A Study on the Characteristics of Distribution of Creeks on the Tsukushi Plain

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Abstract

On the *Tsukushi* Plain (the lower region of *Chikugo-gawa* River, it is the biggest in Kyushu, Japan), the high density creeks were built over a large area to overcome a disadvantage regarding water-use from old times. At the present time, the distinctive rural landscape in this area is recognized as the cultural landscape formed by the customs of that region that reflect the local people's lives and livelihoods.

However, only few attempts have so far been made at the characteristics of distribution of creeks.

Therefore, in this study we attempt to make clear the characteristics of distribution of creeks on the entire *Tsukushi* plain by the close analysis on the topographical conditions and water utilization system. Thereby the distribution range of creeks may be divided into four zones.

Keywords: Creeks; *Tsukushi* Plain; *Chikugo-gawa* River;

1 Introduction

Water is an essential for human daily human life. Before modern times the dwelling was built with due regard to water-use. Therefore the waterway was the common factor of living, and always existed closed to residents.

On the *Tsukushi* Plain in *Kyushu*, the high density creeks were built over a large area to overcome a disadvantage regarding water-use from old times. In this area, creeks had many various functions that sending water, storage surplus water from headstream and drain so as to maximize the use of restricted water source. Namely creeks are an important example of a traditional sustainable water-use system. Also, in Japan, the policy for the landscape preservation in consideration of regional environment is advanced in recent years.

In previous studies of architecture, Kato (1997, 1998) focused on the form and function of creeks and provoked the role for protecting the environment.

Although a large number of studies by Agricultural economy fields have been made on creeks (Watanabe et al, 1968; Kobayashi et al, 2002), the range and condition of distribution hasn't become clear focused on all the area of *Tsukushi* Plain. Accordingly, if creeks are regard as the landscape and environment resources, we should take the property of water into account for landscape and environment preservation.

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2 Study Area

The coastal along the *Ariake* Sea is the plain which developed as a back marsh or alluvial lowland of *Chikugo-gawa* River and several rivers flowing into *Ariake* Sea. In addition the tidal range of *Ariake* Sea is largest in Japan (more than 5 meters). Therefore the extensive plain was produced over the years.

The flat planes had high ratio in the area of *Chikugo-gawa* River basin, and these areas suitable for farm land were large. Lands have to be sloping to some extent in order to be irrigable, so alluvial plains in the lower reach of rivers, where the slope is gentle. Also, the water level of *Chikugo-gawa* River is not stable depending on fluctuation in tide

level. In addition it is difficult to irrigate rice fields by the natural inflow of river water because the riverbed of *Chikugo-gawa* River is very low. Therefore in this area the practical use of restricted water source is an important issue.

3 Methods

In this study, we collected the previous studies and other materials related to creeks and made hearing from affiliated public institutions to make clear the characteristics of distribution of creeks.

Then, we arranged the information on geographical condition and irrigation system on the maps and analyzed the conditions that determine the development and characteristics of creeks.

4 The Characteristics of Creeks on the *Tsukushi* Plain

In large part of the lower reach of *Chikugo-gawa* River, many cultivators had drawn water from Yabe-gawa River and *Kase-gawa* River for irrigation, because of the water level of *Chikugo-gaw*a River was not stable as described above. In this area creeks was sourced from several rivers, *Chikugo-gawa* River, many stream tributaries to *Chikugo-gawa* River, *Yabe-gawa* River and *Kase-gawa* River. Especially, the fresh water by *Chikugo-gawa* River backflow at high tide was stored in creeks because the tidal part was 26 km from river mouth. This fresh water intake method was called "*AO*" in this area.

Also, another peculiar custom of water use was developed in the lower reaches of *Yabe-gawa* River called as '*Harumizu Kanko*'. In the lower reaches of river, cultivators stored the surplus water in creeks before the rice-planting season of the upper reaches of river. Because the rights of the upper reaches of river concerning the water-use are given preference over the rights of lower area. Therefore in the lower reaches of *Yabe-gawa* River, there was the high density creeks on the ground surface, and creeks are very large and deep.

In these reasons, to promote the repetitive water use of creeks had great effect on the forming process of the living environment in this area. And there was a close connection between creeks and the living environment. But most of creeks has been wasted, because of the labor shortage in a small

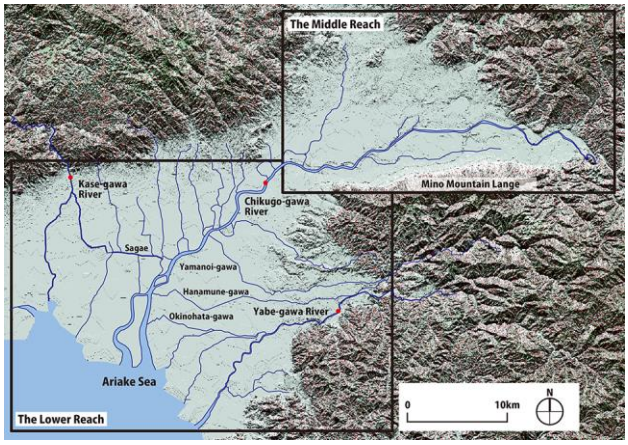

Fig.1. Subject area

population and the change of irrigation method. Therefore government operated large-scale land improvement project has been operated to have always stable water intake capacity in the lower reaches of *Chikugo-gawa* River since 1976. In this work, the fresh water intake method by *Chikugo-gawa* River backflow was abolished in 1998. In addition the adjustment of rice-fields and improvement of prefectural roads has been operated. Thereby, the most part of creeks were changed their forms.

5 Water use on the *Tsukushi* Plain

5.1 Analysis method

We make clear the relationship of the geographical condition, the water intake method and the water management area. In this study we divided *Tsukushi* Plain into the middle reaches and the lower reaches of *Chikugo-gawa* River to analyze creeks (Fig.1).

In addition, we analyze the relationship the geographical condition and the water use by the section model. The intake sources of water on the *Tsukushi* plain can be divided 8 types (Fig.2, Fig.3, Fig.4, Fig.5).

5.2 The middle reaches of Chikugo-gawa River

Fig.2 indicates the source of water intake in the middle reaches of Chikugo-gawa River. The flat stretch of land along the *Mino* mountain range in the left bank of Chikugo-gawa River. The water intake area from Chikugo-gawa River spread in the beltlike shape. In the piedmont as a backland for water intake area from Chikugo-gawa River, the source of water intake is the small river, farm ponds

or both of them.

5.3 The lower reaches of *Chikugo-gawa* River

Fig.3 indicates the height above sea level, the fresh water intake range and the distribution of the fresh water intake facilities. On this map the colored area spread in the wedge shape is less than 5 meters above sea level. The major part of creeks is distributed in this area that is less than 5 meters above sea level. Especially the most high density area is more than 3 meters and less than 4 meters above sea level.

This area roughly corresponds to the fresh water intake area. The fresh water intake methods were different the right bank and left bank of *Chikugo-gawa* River. The small-scaled facilities were normally found at the right bank. The small number of large-scaled facilities were distributed at left bank.

Next, we treat the water use of 2 major river systems (*Yabe-gawa* River and *Kase-gawa* River) except for the *Chikugo-gawa* River. *Yabe-gawa* River system provides the water for 3 canals, *Okinohata-gawa* River, *Hnamune-gawa* River and *Yamanoi-gawa* River through the diversion weirs built for irrigation. The water supply ranges of each rivers are spread gradually toward a downstream side. Therefore there was a chronic shortage of water in the lower reaches of each rivers. In *Kase-gawa* River system, the some water supply canals were intentionally built for irrigation in the early period of modern times.

Fig.4 indicates the sources of water intake in the lower reaches of *Chikugo-gawa* River can be further divided into 2 areas, ‘only fresh water intake’ and ‘major rivers and coexisting with small-scaled rivers’ in the fresh water intake area. Another area can be divided 4 areas “major river” “small-scaled rivers” and “small-scaled rivers and coexisting with the agricultural irrigation pond or wells”.

5.4 Analysis using section models

Fig.5 indicates the section model based on cutting portions showed in Fig.3 and 4. The slope of the riverbed downstream of the lower reaches of *Chikugo-gawa* (about 4/10000) is much more gradual than the middle reaches of *Chikugo-gawa* River (about 15/10000). The slope value of the

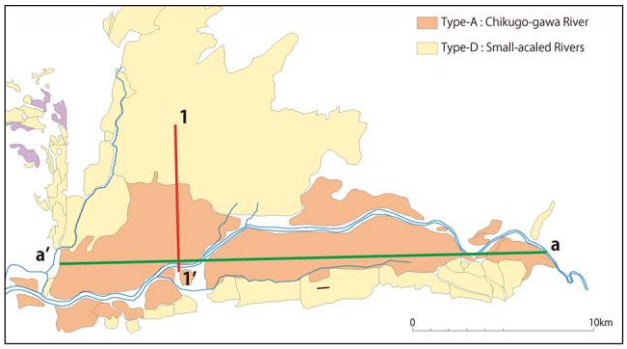

Fig.2. Sources of water intake in the middle reaches of Chikugo-gawa River

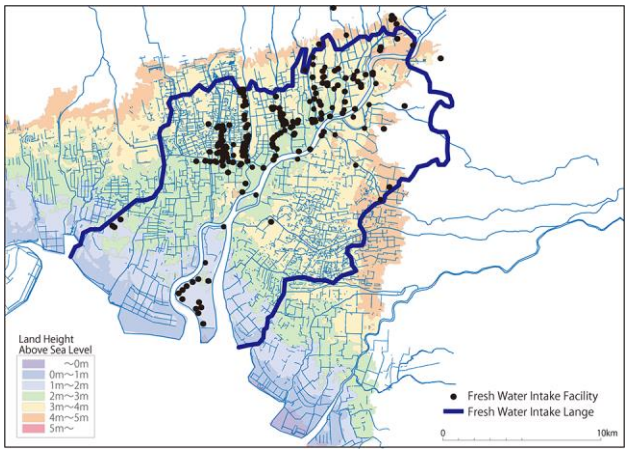

Fig.3. Height above sea level and Fresh water intake range

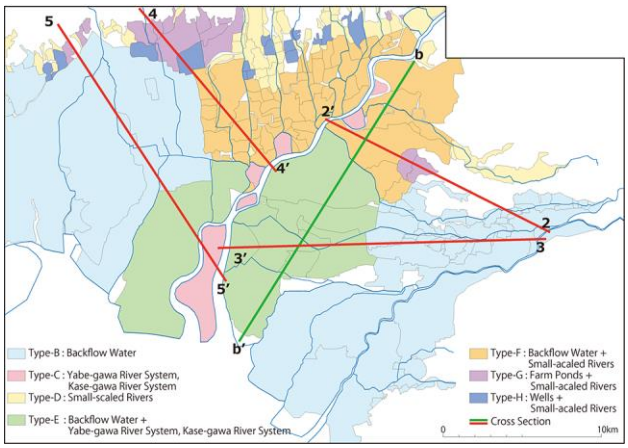

Fig.4. Sources of water intake in the lower reaches of Chikugo-gawa River

middle reaches of *Chikugo-gawa* is not necessarily high, however this difference of slope values influenced the water use conditions.

The section model Ⅰ indicates that the altitude difference is large between settle areas (10 meters above sea level) and the surface of *Chikugo-gawa* River. Therefore it is difficult to intake water directly from *Chikugo-gawa* River. So the water intake dams arranged in the upper reaches of

Chikugo-gawa River for irrigation of the middle reaches of *Chikugo-gawa* River taking advantage of the altitude difference (Type-A). At an altitude of more than 10 meters above sea level, the slope steepened sharply. Then the water of small-scaled rivers is used for irrigation (Type-D).

The section model Ⅱ indicates the high elevation adjacent to *Chikugo-gawa* River. Therefore the irrigation water is depending on the ponds in this area. On Type-F, the altitude difference is comparatively small, then the irrigation water is draw from *Chikugi-gawa* River through the large-size facilities for the backflow water in the area along river.

The section model Ⅲ indicates the area that creek is distributed in a high density. In this area, creeks was required water storage function because the water intake period was limited. Therefore the creek density has been high. Creeks is distributed below 5 meters above sea level. On Type-C, the irrigation water was reserved from *Hanamune-gawa* River taking advantage of the altitude difference.

The section model Ⅳ indicates the area that creeks is distributed in most high density. And Type-F that the irrigation water is draw from small-scaled rivers and backflow water by *Chikugi-gawa* River occupied most of this area. In high altitude areas, farm ponds and wells are utilized for the irrigation water (Type-G, Type-H). Creeks is distributed below 5 meters above sea level like the section model Ⅲ.

In the section model Ⅴ, there is Type-E along *Chikugo-gawa* River and creeks density increase. In the towhead of *Chikugo-gawa* River, the irrigation water is depend on the backflow water (Type-B). The range of Type-C has the similar characteristics of the section model Ⅲ.

In the area along mountain range having stable water intake capacity from *Kase-gawa* River or small-scale rivers, creeks is little distributed. In both banks of *Chikugo-gawa* River neighboring the middle reach of *Chikugo-gawa* River, the irrigation water sources are the water of small-scaled rivers or backflow water of *Chikugo-gawa* River. However in the vicinity of mountainous regions, the multiplex water-use areas are distributed.

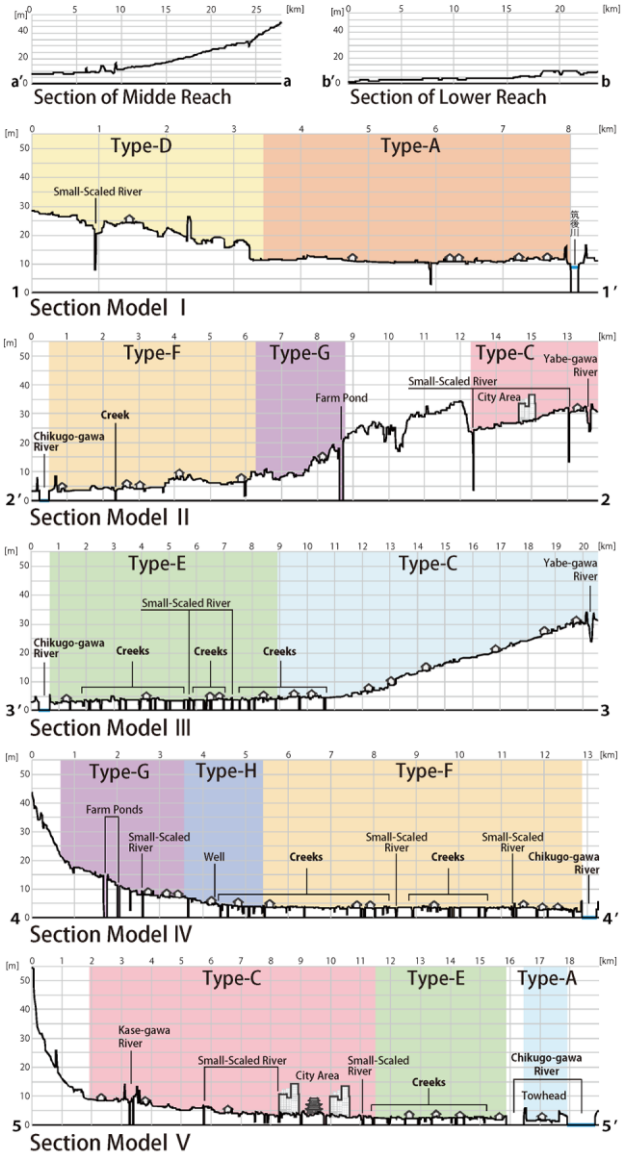

Fig.5. Section model

6 Examination

About creeks we clarify what effects have been achieved and how they worked. Creeks had many functions. In particular, the water storage function was an important characteristic. There were knacks to keep the surplus water from upstream side and draw the backflow water "*AO*".

In the lower reaches of the *Chikugo-gawa* River lacking a water source, creeks had been developed to optimize the use of the limited water resources. The ratio of dependency to the backflow water "*AO*" had be affected by the distance from the mouth of *Chikugo-gawa* River. Also, the distribution of the intake devices for the backflow water has a deviation. In the right bank of *Chikugo-gawa* River, there were many small devices arranged in creeks. On the other hand, there

were a few large devices arranged on creeks in the left bank of *Chikugo-gawa* River. The difference between the right bank and the left bank reacts towards the distribution of creeks.

And the distribution range of creeks is a range surrounded by the range of more than 2 meters above sea level (The coast-line in the early modern age) and the back flow water intake range (Area of *AO*). Moreover, this range can be classified 4 zones because on the density of creeks at *Chikugo-gawa* River and two artificial channels through which water flows as the boundary lines. These two artificial channels, "*Sagae*" and "*Yamanoi-gawa*" were built during the early modern age.

In the right bank of *Chikugo-gawa* River, the artificial channel "*Sagae*" is the boundary between Zone-A and Zone-B. Especially, high density creeks are distributed within Zone-A. In this range, there was a high dependence on "*AO*". On the other hand, relatively low density creeks are distributed within Zone-B.

In the left bank of *Chikugo-gawa* River, the artificial channel "*Yamanoi-gawa*" is the boundary between Zone-C and Zone-D. Especially, high density creeks are distributed within Zone-D. In this range, there was a high dependence on the surplus water from headstream called as "*Harumizu Kanko*". On the other hand, relatively low density creeks are distributed within Zone-C.

7 Conclusion

1) There are 2 water intake types in the middle reaches of the Chikugo-gawa River. One of the type is Type-A, the other type is Type-B. To provide a water taking in water from the Chikugo-gawa River is capable using the gradient of the geographical features.
2) On the other hand, several water intake methods are mixed in the lower reaches of the *Chikugo-gawa* River because irrigation is essential for tremendous sweeping plains. Also, creeks area is less than 5 meter above sea level. In addition creeks area fits within the backwater intake area. Creeks had been developed to overcome a disadvantage regarding water-use from old times differ from the middle reaches of the *Chikugo-gawa* River.
3) The density of creeks has especially high average in Zone-A and Zone-D. Both ranges are dictated by the water-use system of the early-modern period. However the two types differ in the water intake source and method.

Fig.6. Section model

In this study, we made analysis on the topographical conditions and water utilization system. And the analysis of the historical data, formation process and relationship with living environment on creeks are future problem.

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