Property and Issues of the Shirakami-sanchi World (Natural) Heritage Area

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Shirakami-sanchi World Heritage area has had a unique character among Japanese natural conservation areas. Both as a conservation area and as an object for tourism it is very young, having a history of only ten years. It was designated as a conservation area after severe conflict of about 20 years concerning construction of a road across the range.

Utilizing Experience of Nature within Mountainous Area as a Field of Education

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A Geographical Approach to Water Environment in Transfiguration

The Purport of a Symposium and the Point at Issue

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Changes in water environment as induced by human activity have lately become the center of wide interest. The impact of qualitative change in aquatic environment on water resources in future is, however, left for further studies. The present symposium worked out a scheme as a part of the activity by the AJG Study Group on “Geography on Water Environment.” This Study Group has been in action since 1999 by holding up three disputed points as follows: 1) Verification of the validity of geographical methodology in the study on water environment, 2) Recognizing anew the importance of environmental education on the subject of water in the realm of nature, and 3) Reference of database on water environment.

On the ground of product by the Study Group up to now, this symposium aims to take a new look at the importance and necessity of geographical research in the field of water environment. In particular, the focus of the argument is concentrated on the effectiveness of geographical methodology in the advance in water-environmental science. It is pointed out that the particular approach by geography to water-environmental science has a significant as well as substantial validity in clarifying the quantitative relationship between human activities and physicochemical characteristics of water.

Geography as a discipline is a compound of

Visitors of our center often present their impressions that the splendid nature of Shirakami-sanchi is to be kept for our children. Unfortunately, however, some bad effect of tourists has emerged, such as trampling of soil around giant beech trees. Today, research on the influence of tourism is being carried out in the accessible peripheral areas. The results of the research can be used as educational materials.

Meaning of Conservation of Mountainous Area in Akita Prefecture

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Conservation of mountain lands needs understanding of natural ecosystems as a whole. Our ancestors, such as Ainu, have lived symbiotically with their natural surroundings use the “interest” of nature. Utilization of genetic resources of the Shirakami-sanchi has already realized. A comprehensive legislation is necessary for management of the Heritage Area.
many different courses of study, and has two facets including both time and space. For geographers there is much to study in the field of water environment, because a full understanding of water on the earth is insufficient from only a technical point of view. In the study of water environment on a global scale, it is increasingly considered that a geographical approach would contribute to the solution of optimal utilization of water resources and the creation of better water environment in the future.

**Keynote Address:**

**Water Environment of Drainage Basins**

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The water environment is almost controlled by the drainage system, so it is reasonable to understand hydrological properties in each drainage area. At first I prepared a 1 km-resolution DEM conformed as the minimum altitude among 20×20 grids on the 50 m-DEM of Japan. Then I extracted 105 drainage areas of the gauging stations using an improved flood method. They cover totally about 54% of Japanese lands.

The Japan Meteorological Agency (JMA) has prepared the 1 km-resolution monthly climatic data of temperature and precipitation. I tried to separate the cold precipitation (snow) from the total by using the threshold temperature between snow and rain, and also calculated the monthly potential evapotranspiration by the Thornthwaite’s method. Because we receive so much rain during summer in Japan that we have no month of water deficiency all the year round, we can estimate that the actual evapotranspiration equals the potential one.

I calculated yearly runoff value in water budgets \([\text{Runoff}] = [\text{Precipitation}] - [\text{Evapotranspiration}]\) of the 105 drainage basins, and compared them with the runoff values at the gauge stations. The difference \([\text{estimated Runoff}] - [\text{gauged Runoff}]\) is in proportion to the cold precipitation. In conclusion about the drainage water budget, 1) Thornthwaite’s method is useful as a simplified method to understand a wide-area water environment, 2) The efficiency of snow trapping by the current rain gauge system of JMA is low, and 3) Method of separating snow precipitation by a threshold temperature is available for the basin water budget calculation of snowy regions.

The other 1 km-resolution data available for the basin water environment analysis are as follows:

1. Population density of various categories prepared by the Statistics Bureau (http://www.stat.go.jp/english/1.html). Daytime and nighttime population data are available.
5. Various data sets derived from above mentioned basic raster maps: for example, landform characteristics, mean steepness, and drainage network properties.

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**Spatial Variation in Stream Chemistry and Effect of Global Warming on Dissolved Load in Mountainous Headwater Area: Application of Geographic Information**

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The Japanese mountains include usually the subalpine as well as low mountainous environment. To estimate variations in nutrient loads in mountainous catchments with climate changes and acid rain, we confirmed the spatial variation in soil and spring water chemistry and changes in biogeochemical processes linked to temperature in mountainous catchments. The study areas are Kanto Mountains of the western side of Tokyo and Kiso Mountain Ranges of central Japan. The range of altitude on each mountainous catchment is 500 m to 2,000 m and 500 m to 3,000 m, respectively. The pH of waters increased with the subsurface water flow from unsaturated zone to spring as well as HCO₃⁻ concentration in some small catchments. This suggested the continuous
acid neutralization with the flow. The main neutralizing processes were ion exchange in surface soil, chemical weathering in unsaturated zones and denitrification in groundwater. On the other hand, the main proton source was the biochemical process in surface soil and rainfall input. The biochemical process includes the nitrification, organic acid formation and dissolution of CO$_2$. These processes were controlled by temperature and soil water content. The water content varies in a slope scale, and temperature varies in a mountain scale. The base cation concentrations in soil water and spring waters increased with the decrease of the altitude as well as exchangeable base cation content in soil. NO$_3^-$ and organic acid concentrations increased in surface soil with temperature. Former ion concentrations indicate the intensity of strong acid sink. On the other hand, later ones indicate that of strong acid source. These results mean the increments in the acid neutralizing and producing processes with temperature. The acid neutralizing rate was very much higher than the acid-producing rate in low mountainous catchments. On the other hand, both process rates became similar in subalpine catchments of more than 1,800 m. The results of this study indicated the spatial variation in the biogeochemical and acid neutralizing process linked to temperature in mountainous catchments. Based on the above discussions of the proton budget process in surface, deeper soil and spring, we confirmed the acidifying trend at the upper slope and in a subalpine slope. This means that the acid neutralizing process is smaller than the acid producing process in subalpine catchments. Nevertheless the acid source was larger in the low mountain catchments, the acid was buffered because of larger acid sink. Moreover, the variations in the ratio of Al$^{3+}$ and SiO$_2$ concentrations indicated the acidification of spring water as well as soil in subalpine catchments. Finally, we estimated the effect of environmental change on the dissolved load in mountainous stream. The relationship between soil and stream chemistry and temperature supported the estimation. The forecasted results are as follows: Subalpine environments will be altered to transitional zone of low mountain and subalpine and alpine environments to subalpine by global warming. Consequently, the former will increase the nutrient loads, and the latter will release acid loads such as the trace metals.

A Geographical Approach to Water Management in the Sanuki Plain

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This study discusses the possibility of the contribution of geography to water management in the Sanuki Plain based on the field survey. The Sanuki Plain is said to be one of the most water-scarce areas in Japan. There exist about 16,000 irrigation ponds and strict customs about water allocation. The rapid increase in water demands due to the expansion of urban areas and that of industrial production has influenced water allocation in the agricultural sector, which has been using a major proportion of the available water. At the same time, it resulted in damage to the hydrological environment such as water pollution of river and irrigation pond. Thus, the water issues here are to construct a balanced water supply-demand system and to conserve the hydrological environment.

There are three ways to keep the balance of supply and demand for the municipal water system; modification of supply, modification of demand, and doing nothing. The measures to modify the water supply are performed as follows: Construction of multi-purpose reservoirs, groundwater development, water transfer from the agricultural sector within the basin, inter-basin water transfer by constructing a dam in the Yoshino River basin, wastewater reuse, and rainwater use. The methods to modify demands are the restriction of car washing and using swimming pools during drought, educational campaign emphasizing water conservation, and introduction of water-saving devices. "Doing nothing" means accepting water shortage as it is.

Although a large-scale system of water supply has been built in the Sanuki Plain, it is still difficult to supply adequate water during the period of little rainfall. Keeping the balance of supply and demand throughout the year requires the conjunctive use of surface and
groundwater, the conservation of hydrological environment, and the wise management of land use. Geographers can make contributions to the solution of water issues through publishing survey results, recommending better water management, and performing water education, which aims to raise the water literacy level of people through child and adult education.

Integration of Natural and Human Sciences Approaches in Water Environmental Issues: How Can Geography Contribute?

TSUJIMURA Maki
University of Tsukuba

The role of physical and human geographies should be important to solve various kinds of water environmental issues. Geographical hydrology, however, has not been contributing enough to solve these problems. Geographical approach has been typically effective to understand the phenomena occurring in a region, but has not been able to produce a way to solve the environmental issues occurring in the actual society. A task that is required for hydrological science and also geographical hydrology is to propose an effective strategy for water resources based on scientific understanding. For this purpose, we should reconsider the geographical approach to water environmental issues and combine natural science with human science to solve the environmental problems. In our presentation, the way in which geography should contribute to solve those issues was discussed based on some examples taken by geographical approaches.

The relationship between natural groundwater flow system and water use in the Kurobe alluvial fan (Toyama Prefecture, Japan) has been investigated using the typical hydrological approaches since the 1970s. The role of Kurobe River in groundwater recharge is considerably important and water use strategy is successful along the natural groundwater flow system in this region. The case in Kurobe is one of the ideal relationships between water use system and natural water circulation.

From the water chemistry viewpoint, the Sugadaira basin (Nagano Prefecture, Japan) has also been investigated since the 1980s. The process of nitrate loading to the stream via subsurface flow initiated by fertilization has been clarified by intensive field observations. The results of a series of Sugadaira study shows that qualitative and quantitative approaches should be combined with the human geographical approach to make clear the effect of human activities on water resources and chemistry.

The Research Institute for Humanity and Nature was established as a center for global environmental research in April 2001. The objectives of this institute are "Problem of human culture," "Circle of interaction between humans and natural systems" and "Possibilities for future generations." Especially, the most focused task is to make clear the relationship between human activity and natural environment, and to generate ideal future possibilities. In considering the situation of environmental researches, the problems in relation to hydrology and water resources may be one of the main topics to be investigated intensively at least for ten years ahead.

One of the most serious problems in geography and also geographical hydrology is that we have not made enough effort to promote the geographical contribution to solving global environmental issues. On the contrary, such appeals have seemed to be considered as behavior unworthy of a scientist for some traditional geographers. We, geographers, must pay attention to making the results of geographical research known far and wide. Also, we should revalue the importance of linkage of physical and human geographies in water environmental issues and must face the problems occurring in the real world.

Food Supply and Water Resources: A View from Groundwater Issues in the Great Plains of the United States

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Japanese food self-sufficiency is about 40%, that is, Japan imports 60% of food supply from other countries, especially from the USA. The Great Plains in the USA is the so-called "bread basket of the world," whose production is supported greatly by groundwater irrigation from Ogallala aquifer, the largest aquifer in the world, over the eight states in the semi-arid
region. Over pumping or mining of groundwater is resulting in water level decline, especially in Texas High Plain around Lubbock, and southwestern Kansas around Garden City. Since the Ogallala aquifer is not unlimited resources with little recharge, water level decline in these regions is more than 12 meters since 1980. Irrigation farming has been abandoned gradually. For life extension of Ogallala aquifer, various measurements such as controlling well construction and improving water-use efficiency and managements have been carried out, especially under the efforts of groundwater conservation districts. However, exhaustion of groundwater will take place in about one hundred years.

China and other countries also have the same kinds of problems. Under population expansion, water resources shortage, and climate change or global warming, the food problem is becoming more and more serious. Even the USA may not be able to cope with this problem well.

Future situations for food supply in Japan must be changed drastically and policy for that time has to be prepared from now on. Geographers in collaboration with other related professionals have to show possible situations scientifically and to propose realistic solutions.

Geography-Oriented Activities in Recent Global Hydrology

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Hydrologists have been trying to understand the global hydrological cycle. Previous achievements, however, have been limited either in spatial resolution or in number of factors involved. Recently the situation has been improved very much so that hydrologists can assess global water cycle in fine-spatial resolution. Development and publication of many geographical datasets, both in social and natural conditions greatly contributed to this improvement. Obviously new technologies in GIS and satellite remote sensing also rendered great service to this achievement. The most lately published assessment of global water resource uses 0.5-degrees grid datasets, which has become the common grid size in this kind of research.

In these activities using fine-spatial scale datasets, hydrologists noticed the importance of understanding geographical distribution of hydrological components, because one can easily detect interesting features of distribution of some hydrological factors when fine-scale datasets are used and visualized by GIS technique.

Among several components of global hydrological cycle, atmospheric and oceanic water cycle has been investigated well by hydrologists; but water movement on terrestrial region has been paid relatively less attention. For example, many researches on global water cycle using GCM were carried out by means of atmosphere-ocean coupled model; land-surface component was unrealistically simple in these experiments. One main reason of this is that only land-sea distribution on earth and sea surface temperature has been considered to be the most significant factor that determines global climate and the effect of land surface has long been neglected. This neglect is also due to the lack both of datasets representing ground surface features such as soil properties and vegetation type and a sophisticated land-surface hydrological model that can simulate evapotranspiration, radiation transfer, heat transfer, infiltration and runoff in realistic way.

Recently, however, scientists implied that ground surface hydrological conditions like soil moisture would strongly affect climate a few months later. Therefore, atmosphere-land surface interaction or land-sea interaction or even atmosphere-land-surface-river-ocean interaction gradually became the center of public attention.

Under such interests, hydrologists and ecologists developed LSM (land surface model) and validated them based on intensive field observation. These improvements together with global hydrological and economical datasets mentioned above directed scientists to studies on the role of land surface on the global water cycle. For example, during the last two decades recent decrease of September rainfall around Thailand has been attributed to deforestation.

Hydrologists again realized the importance of geographical distribution of hydrological factors through such studies; strong dependency
of some hydrological factors to other surface condition such as geology, topography, land use and so on makes their distribution much more complex than that of the ocean surface. This complexity will make atmosphere-land surface interactions quite difficult to understand.

Furthermore, the anthropogenic effect on water cycle is still an unsolved issue of the global water cycle. No LSM can treat irrigation and canal development effects on the water movement of the surface. Geographers are expected to contribute to this issue through their interest both in human/social science and natural science by the research community interested in the global water cycle.

A Review on Water-Environmental Geography in Japan

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Hosei University

In recent years, water-environmental changes have caused so many problems on a global scale or close to us that geography is expected to make contributions to the study on those problems as a synthetic science. Although geography has not developed only as an applied science, it is important to argue and reconsider the effectiveness of the geographical viewpoint and method for the study of water-environmental problems.

Therefore, to readjust products on water-environmental problem in the field of geography in Japan, I sorted through articles and symposiums from Geographical Review of Japan Vols. 1-74 and analyzed long-term tendency of the study in this field. The result of this analysis shows: 1) There were few researchers and themes in the early period 1925-1945, 2) Publications increased gradually in 1946-1977, 3) Publications became diversified including studies of foreign countries in 1978-1994, and 4) Publications decreased sharply after 1995. This shows that studies on water resource development and environmental change increased in the 1960s and 1970s under the influence of the high growth of the Japanese economy. Contents of the study fractionated in the 1980s, and many researchers transferred their products to journals of other fields in the 1990s.

Therefore there are few articles on water-environment in Geographical Review of Japan recently, but many studies from the geographical viewpoint or using geographical method are available in other journals. So we must analyze articles including these to understand the effectiveness of the geographical viewpoint and method for the study of water-environmental problems.

Next I picked out records of the study and working groups concerned with water-environment in the Association of Japanese Geographers and assessed their activities. The result of this analysis shows that they are influenced by international movements such as IHP (International Hydrological Programme) and IHID (International Hydrological Decade) and the importance of the activity of the study group on water-environmental geography, started in 1999, is recognized again.

An extension of this study is to make a database of literature on water-environmental problems not only in Geographical Review of Japan but also in other field articles, and it must be attended with time-spatial information using GIS. Furthermore, we must argue the effectiveness of geographical viewpoint and method for the study on water-environmental problems including other field researchers. On the other hand, it is important to emphasize environmental education on water-environment and upbringing of younger members of the Association.