The Relationship between Evaluations of Water Channels Landscape and Landscape Elements in Sub-urban Residential Area in Tokyo, Japan

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Abstract. This study clarified how people's evaluation of the water channel landscape affects due to differences in landscape elements. To evaluate the success of the water channel landscape, a land-use maps of the areas around the water channels were created. After that the maps were used to classify land-use into eight types. In addition, the target water channels were classified into four types based on land-use around them and whether people could access them. Results showed that the land-use around water channels has an affect on how people view them. We also conducted workshops to clarify the relationship between the public impressions of water channel landscape as a familiar green space and landscape elements in residential areas. According to the participants, their preference for water channel landscapes of this type was based on three elements: the vegetation, revetment, and fences. Furthermore, it was clarified that these three elements created an atmosphere around the water channel and that this atmosphere played an important role in determining the impressions people have of the water channel landscape.

Keywords: water channel landscape, landscape elements, landscape evaluation, impression

1. Introduction
Recently, river restoration or city planning along rivers has become popular.[1][2][3][4] Planning that contributes to ecological conservation, flood control, and human comfort is being carried out for rivers around the world, particularly in Europe [5], and the riverine landscape is being regarded as important. There have been many studies on river landscapes.[6][7] In residential area, a water channel can play the same environmental role as that of a river. Recently, populations have become concentrated in urban areas, and the importance of familiar natural elements in residential areas has increased. For this reason, the environmental functions of water channels have attracted attention, and some research has been conducted on the ecology in water channels or changes in water channel networks.[8][9] However, in contrast to rivers, the evaluation of water channel landscapes or the elements that make up those landscapes has not yet been done.

There are various suggestions on how to define a landscape [10][11][12]; however, it can be said that landscape is a subjective value determined when an individual recognizes an object visually. Therefore, in landscape planning, it is important to understand the sensibilities of the person who enjoys a landscape. As people recognize landscapes in which they see an object in a space, it is also necessary to clarify the characteristics of the space in which people perceive the landscape, what about the space feels good, or what elements are used to create the landscape. This study intends to clarify how people's evaluation of the water channel landscape affects due to differences in landscape elements.
2. Study Area
In this study, eight cities in a residential area of Tokyo, Japan—Akishima City, Tachikawa City, Kokubunji City, Koganei City, Mitaka City, Kunitachi City, Fuchu City, and Chofu City—were selected as the research area (Figure 1). In these eight cities, there are 62 springs with sources in two escarpments (Kokubunji Escarpment and Fuchu Escarpment), and the water channels originating from these springs form a net. This study first focused on 23 of these water channels in the eight cities.

![Figure 1. The eight cities selected as the target area in Tokyo](image)

3. Method
3.1 Determining land-use types around the water channels and categorizing the water channels based on land-use
First, a land-use map of the areas around the water channels was created using topographic maps (provided by the Ministry of Land, Infrastructure, Transport and Tourism) and aerial photographs (provided by the Geospatial Information Authority of Japan). This land-use map also included the results of a field survey, and it was used to classify the land-use around the water channels into eight types. Finally, the target water channels were classified into four types based on these eight land-use types.

3.2 Evaluating factors of the water channel landscape using the KJ method
We conducted workshops to clarify the relationship between the public impressions of the water channel landscape as a familiar green space and the landscape elements in residential areas. Eleven accessible water channels in public areas were selected from the four types, and the landscape elements of each channel were extracted in five photographs that clearly showed their characteristics. The workshop used the KJ method to evaluate landscape preferences related to each channel and understand the factors behind those evaluations.

The KJ method is one of the brainstorming methods to organize dates.[13] First, cards written in the date or opinion about subject of discussion are created, and then some groups of cards are made by gathering these cards according to the content of date or opinion. This makes it possible to understand the relationships between groups of cards, and is useful for collecting much data and opinions.

The participants in the workshop were 62 university students interested in maintaining green spaces. They were divided into 10 groups and were shown the five photographs. Afterward, they were asked to arrange the photographs in the order they felt indicated their
preference for the impressions that elements of the landscape of each water channel generated and explain why they felt an element was preferable or was not.

3.3 Analysis
The relationship between the evaluation of the preferences for the water channel landscape and certain landscape elements therein was analyzed. We considered whether the evaluations were related to the overall atmosphere surrounding the water channels and whether the surrounding land-use affected the landscape of the water channels. Finally, we considered the landscape elements that determined the impressions generated.

4. Result
4.1. Land-use category around the water channels
Table 1 shows the process of categorizing water channels into four types according to land-use classification. Water channels were divided into four types based on eight types of land-uses surrounding water channels: residential, road, wall, park (including plaza), forest, promenade or path in a shrine or temple, forest on an escarpment, and other buildings (for example, museums or agricultural warehouses), and whether or not they were accessible to the public. The four types are: open public space type”, “closed to the public type”, “open but private space type”, and “park type” (Figure 1).

“Open public space type” channels are those in public spaces in residential areas that people can see them from the road or the promenade built around it and which they can get close to. “Closed to the public type” is a water channel in a public space in a residential area “Open but private space type” water channels are located in private spaces such as in a temple or on a corporate site, that are open and accessible to locals. “Park type” water channels are those that can be accessed because the area around them is maintained as a park. Where the water channel is shielded by houses or walls and, thus, cannot be seen or accessed.
Table 1. Land-use surrounding water channels and categorize of water channels

| No. | Land use around the water channel | Access to water channel | Category of water channels |
|-----|----------------------------------|-------------------------|----------------------------|
| 1   | Wall  | Road           | ○ ■                      | Open public space type    |
| 2   | Regidential | Promenade or path in the shrine or temple | ○ ◆                   | Open but private space type |
| 3   | Promenade or path in the shrine or temple | Promenade or path in the shrine or temple | ○ ◆                   | Open but private space type |
| 4   | Wall  | Other building | × ▲                      | Closed to the public space type |
| 5   | Park  | Road           | ○ ■                      | Park type                |
| 6   | Park  | Park           | ○ ■                      | Park type                |
| 7   | Forest on the escarpment | Promenade or path in the shrine or temple | ○ ◆                   | Park type                |
| 8   | Forest on the escarpment | Park                     | ○ ■                      | Park type                |
| 9   | Forest on the escarpment | Other building           | ○ ■                      | Open but private space type |
| 10  | Wall  | Road           | ○ ■                      | Open public space type    |
| 11  | Forest on the escarpment | Promenade or path in the shrine or temple | ○ ◆                   | Park type                |
| 12  | Promenade or path in the shrine or temple | Wall                    | ○ ■                      | Open public space type    |
| 13  | Regidential | Regidential      | × ▲                      | Closed to the public space type |
| 14  | Wall  | Road           | ○ ■                      | Open public space type    |
| 15  | Wall  | Park           | ○ ■                      | Open but private space type |
| 16  | Forest | forest         | ○ ■                      | Open but private space type |
| 17  | Forest on the escarpment | Park                    | ○ ■                      | Park type                |
| 18  | Other building | Other building | ○ ■                      | Open but private space type |
| 19  | Other building | Road           | ○ ■                      | Open public space type    |
| 20  | Other building | Road           | ○ ■                      | Open public space type    |
| 21  | Other building | Other building | ○ ■                      | Open public space type    |
| 22  | Wall  | Promenade or path in the shrine or temple | ○ ■                      | Open but private space type |
| 23  | Wall  | Promenade or path in the shrine or temple | ○ ■                      | Open but private space type |

【Category of water channel】
▱ open public space type ▲ closed to the public type ◆ open but private space type ● park type
4.2 Profile of workshop participants
The 62 respondents were all students in a department of horticulture; 29 were male and 33 were female, and all were aged between 18 and 25. None of them had visited the target water channels; they saw the for the first time in the photos shown at the workshop.

4.3 Relationship between the evaluation of water channels and landscape elements
Table 2 shows the results of the relationship between landscape elements and the impressions generated by the five photographs (water channel A-E) of the 11 channels classified as an “Open public space type” in section 4.1. In the workshop, participants were instructed to arrange five pictures in order: water channel A-E, based on their impression of the water channel, and write down why they feel so.

The evaluation count in Table 2 shows the number of comments participants made about the water channel landscape. In these, comments about vegetation were most common, accounting for 80(32%) of the 247. Comments about revetment and fence accounted for 55 (22%) (only 16 mentioned revetment, and only seven mentioned fence).

These participants’ comments suggested that vegetation along the water channels (including the flora in adjacent residential areas), stone wall revetments, and fences meant to prevent falls may decide the character of the water channel landscape. It was also found that the land-use around the water channels, not just the channels themselves, had an effect on the impressions. The entire atmosphere surrounding the water channels affected the impressions.
Table 2. Relationship between the landscape elements and the impression of the landscape

| Evaluation from students | Evaluation count | Individual elements of landscape | Entire atmosphere | Surrounding elements | Impression | Items regarding to water channel recognition |
|-------------------------|------------------|----------------------------------|------------------|---------------------|------------|---------------------------------------------|
|                         | A    | B    | C    | D    | E    |                                     |                  |                     |
| lots of green           | 14   | 14   | 14   |       |      | vegetation                         | positive         |                     |
| planting is maintained  | 3    | 6    | 6    |       |      | vegetation                         | positive         |                     |
| it has a nicely balanced the area in the sun and shade | 1    | 1    |       |       |      | vegetation                         | positive         |                     |
| construction the nature was made use of | 2    | 1    |       |       |      | vegetation                         | positive         |                     |
| looks like it does not maintain | 1    | 3    | 5    |       |      | vegetation                         | positive         |                     |
| water channels are not noticeable | 2    |       |       |       |      | fence                             | positive         |                     |
| unregulated planting    | 2    | 1    |       |       |      | vegetation                         | positive         |                     |
| little green and inorganic | 1    | 2    |       |       |      | vegetation                         | positive         |                     |
| artificial              | 1    | 3    | 3    |       |      | vegetation                         | positive         |                     |
| water channel is hidden by growing plants | 2    |       |       |       |      | vegetation                         | positive         |                     |
| a lot of surfaces constructed by concrete | 3    | 4    | 3    |       |      | revetment                          | positive         |                     |
| the landscape of water channels and surrounding are divided | 1    | 1    | 1    |       |      |                                     |                  |                     |
| the overall impression is good in order | 8    | 1    | 7    | 3    |      |                                     |                  |                     |
| fence, revetment and road match the atmosphere | 4    | 2    |       |       |      |                                     |                  |                     |
| the atmosphere of the house and the water channel is matched | 1    | 2    |       |       |      |                                     |                  |                     |
| it can feel a natural atmosphere | 3    | 1    |       |       |      |                                     |                  |                     |
| refreshing cool atmosphere | 10   | 3    | 4    |       |      |                                     |                  |                     |
| it can feel that the width of water channel is wide | 1    | 1    | 1    |       |      |                                     |                  |                     |
| it can feel many types of plants | 1    | 1    |       |       |      |                                     |                  |                     |
| vegetation is close to native environment | 2    |       |       |       |      |                                     |                  |                     |
| it can feel a rich ecosystem | 2    |       |       |       |      |                                     |                  |                     |
| it can feel that the water surface is close | 2    | 2    |       |       |      |                                     |                  |                     |
| it can feel a bright atmosphere | 1    | 1    |       |       |      |                                     |                  |                     |
| the water looks clean | 1    | 1    |       |       |      |                                     |                  |                     |
| it cannot feel a natural atmosphere | 2    | 1    | 3    |       |      |                                     |                  |                     |
| a closed and dark atmosphere | 1    | 1    | 2    |       |      |                                     |                  |                     |
| water channels don’t harmonize with the surrounding landscape | 2    | 3    |       |       |      |                                     |                  |                     |
| it can feel that there is little water because covered by plants | 1    | 5    | 1    |       |      |                                     |                  |                     |
| houses, cars and advertisement nearby the water channel are noticeable | 1    | 4    | 8    |       |      |                                     |                  |                     |
| gloomy atmosphere | 1    | 3    |       |       |      |                                     |                  |                     |
| it cannot feel to walk | 2    |       |       |       |      |                                     |                  |                     |
| safe because there is a fence | 7    |       |       |       |      |                                     |                  |                     |
| the border between water channels and roads is clear by being fences and revetments | 4    | 5    |       |       |      |                                     |                  |                     |
| it feels danger because the border between water channels and roads is not clear | 3    | 3    |       |       |      |                                     |                  |                     |
| it seems to fall into the water channel | 7    | 7    |       |       |      |                                     |                  |                     |
5. Discussion
Participants’ comments on their impressions of water channels showed that water channel landscape with vegetation appropriate management, and revetments in harmony with the surrounding environment created good impression. Additionally, people feel safe with fences installed along water channels but recognized their artificiality.

The following are suggestions for three landscape elements that the survey revealed as important.

(1) Planting around a water channel, when the surrounding vegetation is effectively managed such that it does not reduce the visibility of the water flow, is preferred as part of the water channel landscape. However, if plants grow enough to hide the water flow, they give a closed and negative impression of the landscape.

(2) Regarding the stone wall revetments, it was recognized that they give the water channel landscape a natural atmosphere compared to revetments constructed only with concrete.

(3) Although fences meant to prevent falls have been perceived as negative in terms of landscapes, because of the artificial impression they create, they are recognized as significant safety factors.

(4) Different types of land-use around the water channels, such as roads, houses, and parking lots, were also recognized as part of the surrounding environment that affected the evaluation of the water channel landscape.

Thus, to maintain a preference for the water channel landscape in a suburban area, it is clear that maintaining and managing vegetation appropriately and creating natural-looking revetments and structures that make people feel safe are necessary.

6. Conclusion
In this study, grasping the landscape elements of water channel by interpreting topographical maps and aerial photos and using workshop exercises clarified the relationship between the impressions of water channel landscapes as familiar green space and landscape elements.

Consequently, water channels were divided into four types. Regarding the “Open public space type” often seen by people, vegetation, revetments, and fences were the main factors determining impressions of the water channel landscape. Additionally, it was also showed that vegetation and revetments particularly affect the maintenance of the water channel and the entire atmosphere surrounding it, while the presence of the fence helps people to recognize the importance of safety. This result shows that, it is necessary to plant management and improve of revetments in harmony with the surrounding environment to create a water channel landscape that favors people.

Water channels are connected in a network, and capturing the characteristics of an entire landscape via this network is important for creating a landscape for a region. However, this study only clarifies that the relationship between evaluations of landscapes and landscape elements for accessible water channels in residential areas. Therefore, it may also be worth researching the relationship between impressions of the landscape and landscape elements, clarified for the other three types of water channels identified in this study.

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