surface, influences the water cycle through multiple pathways. Near the surface, soil water controls evapotranspiration (ET) and hence water-energy exchange between the land surface and the atmosphere, directly affecting the physical climate; by limiting ET, soil water availability affects land ecosystem dynamics, indirectly affecting the climate; immediately below, the shallow phreatic groundwater feeds streams, lakes and wetlands; further down, groundwater storage in the aquifers provides vital support for water and food (via irrigation) security in societies on arid and semi-arid lands. Thus, understanding the changes in TWS is the key to understanding the dynamics of groundwater systems, especially in highly managed agro-ecosystems, toward identifying and solving groundwater related problems. In this study, we use a global land surface model (LSM) called the HiGW-MAT, which simulates both natural and human-induced changes in the terrestrial water cycle, to explore the changes in various TWS components over the Indian subcontinent. The model explicitly simulates the changes in different TWS components caused by both natural climate variability and human land-water management. We combine model results of TWS change with the data derived from the Gravity Recovery and Climate Experiment (GRACE) satellite mission to understand how groundwater systems are responding to climatic drivers and human land-water management in the region. Results indicate a rapid decline of groundwater resources in part of the region; these results are in line with previous findings but provide further insights on the changes and interactions between different TWS components which are explicitly simulated by the model. Finally, we compare the results from the simulations with and without human impacts to attribute the changes in TWS components to natural and human-induced causes.

Keywords: Hydrological cycle, terrestrial water storage, groundwater, GRACE

Conservation and Restoration of Wells in Ogaki City

*Syoukan Kou[1]

1.Graduate School of Horticulture, Chiba University

1. Research Purpose and Background
Flowing wells, which naturally supply an abundance of quality groundwater, have been utilized in Ogaki City since the Edo Period. Wells survived as a connecting factor among the people in each local community. The purpose of this research is to clarify the history of the restoration of wells in Ogaki City and their current conditions.
2. Study Methods
Bibliographical research and field research were conducted in order to understand the history of restoration of wells in Ogaki City. Field research was organized after studying the current conditions of the wells, to uncover utilization and their design methods.
3. History of Conservation and Restoration of Wells in Ogaki City
The land of Ogaki City was formed by sedimentation of a river, and this enabled the formation of flowing wells, which naturally supplied an abundance of quality groundwater from the Edo Period. In the late 1960's, during the period of high economic growth, most flowing wells disappeared due to groundwater utilization for factories, which caused a severe drop of the groundwater level. In recent years, factories have been shut down in the consequence economic stagnation and the fall of the textile industry. This resulted in a rise of the groundwater level, and the government together with citizens and volunteer organizations started cooperating to utilize water for city planning.
4. Conservation and Restoration of Wells
(1) Environmental Development by Equipping Wells
Restoration of wells was initiated mainly in the castle town around Ogaki Castle, which has always supplied ample amount of groundwater since the Edo Period. The newly equipped wells had a classic design which imitated a natural pond as well as other unique ones. The surrounding environment around the wells became naturally with planting, and now serves as a recreational area for citizens. The wells and their surrounding environment are managed through the cooperation between the government and the local residents. Due to sharing water and cleaning wells, wells are contributing to energize local community, serving as a central point for the citizens to exchange information.
(2) Environmental Educational by Utilizing Wells
There are pond and water ways derived from the well of Kagano Hachiman Shrine in Ogaki City; and Smallhead Sticleback, fresh water fish which is designated as an endangered species, inhabits in this pond and water ways. Environmental education has been implemented so that the community would feel attachment to nature. An annual program has been developed for the primary and middle schools in the city, with which students observe the wells, ponds, surrounding environment of the water ways, and Smallhead Stickleback. They also conduct water quality survey and learn how Ogaki City manages its environment.
(3) Earth Thermal Energy Generation by Well Water
Ogaki City has been discussing earth thermal energy utilization since 2013, in the course of energy efficiency measures. The temperature of well water is stable throughout the year; therefore, it can be utilized as an energy source for air conditioning and water heating. As a result, since June 2015, the city has been distributing subsidies to offices, corporations, and organizations, which would install earth thermal energy heat pump facilities. This is, as mentioned above, one of the energy efficiency measures.

5. Conclusion
In Ogaki City, wells created a city environment which incorporates nature. At the same time, they are also utilized for the promotion of environmental education and for energy efficiency measures. Wells made the nature and life of the city rich, and contributed to energize local communities. Participation and cooperation among the diverse stakeholders, including local residents, in conservation and restoration of groundwater would be expected for the future.

Keywords: Ogaki, Wells, Conservation, Restoration

①	加賀野八幡神社井戸 1874年	⑧	大垣女子短期大学「みずきの森水」 2007年
②	春日神社「春日の宮湧き出ずる名水」 1962年	⑨	高屋稲荷神社 2008年
③	西之川ハリヨの池広場 1965年	⑩	弘法の井戸広場 2009年
④	大手いこ井の泉緑地 2003年	⑪	三城公園 2011年
⑤	八幡神社「大垣の湧水」 2003年	⑫	むすびの泉 2012年
⑥	栗屋公園 2004年		
⑦	金蝶園総本家大垣東店「菓生の泉」 2005年		

注：赤字は大垣城城下町以内の井戸を示す

Airborne pathogenic bacteria risk related to a storm water retention basin

William Langlois de Septenville[1], *Florent Renard[1], Didier Blaha[2], Emilie Bourgeois[2], Claire Harpet[3]

1.University Jean Moulin Lyon 3, UMR 5600 CNRS Environment City Society, 2.UMR 5557 CNRS, Microbial Ecology, 3.University Jean Moulin Lyon 3, Institut de Recherche Philosophique (IrPhil)

Stormwater management is a major concern for urban areas, especially within the context of increasing urban development and climate change. The Greater Lyon (France) is engaged into a sustainable water management. The Django Reinhardt infiltration basin is part of it. Its catchment area is a 185 ha industrial zone, highly impervious, drained by a stormwater separate system. Only stormwater are managed by the basin and, intermittency, some waters, which come from cooling of industrial process and considered as clean, can be injected in rain pipe networks. Django Reinhardt basin is composed by two compartments: one for sedimentation, to get rids of suspend pollutants, and one to infiltrate decanted water. A recent sedimentological study has shown the presence of pathogens bacteria (Sebastian et al., 2014), which can be aerosolized and disseminated into the local environment. This situation exposes surrounding population to a bacterial contamination risk, no yet qualified nor quantified (Lipeme Kouyi, 2014). This study aims to measure this aerosolization, examines extend of the potentially generated plume and its impact on the surrounding population. The final objective is to improve the knowledge and management of this risk. To ensure this objective, the project is highly multidisciplinary and associates skills of life sciences (microbiology) and social and humans sciences (anthropology and geography). The interactions between hazard and vulnerabilities of assets are taken into accounts to get a global vision of this risk. Spatial hazard characterisation is considered as a crossing between dispersion climatic factors, particularly the wind, and abilities of bacteria to survive under local environment. The area considered for exposure is a 1 km buffer zone around the basin, in accordance to previous studies (Dugan, 2014; Kazmierczuk and Bojanowicz-Bablok, 2014). However, to achieve spatial and pathogenicity plume extend (figure 1), inactivation bacteria during airborne must be include. To get a better consideration of local diversity land uses, a visual interpretation is conducted on aerial pictures (10 cm resolution). It allows to improve vulnerability characterisation by considering physical activities or temporality occupation of identified land parcels. First results indicate that the potential plume generated may extend on a N/S transect and affect three different areas: an industrial zone; a residential zone where some sport fields are locted; and an international conference hall (Eurexpo).

This work was supported by the LABEX IMU (ANR-10-LABX-0088) of Université de Lyon, within the program Investissements d'Avenir (ANR-11-IDEX-0007) operated by the French National Research Agency (ANR).

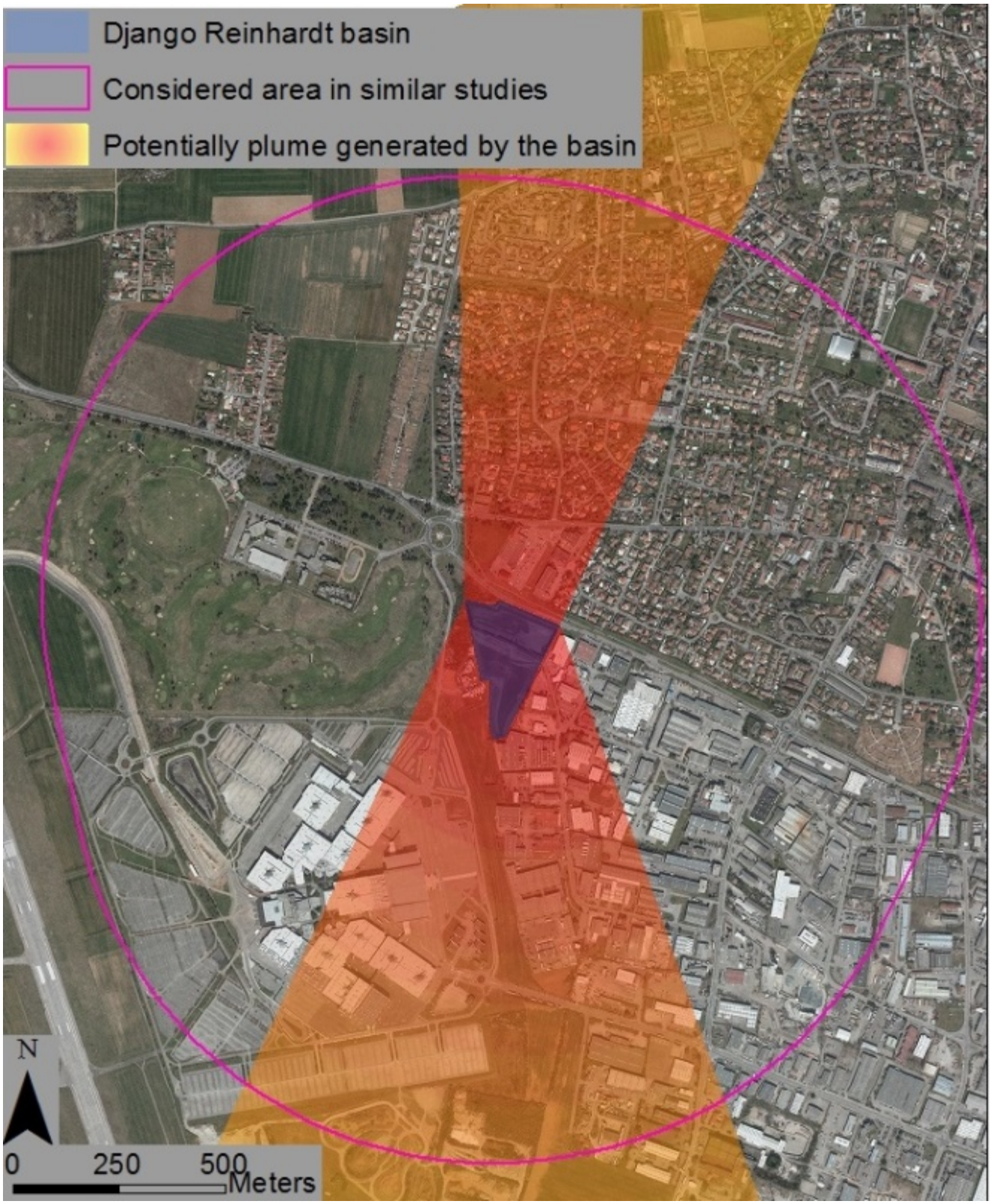
Dungan R., 2014. Estimation of infectious risks in residential populations exposed to airborne pathogens during center pivot irrigation of dairy wastewaters. Environ. Sci. Technol. 48, 5033–5042.

Kazmierczuk M., Bojanowicz-Bablok A., 2014. Bioaerosol concentration in the air surrounding municipal solid waste landfill. Environmental Protection and Natural Resources 25 (2), 17–25.

Lipeme Kouyi G., Cren-Olive C., Cournoyer B., 2014. Chemical, microbiological, and spatial characteristics and impact of contaminants from urban catchments : CABRRES project. Environ. Sci. Pollut. Res. 21 (8), 5263-5266.

Sébastian C., Barraud S., Ribun S., Zoropogui A., Blaha D., Becouze-Lareure C., Lipeme Kouyi G., Cournoyer B., 2014. Accumulated sediments in a detention basin: chemical and microbial hazard assessment linked to hydrological processes. Environ. Sci. Pollut. Res. 21 (8), 5367-5378.

Keywords: water, hazard, bacteria, Lyon (France)



Application of the geothermal snow melting system at the campus of Seoul National University

*Sung-Min Kim[1], Jin Son[1], Myeongchan Oh[1], Hyeong-Dong Park[1]

1.Dept. of Energy Systems Engineering, Seoul National Univ.

Seoul, the capital city of South Korea, has four distinct seasons and the snowfall causes some problems in winter. Especially the campus of Seoul National University located in Mt. Gwanak is high-altitude area with lower temperature than downtown. Therefore, the roads are frozen frequently and it may cause significant problems to pedestrians and cars. However, occasional snow removal works by snow-plough vehicles or human powers cannot meet the immediate needs. In this study, geothermal snow melting system is designed and applied to the road from the bus stop to the buildings of the engineering college for enhanced safety of students and faculties. Mt. Gwanak comprises a basement of granite so that geothermal snow melting system depends on just the geothermal gradient due to lack of other magmatic heat sources. A borehole was drilled to a depth of 500 meters from ground level and three other boreholes were 140 -170 meters for further monitoring. The weathering grades of the rocks are mostly classified from moderately weathered to fresh. Therefore, this area is estimated to be suitable for the heat exchange with groundwater using geothermal heat pump. The heat pump system of 30 RT (Ton of Refrigeration) was installed and 8 lines of pipes were employed to the 155 meters road with 1.45 meters width for water circulation. As a result of recent operations on January 26, 2016, a few cm of snowfall was melted instantly.

Keywords: geothermal, snow melting system, water circulation, heat pump, borehole

Geometry Of Aquifer Based On Geophysics and Hydrogeology Data in Jatinangor, Sumedang, West Java

*Gisca Gia Frini[1], Mohammad Sapari Hadian[1], Undang Mardiana[1], Muhammad Kurniawan Alfadli[1]

1.Geological of Engineering Faculty, University of Padjadjaran

Water is one of the essential requirements for society nowadays. Jatinangor is an education area that has rapid development. Rapid development has many impacts to water demand which is increasing year by year. The main issue is about the situation of groundwater in Jatinangor is growing crisis. Therefore, Jatinangor is feasible to do the research to know the causes and the suggestion for groundwater resources.
This study aimed is to find out the position of the aquifer at a certain depth and determine the condition of the subsurface based on geophysics and hydrogeology data. After that, geophysical and hydrogeology data are correlated that could be a model geometry of aquifer. Based on the geophysics data, there are 60 points geoelectric around campus University of Padjadjaran which is have three classifications of the resistivity range such as low resistivity (0-60 Ohm-meter) for tuff, medium resistivity (61-100 Ohm-meter) for pyroclastic flow breccias, and high resistivity (101-571 Ohm-meter) for pyroclastic fall breccias. These rocks are distributed on 0 meter until 125 meter. Schlumberger method is used for this research.
Based on the hydogeological data include hydrogeology mapping and 4 wells, the research area have four system aquifer are aquifer 1, aquifer 2, aquiclud, and aquitard. The analysis from 4 wells correlation showed that the Self-Potential (SP) Logs can be seen that the Self-Potential value of tuff is 0-10 mV and Self-Potential value of breccia is -10 to 0 mV. Overall, geometry of aquifer is divided into three packages of aquifer system based on the similarities of the resistivity at different depths, Package 1 on 90-180 meters has pyroclastic flow breccias and the thickness is 100m as an aquifer 2, Package 2 on 10-90 meters has pyroclastic fall breccias and the thickness is 70m as an aquiclud, Package 3 on 0-10 meters has clay soil and the thickness is 10m as an aquitard. From the analysis, it is known that the research area still have good potential for groundwater resources but the government must have rules for the urban planning and do reforestation to increase the quality of groundwater resources.

Keywords: aquifer, geometry, Jatinangor

