of the existing stock of social infrastructure. Then an important issue for planning in a community is how to take over the regional property of its own history and culture in the region. Do geographers well recognize this transition period in urban and regional planning? The nurturing of talented professional geographers cannot be realized without facing up to policy issues in the real world—urban and traffic problems, environmental issues on global to neighborhood scale and disaster prevention *etc.*

As a think-tank professional concerned with urban and regional policy, I would like to indicate two points: to build a two-way exchange system with the technical experts experienced in business, which will result in thoroughly understanding social needs and issues; to arrange a program enabling to raise the level of geographical knowledge and skills already learned.

In order to strengthen the interface between

geography and social issues, a joint-meeting together with the administrative body, the think-tank and the NPO is recommended, as well as an internship system which, through the on-the-job experience, enables students to know how geographical skills and the design ability are practically used in the business spot. The design ability itself to grasp the main points and to structure them is developed not by lecture but by seminar; for example, the workshop is suited to the theme of machi-zukuri (community planning). Needless to say, it is important to improve spatial information processing technique and presentation technique. Also the consensus formation among various agents is now indispensable to a successful machi-zukuri (community planning). It will be fruitful for teachers and students to invite, to the educational spot, technical experts experienced in these techniques in think-tank and civil engineering consultants.

Open Symposium III: Prospects for the Land-human Relations in the Central Kanto Basin: A Contribution to Environmental Resources Management in the Near Future

Introduction

Organizers: MOTOKI Yasushi*
and TAMURA Toshikazu**

*Saitama University

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This symposium aims at discussing the role of geography in the cognition and solution of the problems on regional- or local-scale environmental resources management in the central part of the Kanto plain, central Japan, where intensive artificial land-transformation has been concentrated and accumulated in an actively changing tectonic and hydro-geomorphic setting. The papers presented in the symposium deal with the following matters, respectively: comprehensive presentation of the physical setting of the area particularly geomorphic changes in a continuing tectonic movement; relationship between natural processes and human interventions in the historically changing river courses; history of land-use, flooding, reclamation, irrigation, canalization and the principles of land-development planning

in the area, and characteristics and problems of present-day surface- and groundwater utilization and control. Based on these matters, general discussion focuses on the prospects of sound management of environmental resources as a whole in the area in which the most overpopulated zone in Japan is located.

Geo-environmental Map of the Central Part of the Kanto Basin

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In order to contribute to the discussion in the symposium, we compiled a map which shows comprehensive geo-environmental setting of the central part of the biggest plain in Japan. Since the plain is well known as a tectonic basin which originated in the Miocene and is still active, tectonic and geo-structural information is necessary to be shown on the map. It is desirable for the

map to show some features which indicate the effects of basining movement to human living environment. The terraces and alluvial lowlands are important mapping subjects because they have provided the bases for land-use. The area submerged in the Holocene transgression should be also mapped since the transgression controls the later development of the alluvial lowlands. Some microlandforms such as natural levees and beach ridge ranges on the lowlands, which were developed in the regression stage, cannot be omitted from the map because they have important functions in daily living and farming activities as well as in natural disasters such as inundation and earthquake. The map must display main river courses in various ages because the frequent river relocation is one of the targets of discussion particularly on the effect of tectonic basining and volcanic eruptions to river-course changes and on the intention of river works. The map shows major irrigation canals which have been constructed in the development of paddies on the alluvial lowlands since the 17th century. Although the area has suffered from innumerable times of flood hazards, the map shows major embankment-broken points and isochrones of flood-water arrival in the event caused by the typhoon Kathleen in September 1947, because it is the sole big inundation event which was recorded in detailed-scale maps. On land subsidence which is a typical man-induced natural hazard in the industrialized alluvial lowland, the map illustrates the areas of considerable subsidence rate, which has shifted northward from the southern margin of the central Kanto basin, i.e., East Tokyo, to the core area of the basin, i.e., the northeastern part of Saitama prefecture, due to sequential changes in volume and regulation of groundwater usage. The whole content as above was compiled on a multicolored map which was presented in the symposium room.

Natural and Artificial Change of the River Courses Concentrated in the Central Part of the Kanto Basin

SAWAGUCHI Hiroshi
Gunma University

Continuing tectonic basining has resulted in the concentration of many rivers into the central part of the Kanto basin. The Tone, the principal

river in the Kanto basin, flowed southward from the western part of the central Kanto basin to the present Arakawa lowland in the end of the Pleistocene and, probably, in the Mid-Holocene at the maximum of the transgression. Later, the Tone shifted eastward and invaded the Kazo lowland situated at the core of the central Kanto basin which had been drained by the former Watarase river. The change is considered to have been forced by the eastward development of the Arakawa alluvial fan under the effect of subsidence of the Kazo lowland, which is an expression of continuing tectonic basining. Temporal northeastward shift of the Tone occurred at the center of the Kanto basin probably in the 6th century and some later times. It may have been caused by sudden increase of load as a result of the eruption of volcanoes situated in the upper Tone watershed. Since the early 16th century, most changes in major river courses in the area had been conducted by the Tokugawa shogunate, the paramount feudal administrative authority. At almost the same time, the course of the Arakawa was artificially bent southward surrounding the western fringe of its fan at Kumagaya. A series of artificial changes of the Tone river course, which was lastly connected directly to the Pacific Ocean, is collectively called the eastward shift of the Tone. Many opinions have been presented on the intention of the artificial shift of the Tone. One insists on the defense of the shogunate capital Edo, present Tokyo, and surrounding farmlands against flood damages. Another thinks the improvement of water transport to Edo as more important. Importance of agricultural development in the floodplains and delta areas is not ignored. The eastward shift of the Tone should be considered in the broad sense to have been completed by the river-course improvement in the 20th century.

Development and Disaster in the Central Kanto Basin: Ancient and Middle Ages

YOSHIKAWA Kunio
The Field Work Institute

Human activities in the central Kanto basin have been affected by the environmental conditions and have transformed the environment at least since the ancient ages. It is well known that many big tomb mounds of local chiefs in the 6th

century are buried at their foot in the Kazo lowland, the core of the central Kanto basin. The fact demonstrates the continuing tectonic subsidence in the Kazo lowland during the historic times. Distribution of the jori field pattern as a result of planned agricultural development in the ages succeeding to the time of old tomb mound construction indicates that the stable ground surfaces in those days were extended in the areas surrounding the Kazo lowland. But the pattern has not yet been found in the Kazo lowland proper which seems to have frequently suffered from inundation due to its low-lying position as an expression of the tectonic basining. In contrast, many remains such as small castles of the 13th to 16th centuries are found in the Kazo lowland. This seems to correspond with the agricultural development of the floodplain in conjunction with the construction of embankments along major rivers in those days. Many administrative documents of the middle ages tell of the active redevelopment of wastelands and reconstruction of damaged embankments in the area. Redevelopment and reconstruction as above suggest the occurrence of preceding natural hazards and/or wars. Apart from wars, there are many records of natural hazards such as flooding and earthquakes by which the area was severely damaged.

A Development Principle for the Marginal Wetlands of the Central Kanto Basin in the Edo Period

MOTOKI Yasushi
Saitama University

The marginal wetlands are defined as the area where high risk of inundation restricts human occupation. Apart from reclamation or poldering, it is remarkable as a way of improving such unfavorable conditions that coexistence of living space including settlements and paddy fields with surrounding waters is maintained by earthworks. The land-use system consists of artificially banked paddies and surrounding creeks which were dug to provide banking material. Such a creek landscape was sporadically found around the Kazo lowland in the core of the central Kanto basin. It mostly originated in the early 18th century. Artificial relocation of river courses of the Tone and the Arakawa in the preceding century reduced the floodwater discharge

into the Kazo lowland and its surroundings. At the same time, construction of new canals made the ponds and marshes in the area free from the role of irrigation source to the downstream paddies. The situation enabled the construction of banked paddies and dug creeks in the marginal wetlands of the area. In the succeeding period, the banked paddy construction was forced by the rewetting of the area due to aggradation of the Tone riverbed and consequent inflow of floodwater into the area. Consequently the creek landscape continued to exist until the 1960s. The principle of development of the land-use system is as follows. Creeks are surrounded by banks and outer trenches which hinder the inflow to and facilitate drainage from the core area, respectively. Paddies are built by earth dug out from the bottom of creeks. Irrigation water to the paddies is introduced from both the outside using pipes and siphons in part and the creek network. Living in the settlements of banked paddies and creeks is supported by the multilateral use of creeks, such as for transport, fishing, and collection of manure. A kind of recycling use of environment made it possible to sustain the creek landscape for 300 years in an area which is originally rather unfavorable to rice cultivation. The idea of such recycling use of land and water may be applicable to environmental resources management in modern urbanized areas too.

Characteristics of Irrigation and Flood Control in the Central Part of the Kanto Basin: Modern and Contemporary Periods

UCHIDA Kazuko
Okayama University

This paper discusses the characteristics of surface water utilization and management in the central Kanto basin where new issues of irrigation and flood-control arose as a result of the relocation of the Tone and the Arakawa river courses in the 17th century. It refers to two major irrigation canals constructed by the Tokugawa shogunate authority, the Kasai irrigation canal and the Minumadai irrigation canal. The former, using previous river courses, flows southward along the thalweg of the basin and has many sluices on the canal itself to store water for irrigation. In order to supplement the lack of

irrigation water, the canal was later extended northward to take the waters of the new Tone mainstream. Consequently it required about 100 years for its accomplishment. The canal is, due to its location and the process of construction, characterized by reuse of water in the drainage-irrigation system. The construction works were planned and carried out in Kanto style. In contrast, the latter is a newly-constructed canal passing through relatively higher positions in the basin and was completed in only half a year. It has no facilities for storing water and functioned simply to supply water from the new Tone mainstream to the lower basin where a former irrigation pond, Minuma, was reclaimed for paddy development. Drainage and irrigation were separated in the new canal. The construction works were planned and carried out in Kishu style. The two canals were functionally connected with each other because the drainage from the latter supply water to the former situated in lower position than the latter. In comparison with the cases in other areas where main river courses were relocated artificially in Japan, the central Kanto basin is characteristic in the following points: The relocated trunk river was used as major source of irrigation water. Intake of much water to the new irrigation canals was made without sluices. The newer one, the Minumadai canal, could take water from the new Tone mainstream at the point which is located upper than the intake point of the Kasai canal. The latter characteristics originate from both the geo-environmental conditions of the central Kanto basin and that the construction works were made as a kind of national project. Although the modern system of surface-water use in the area follows the above-mentioned one, several problems are arising in changing social conditions.

The Geographical Features and Some Problems of Groundwater Utilization in Kanto Area

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This paper overviews the hydrogeologic char-

acteristics and the groundwater utilization features of the Kanto basin, the biggest late Cenozoic sedimentary basin where most intensive use of groundwater resources has been made in Japan. Within the basin in which sediments more than 2500 m thick are accumulated, the basal surface of the middle to upper Pleistocene Shimousa group, on which groundwater flow is most active, reaches 500 m below the present sea-level or deeper in the area along the northeastern coast of Tokyo Bay. Because the area is one of the cores of the modern industrial zone, active use of groundwater there has induced rapid lowering of artesian-water table at the rate more than 3 mm/day. Moreover, the underlying lower Pleistocene Kazusa group contains abundant fossil water which is a target of natural gas exploitation. The compound nature of the groundwater system as above have been analyzed areally and three-dimensionally using the distribution of water temperature, water quality, isotope composition, groundwater potential, etc. The studies show that the macro-system of groundwater flow in the Kanto basin is controlled by geologic and geomorphic structure and its detail is modified by human activity. In the latter case, groundwater environment does not correspond to geologic and geomorphic environment. Temporal and spatial change of land subsidence zones provides a good example of the latter. The rate of circulation in a proper unit of groundwater system provides important information in the evaluation of groundwater resources. Studies in Tokyo downtown have revealed the decrease in both recharge and capacity of groundwater due to the increase of both impermeable ground surface and underground constructions. It is an expression of weakened groundwater circulation system. Sustainable use of groundwater resources in the Kanto basin will be made possible by comprehensive management of groundwater circulation system including some regulations of water use in a suitable areal unit which is not restricted in administrative boundaries.

Existing Problems on the River Management in the Center of the Kanto Basin

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Ministry of Land Infrastructure and Transport

The rivers in the Kanto plain have provided

the basis for modern systems which have supported convenient human life in the Tokyo metropolitan area and its surroundings. However, a kind of overuse of river environment mostly by urbanized living seems to suppress the environmental soundness of rivers, which is not restricted in quality and quantity of water. Change in flood hazard types and land subsidence areas give good examples. The whole problem concerning surface and subsurface water environment should be considered in a compound system of water circulation and its vessel. In this context, the history of river management in the central Kanto plain since the eastward shift of the Tone river in the 17th century should be reappraised from the viewpoint of geo-environmental setting as a field of water circulation. Present situation of rivers as a result of repeated artificial alterations may have some unsuitable aspects to geo-environmental setting. Moreover, the effect of ongoing climate change to both flooding and water shortage in the area is a matter to be worried about. At the same time, the existing situation of national economy calls for more systematic and wiser treatment of the environmental and hazard-mitigation matters. The scheme of river management and, furthermore, water culture for the near future of the central Kanto basin must be established in consideration of these perspectives and constraints.

General Discussion

The detailed processes of shift of the river courses are still a matter of argument. Particularly the northeastward shift of the Tone at the lower margin of its alluvial fan in the 6th century, which was indicated by Sawaguchi, was discussed. Although the shift is a natural one, it is discordant with the trend of topography and tec-

tonic movement. Influence of volcanic activities to the river-course shift was strongly suggested based on the facts that volcanogenous material of Mt. Haruna's eruption in the 6th century is contained in fluvial deposits which fill the channel after the shift. There is a long history of dispute on the aim of a series of artificial eastward shift of the Tone since the early 17th century. It was suggested that the important point in the aim of works changed in the history of river-course shift. It was pointed out again that the works for river shift have been conducted from the viewpoint of resources use and hazard mitigation in the downstream area, i.e., Edo and Tokyo, and that partially obsequent trend of the rivers as a result of the tectonic basining has not been surmounted or has been intensified in a series of artificial river-course shifts. Consequently the stress between the tectonic trend and river courses was concentrated in the core zone of the central Kanto basin, i.e., the area including the Watarase detention site and the eastern lowlands of Saitama prefecture. Each river works including construction of irrigation, transport, and flood control facilities is worth reappraisal on both its purpose in those days and its effect on environmental function. It is hoped that the intrinsic disadvantage of water use and control in the whole central Kanto basin will be noted in the planning of more systematic management of environmental resources.

All the presentation and discussion in the symposium were chaired by KUBO Sumiko, AKAGIRI Takekazu, MATSUDA Iware, and the organizers. Discussion was made by SAITO Kyoji, MATSUURA Shigeki, HASHIMOTO Naoko, YAMAMOTO Keiichi, and others, as well as all presenters and chairpersons. The records were summarized by the organizers.