

A Behavioral Study of Visitors after Long Years in a Gentle Slope Shape Channel of Ongagawa River

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Abstract— Ongagawa River Nogata district is one of a few contemporary cases in Japan that has successfully restored the riverfront from a compound-shape channel to a gentle-slope-shape, water-friendly public open space in the city's central area. This paper aims to analyze the effect of the gentle-slope-shape channel spaces on the change in the visitor's behavior before and after restoration. Behavioral observation surveys and a series of onsite interviews are adopted to clarify the relationship between the changes in space utilization by visitors and the design intent.

Index Terms— Behavioral study, gentle-slope-shaped channel, river restoration, design intent.

I. INTRODUCTION

Since 2004, the Council for Revitalizing Ongagawa River and the Citizen's Subcommittee have been established in Ongagawa River Nogata district, and river improvement projects have been practiced here. The council members include the Ministry of Land, Infrastructure, Transport and Tourism Ongagawa River Office (ORO), surrounding citizens, and an advisor (Associate Professor Akihiko HIGUCHI, Kyushu University Graduate School of Landscape Design Laboratory).

The river channel of Ongagawa River Nogata district before the restoration was a compound-shape channel that was often seen in urban river development in Japan since the 1960s. The river was used as a drainage channel.

In 2004, ORO budgeted a river improvement project due to the need for countermeasures against flooding. At the Citizen's Subcommittee, which was to incorporate citizens' opinions into the improvement plan, there were many voices demanding that the river be improved so that it could be used freely over a wide area. These opinions suggest that river channels in the city center are being reevaluated as public open spaces along the waterfront as urban amenities.

In order to meet these demands, the concrete block revetment in the lower part of the water was removed. The slope from the middle of the embankment to the water's edge in the lower part of the embankment was made gentle slope shape, resulting in a high-water channel section that gently connects the water surface and the embankment. As a result, from 2006, restoration work was carried out on both banks within a range of about 600m.

There are other cases of gentle-shape cross-sections in Japan's river channel, including the gently sloping embankment of Shinanogawa River, Shirahige district of Sumidagawa River, and Watari district of Abukumagawa River. The case of Ongagawa River is characterized by the

fact that its river channel has a gentle slope with undulations that is widely applied from the middle of the west side bank embankment to the low water channel.

It is necessary to accumulate knowledge not only about its river engineering characteristics but also about the characteristics of river space usage by citizens in order to standardize this type of gentle slope improvement as one of the options for river improvement in urban settings in the future.

The purpose of the study is to clarify the relationship between space utilization and the design intent by observing the changes in space utilization on the gentle-slope-shape channel of Ongagawa River Nogata district and analyzing how the initially intended design was affected.

II. RELATED STUDY

In recent years, related studies have been conducted on gentle slopes in river channels from the perspective of conservation and restoration of the natural environment as river restoration has progressed throughout Japan [1].

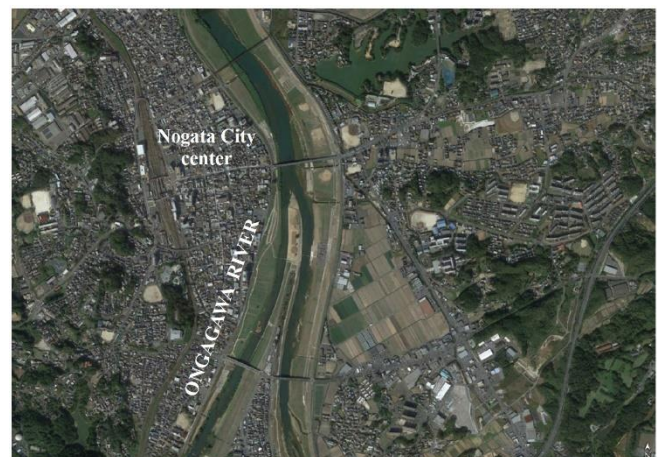


Figure 1. The Ongagawa River Nogata district and its surroundings.



Figure 2. Previous high water channel on the west bank is flat, and a visitor neither feels the longitudinal depth nor sees the water's surface



Figure 3. The condition before restoration.

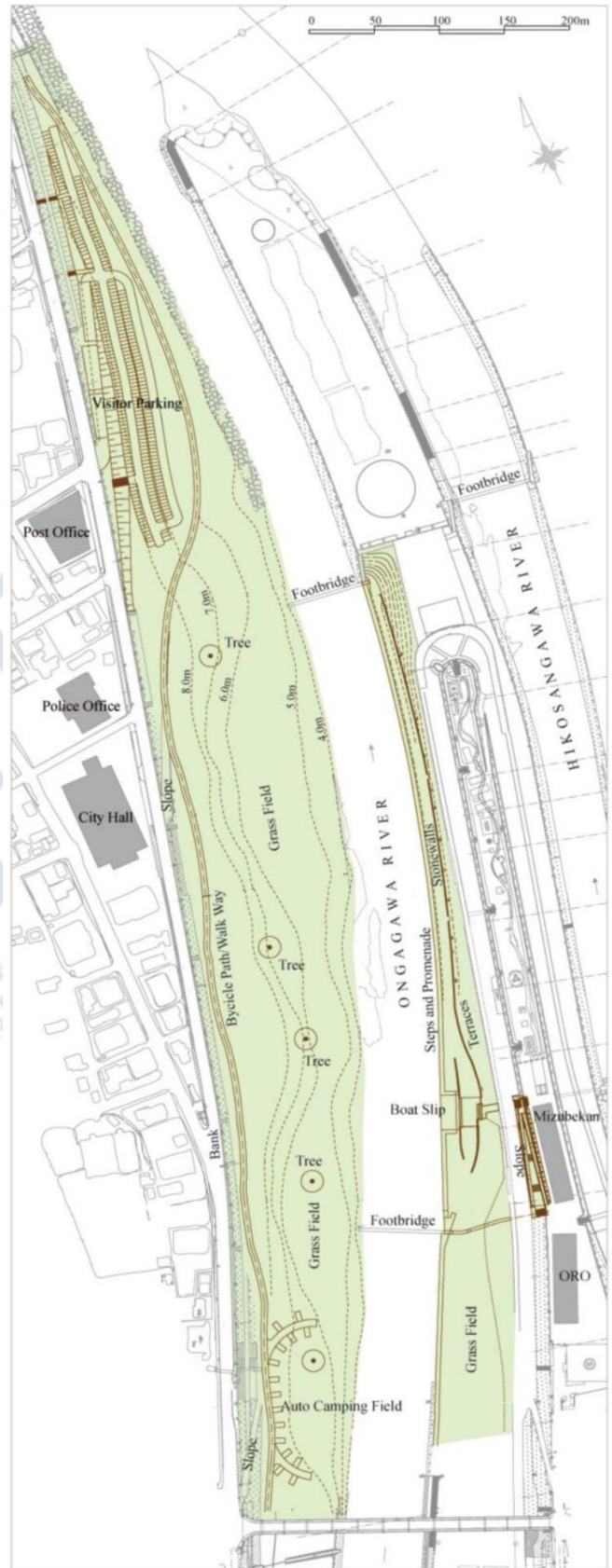


Figure 4. The plan of the completed design.

However, there are no researches that focus on the gentle slope of the high water channel in the city center, which is still rare in Japan, and how the alteration of the topography and scenery can affect the behavior of visitors. Higuchi et al. investigated the behavioral characteristics of visitors in 2006, immediately after the restoration of the west side bank of the Ongagawa River Nogata district, and compared it with the situation before the restoration [2]. However, since the investigation was just after the restoration, space utilization after long-term changes has not been investigated. Generally, Landscape design must withstand long-term change. Therefore it is meaningful to investigate the condition after the long-term change.

This study is novel in that respect, investigating the condition in 2018 by adopting the same survey method as Higuchi's research and clarifying the relationship between the change in spatial usage after the long-term changes and the design intentions.

III. OVERVIEW OF THE RIVER IMPROVEMENT DESIGNS

Fig.1 shows the Ongagawa River Nogata district and its surroundings. This river channel is located in the center of Nogata City, Fukuoka Prefecture, and the urban area is developed near the west side bank river channel. Fig. 2 and Fig. 3 shows the condition before the restoration. Next, Fig. 4 shows the plan of the completed design. Also, Fig. 5 shows the sectional difference between the completed design from the previous condition. The main design elements before and after the restoration are shown in Table 1.

Table 1. The main design elements before and after the restoration.

	Before Renovation	After Renovation
Water stage	Approx. 200m x 100m	Removed/ Covered
Auto-camping site	Approx. 200m x 50m (30 cars)	Shrunked/ Modified (15 cars)
Maintenance road	Asphalt paving, 10m width, linear shape	Soil-mixed paving, 4m width, curved shape
Low water bank embankment	Concrete block wall	Foot protection stones
High water channel	Flat, Asphalt and Concrete paving, Wild grass coexist	A gentle slope with undulations (2-25%), Mostly, Wild grass

The design elements result from intensive discussions among the design team, ORO, and the Council for Revitalizing Ongagawa River. Many design issues were raised in the early stage of the design work, and the design team responded to all of them integrated and created the

completed designs. The details of the designs are the following.

- 1). As Ongagawa River turns to the west in front of the city hall, the west side riverfront has a tendency of sedimentation from a river engineering point of view. This means that maintaining the existing concrete wall along the present low-water channel is not necessary for flood control. It should be replaced by a sandy beach where people can access the water safely and comfortably.
- 2). To smoothly connect the proposed sandy beach and the existing bank, it is most appropriate to reshape the existing high-water channel into a gentle slope. The slope gradient could differ from 2% to 15% depending on the width of the plain and the topographical design.
- 3). Making a gentle slope by digging the high-water channel also increases the cross-sectional area of the waterway, and this will improve the river's security for flood control.
- 4). The new, sloped grass field can have gently changing naturalistic topography that the river used to have. The carefully designed topography of the field would accommodate various activities. Citizens can find how to enjoy the space, including a picnic, fishing, jogging, walking, bicycling, softball, and other activities suitable along the river.
- 5). As many trees as possible following the flood control regulation should be planted on the grass field. These trees will enhance the naturalistic atmosphere of the place and also provide shade to visitors. They should be chosen from local species. They should also be planted above the ground water level so that the roots can breathe.
- 6). Existing single-use facilities such as parking lots and paved driveways on the west side riverfront should be replaced by a large multi-purpose grass field. The area should not be divided into any segments for limited uses..

Table 2. Survey dates

	Survey dates	Average temperature	Number of people surveyed
Weekdays	Nov. 7th, 2018 [Wed]	15.4°C	90
Weekends	Nov. 11th, 2018 [Sun]	13.4°C	145

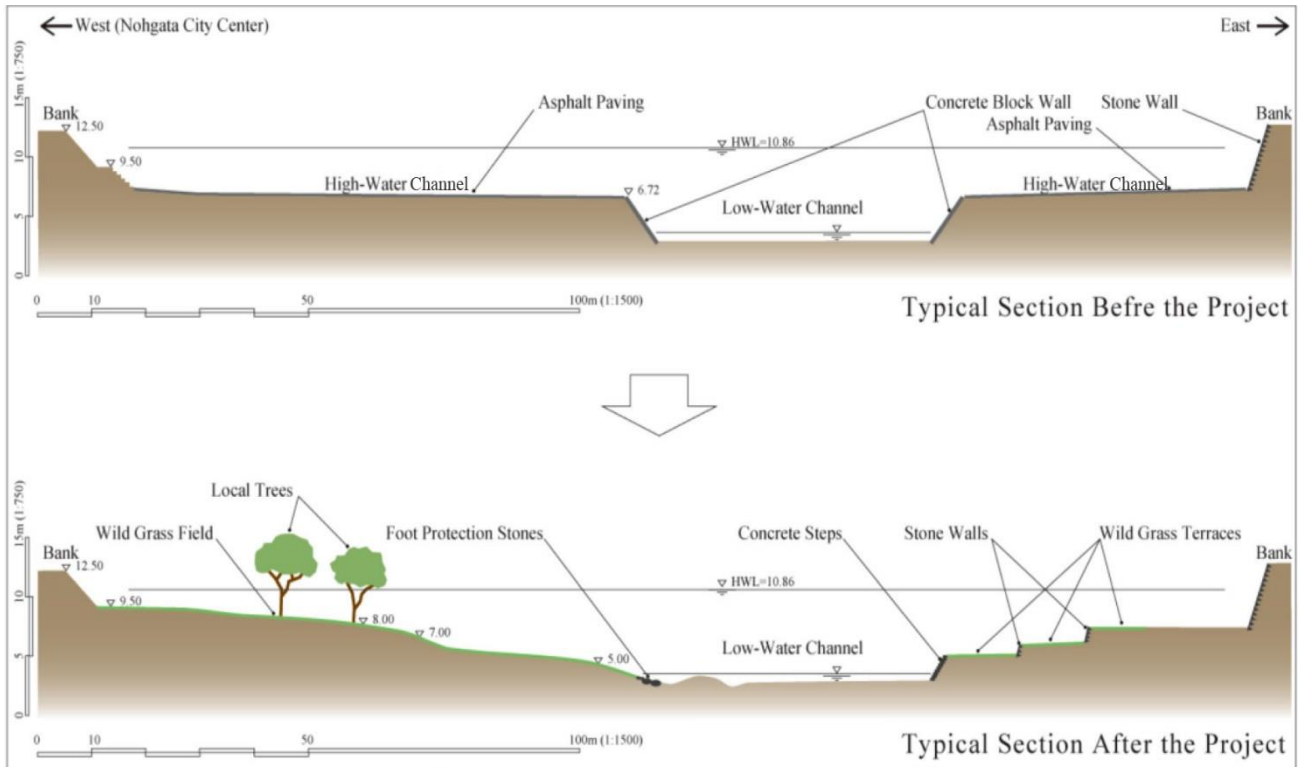


Figure 5. Typical section of before and after the renovation

IV. SURVEY METHOD

(1) Scope of the survey area

The scope of the survey is the entire area of the restoration project, indicated by the dotted line in Fig. 1.

(2) Survey period

The field survey was conducted in October and November 2018, when the surrounding citizens fully recognized the existence of the improved river channel after the 2006 restoration. The dates were weekdays and weekends with good weather, as shown in Table 2. The survey time is about 10 hours from 7:00 to 17:00 (from sunrise to sunset. No night lighting was installed in this river channel, so the survey after sunset was not conducted).

(3) Survey procedure

Surveyors waited near the main entry spots (stairs, slopes) to the river channel on the west side bank of the Ongagawa River Nogata district, tracked visitors, and traced the flow of their movements. Next, surveyors conducted an interview survey by calling out to the visitors when they left the scope of the survey area.

The reason for adopting the method of tracking the behavior of visitors as the survey method is that (1) it is possible to accurately traced the flow of visitor movements from entry to exit, and (2) interviews are conducted immediately after recording the flow line.

There were individual visitors and groups of two or more people, such as parents and children. However, I counted one visitor group as one event, regardless of whether they were single or multiple.

V. FINDING AND CONSIDERATION

(1) Attributes of visitors

Table 2 shows the number of visitors and of survey subjects by the date of survey implementation. On weekends, it is surveyed 145 of the 389 visitors, which is about 30%. It is safe to assume that the attributes of the survey samples, their movements in the river channel, their purpose of visit, and others are almost representative of the all visitors.

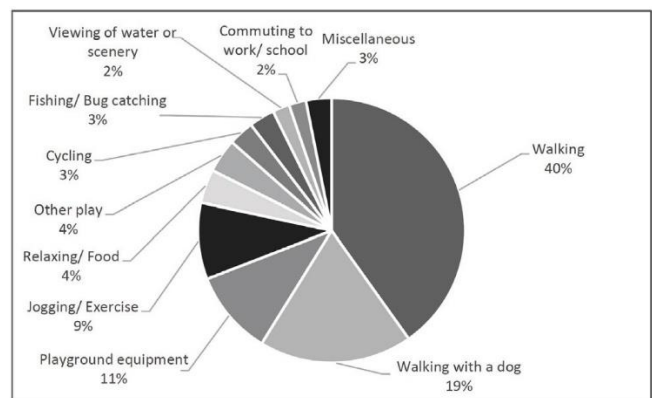


Figure 6. The composition ratios of the purpose of visit on weekdays. (n=97)

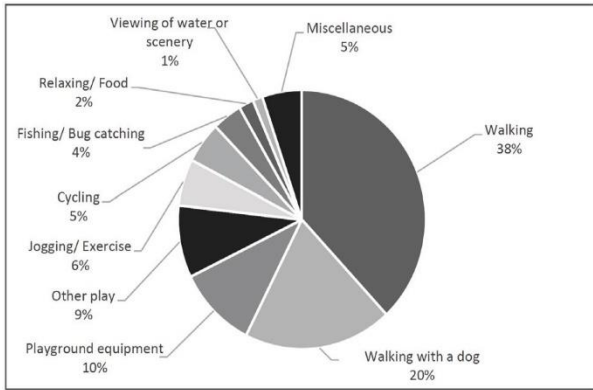


Figure 7. The composition ratios of the purpose of visit on weekdays. (n=155)

Next, Fig. 6 and Fig. 7 show the composition ratios of the surveyed samples by the purpose of use. On weekdays, 40% of the samples were for walking, followed by 19% for walking their dogs. Even on weekends, 40% of visitors came for the purpose of walking, followed by those who wanted to walk their dogs, at just under 19%.

On both weekdays and weekends, approximately 60% of the total visitors are walking or walking with their dogs. From

this, the majority of visitors have a place of living or working around the river channel. Also, there are various purposes for visiting other than walking or walking with their dogs.

As described above, similar trends were observed in the purpose of visit and the time of visit on weekdays and weekends, and it can be safely assumed that the river channel has become a daily activity space for the residents living in the surrounding area.

(2) Distribution of walking routes

Fig. 8 shows walking routes for 90 visitors on weekdays. While many visitors can be seen walking along the promenade, the number of lines indicating the walking route can also be read along the waterfront line of the low waterway. In addition, it can be seen that the walking route is widely dispersed over the entire river channel, including the part where the water stage has been removed and the auto-camping site that has been reshaped. In addition, there are many lines of traffic that are almost parallel to the contour lines (thin dotted lines in Fig. 1), representing the topography of the gentle slope, suggesting that there is some relationship between the topography and the behavior of visitors.

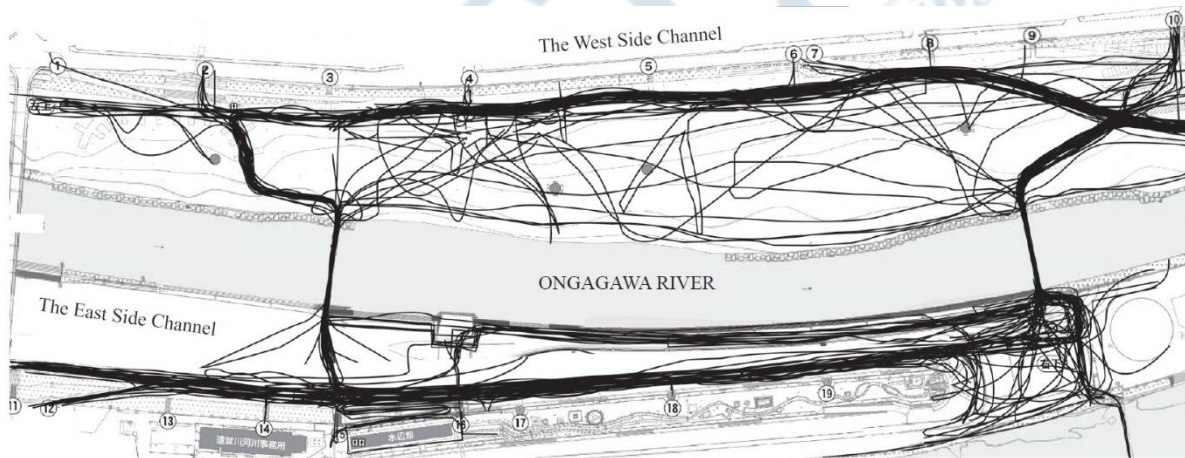


Figure 8. Weekday visitors flows.

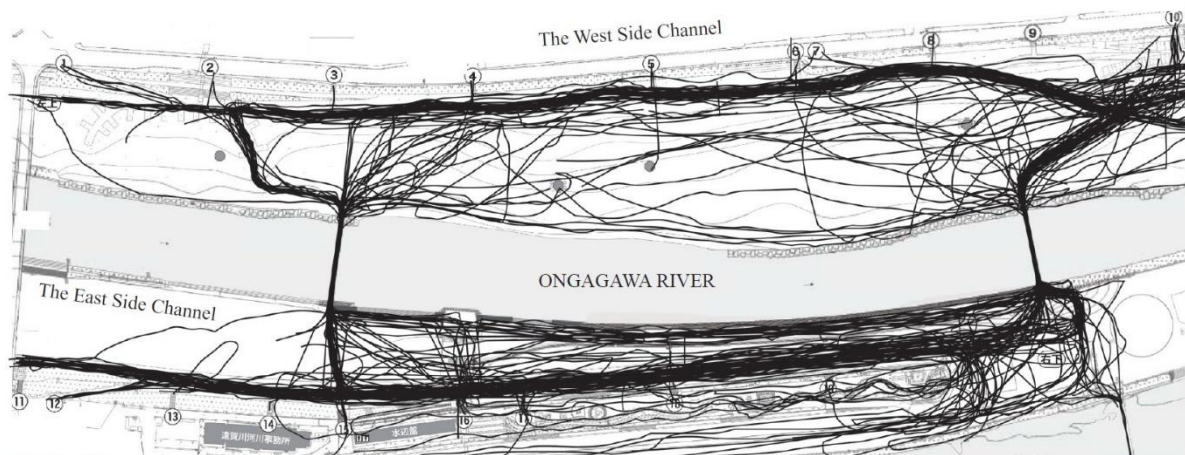


Figure 9. Weekend visitors flows.

Fig. 9 shows walking routes for 145 visitors on holidays. While it can confirm the existence of a group that chooses to walk along the promenade, walking routes are more widely distributed over the river channel than on weekdays, such as walking freely on grassy slopes. It can be confirmed that many flows of visitor movements are concentrated at the water's edge, in part around subsidence bridges and the part where the old water stage was removed. In addition, it can be confirmed that there are many traffic lines with curves parallel to the contour lines, just like after the repair on weekdays, and many traffic lines pass near tall trees (brown circles in Fig. 1).

To summarize the above, on weekdays and weekends, there is a tendency to use the river channel more widely than before the restoration. Secondly, there is a tendency to be closer to the waterfront. Thirdly, there is a tendency for the topography and arrangement of tall trees to affect the movement of visitors.

(3) Relationship between design intentions and space utilization



Fig. 10. Renovated high water channel on the west bank gentle slope shape with undulations, and a visitor feels the longitudinal Depth and sees the water's surface.



Fig. 11. Restored high water channel on the west bank has spaces that can be used for multiple purposes, various waking spaces, and a visitor sees the water's surface.

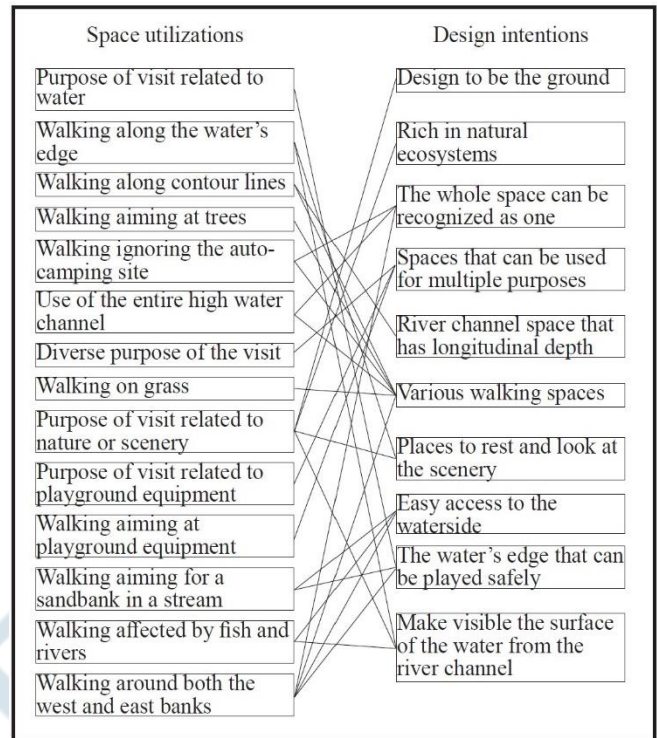


Figure 12. Relationship between design intentions and space utilization

Fig. 10 and Fig. 11 shows the condition after restoration. Fig. 12 shows the relationship between river space utilization and design intentions. The right side of the figure shows the design intentions, and the left side shows the space utilization patterns found in the survey data that are considered to be related to these design intentions.

1) From the fact that "Use of the entire high water channel" and "Diverse purpose of the visit," it is considered that the use is related to the design intention of "Spaces that can be used for multiple purposes" and that "The whole space can be recognized as one." In addition, the "Walking around both the west and east banks" is because the number of visitors who walk not only on the west side bank but also on the east side bank has increased due to the development of the east side bank waterfront promenade.

Therefore, the design intention that "The whole space can be recognized as one" is working effectively.

2) Space utilization such as "Purpose of visit related to water," "Walking along the water's edge," "Walking along contour lines (undulations)," "Walking aiming at trees," "Walking ignoring the auto-camping site," "Use of the entire high water channel" is confirmed. It is considered that there is a strong relationship between space utilization above and design intentions of "easy access to the waterside," "The water's edge that can be played safely," and "Make visible the surface of the water from the river channel," "Various walking spaces," and "River channel space that has longitudinal depth."

- 3) "The purpose of visits related to nature and scenery" has a strong relationship with the design intentions followings; "Make visible the surface of the water from the river channel," "Rich in natural ecosystems," "Places to rest and look at the scenery," and "to design to be the ground." "Design to be the ground" means treating the active elements of the site as the figure, such as the water surface, the reflection of the sky and sunlight, the mountains, the fish and wild birds, and the people enjoying their time. To summarize the above, there is a tendency for design intentions to affect space utilization.

VI. CONCLUSION

This study conducted tracking-visitor surveys and interview surveys on space utilization of river channel visitors on the gentle-slope-shape channel of Ongagawa River Nogata district and clarified the relationship between the design intent and the changes in space utilization by visitors, mainly local citizens, over the 12 years after the restoration. As a result, it was clarified that the changes in space utilization was mainly due to the initially intended design effect.

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