

# Designing the Value of Water Infrastructure for Sustainable Regional Inheritance: A Case Study in the Lowland Wetlands of Niigata, Japan

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**Abstract.** A comprehensive approach that does not merely appeal to cultural and landscape significance is necessary to preserve the historical cities under the condition of social and climate change. This paper aims to develop a design method that contributes to the planning of sustainable cities in a practical way through action research, focusing on water infrastructures that support people's daily life. The case study site is the watershed of Fukushima Lagoon in the low-lying plain in Niigata Prefecture, Japan where the water network had been developed and transformed for centuries. As the hypothetical theoretical framework, we set a definition of the idea of community-based water infrastructure, visualization of its characteristics, and the design action at the target site as local key spots. Based on them the characteristics of the water infrastructures were visualized by the Historic Landscape Characterization map and booklets with full illustrations to share with various stakeholders. The ongoing design actions with the community at the extracted local key spot, the Furuoota River are also reported. In conclusion, a concept of designing the value as a planning process for the sustainable preservation of the built environment and community is proposed with an emphasis on focusing on water infrastructures.

**Keywords.** *Community-based water infrastructure, Design methodology, Sustainable preservation, Wetland*

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## 1 Introduction

The preservation of historic cities is necessary. No one would disagree with this. However, its meaning and purpose, i.e., its context, are diverse. Preserving historic cities is important because they possess a distinct beauty and value that differs from modern cities. This understanding is widely held and its most representative values are defined in UNESCO's World Cultural Heritage selection criteria. The historical buildings are the crucial components of historical cities, and their value is evaluated not only in terms of visual appeal but also in terms of people's usage and attachment to them and their affinity with the local environment (Tweed et al., 2007) (Coeterier, 2002) (Yee Sing et al., 2016). Furthermore, from the perspective of resilience to climate change and changing social conditions, there are interests in cities that have been sustained over a long period, and there is a search for ways to apply their values to the present day (Millennium Village Project, 2016). From this perspective, it becomes increasingly important to discuss not only the preservation of the elements that consist of the historical city but also the planning theory of urban preservation in terms of the historical city itself, to pass it on to the future in a sustainable manner. This paper aims to develop a design method that contributes to the planning of sustainable cities in a practical way, focusing on water infrastructures that support people's daily life.

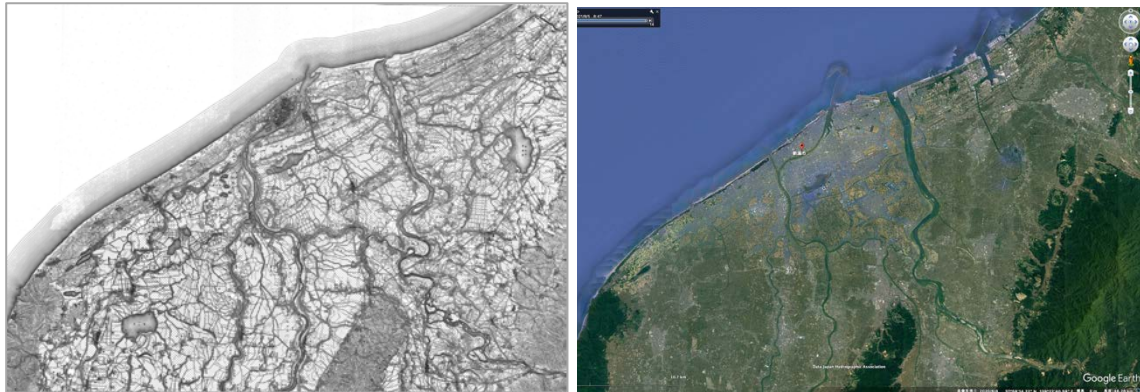
Over time, regions have developed water infrastructures that serve to provide both water supply and flood control. This includes waterways and facilities which control the usage and level of water. These infrastructures have undergone significant changes, especially in the latter half of the 20th century. Since the introduction of modern technology to infrastructure for water use and flood control, the scale of them has been dramatically expanded and systematized. At the same time, these modern technologies also changed people's lives and industries. Changing the purpose of their existence would require the demolishing and rebuilding of facilities, which would make it difficult to maintain and preserve a historic city. Therefore, a comprehensive approach that does not merely appeal to cultural and landscape significance is necessary to preserve such historical cities.

From this perspective, we have conducted researches on the transition of lagoons and water networks in Niigata city located on the Echigo Plain, a rice-producing region of Japan, focusing on the relations in water infrastructures and the community who use and manage them. At the same time, we have engaged in community development actions that make the value of the landscape and environment sustainable by the conservation and succession of specific facilities. Through this practice, we present a design methodology to create new values as well as inherit the historicity of the city by promoting the continuous use and updated utilization of infrastructure while its role has been transformed. This paper reports on the framework for the methodology and the results of the survey and analysis based on it, as well as the status of the practical community development actions.

## 2 Overview of the Target Site

The practical case study site is an area centered on Fukushima Lagoon in the low-lying plain known as the Echigo Plain in Niigata Prefecture, Japan. The Echigo Plain was formed by sedimentation from rivers flowing out of the mountains behind it, but the river mouth is limited due to the dune rows and hills along the coastline, and there are many wetlands in the extremely low-lying plain. As a result, construction activities for drainage and reclamation have been carried out since the premodern period. In the modern era, large-scale channel excavation, river improvement, and mechanical drainage have led to extensive reclamation of wetlands and conversion of paddy fields. As a result, the Echigo Plain became a major rice-

producing region (**Figure-1**). At the same time, the development of this water infrastructure contributed to the reduction of flood damage. The network of waterways, which were like a mesh network, also served as transportation routes by boat, but this role has been lost with the development of roads. Wetlands used to be important resource extraction sites for fish, plants, and birds, but with the reclamation of land, these activities have disappeared. Since the 1990s, the core building and park have been developed to utilize the Fukushima Lagoon, which is the largest lagoon left in Niigata City as a natural environment site, and it has become a representative resource of the region, with lively citizen activities. However, the value of Fukushima Lagoon should be understood not only as the natural environment but also as part of the water infrastructure network that has supported the water cycle in the region in the historical context.



**Figure-1.** Transition of the Echigo Plain from 1911(left)<sup>\*1</sup> to 2022(right)<sup>\*2</sup>

Source: \*1 'Wetland and lagoon studies for all- A new regional studies in Echigo plain-', \*2 Google Earth

### 3 Hypothesis for the Development of Design Methodology

To promote the inheritance of the historicity and the creation of new value of the target site centering on Fukushima Lagoon, we have drawn a theoretical framework as a hypothesis based on our field research experiences to develop a design methodology. We have conducted surveys, spatial analysis, and practical community development activities based on the framework as follows.

#### The Concept for Water Infrastructure

First, infrastructures related to water, which is the focus of this study, should be considered an integral idea of both the facilities and the entities, especially the communities that use and manage them. Then we defined this idea of water-related infrastructure as 'community-based water infrastructure (CbWI)'. It has consequently changed along with the construction technology and lifestyle but remains partly so that the facilities of different forms and characteristics coexist in the region playing each role. It is effective to start from this viewpoint and consider planning and design based on the historical nature of the infrastructure.

#### Visualization of the Characteristics of the 'Community-based Water Infrastructure (CbWI)'

The diversity of entities involved in use and management is considered to enhance the sustainability of the CbWI, so it is effective to present the characteristics of CbWI in a form that can be shared among various stakeholders. The aims of visualizations are both communications with stakeholders and analysis serving as site selection for the planning and design.

#### The Design Action at the Target Site

Based on the analysis showing the characteristics, target sites that should be focused on in terms of conservation and utilization are extracted. For the extracted sites, which we call ‘local key spots’, we will design a series of actions to increase their value by considering facility improvement and/or re-design and encouraging the updated usage by the community.

In the following chapters, the results of each attempt made in a sequence will be reported.

#### 4 Visualization of the Characteristics of CbWI Centering on Fukushima Lagoon

The Echigo Plain is originally low in elevation and flat, with dunes along the coastline, making inland drainage difficult, including wetlands where the water surface is lower than the sea level. Therefore, attempts to construct artificial drainage channels have been made since premodern times, and since modern times, a large-scale network of waterways by the government has been developed with the introduction of mechanical drainage, to improve agricultural production and the living environment. The history of infrastructure construction, known as the "war against water," is presented as the story of the region, and wetlands and lagoons have been regarded as unproductive land and have been reclaimed endlessly.

But in the late 20<sup>th</sup> century, the concept and policy of water management turned to be more nature-based and wholistic. It is represented in the remade wetland project in a part of Fukushima Lagoon that the former rice paddies are being converted back to wetlands to enhance the function of retarding basin and habitation site for creatures. Including these water infrastructure and lagoon transitions in the region, we have created a booklet to show the landscape characteristics of Fukushima Lagoon, which is now considered valuable from the only perspective of the natural environment and bird sanctuary. We introduced some section illustrations representing the characteristics of the geography, land use, and water control facilities (Figure-2).

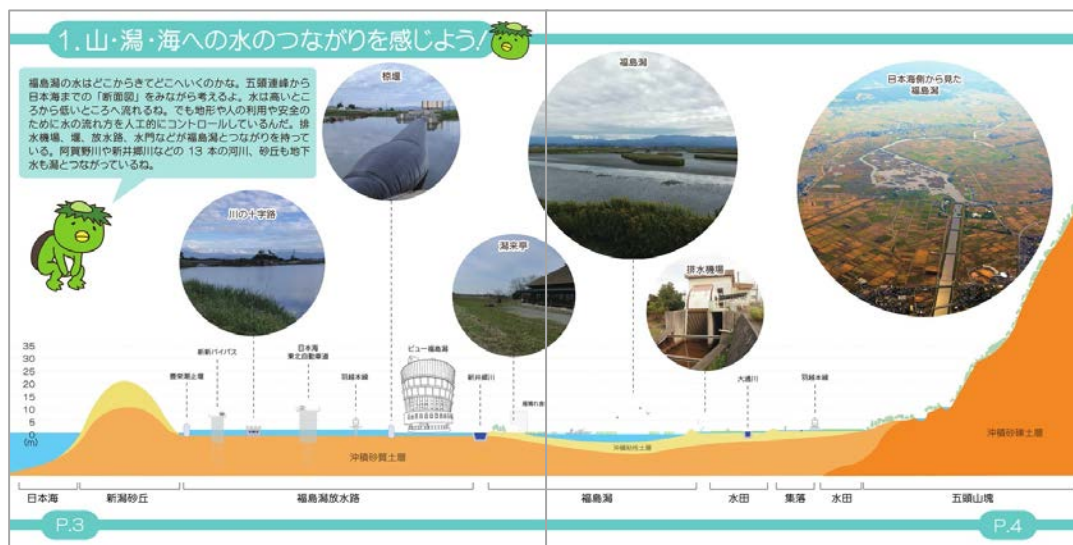


Figure-2. A section illustration showing the characteristics of the CbWI in the booklet

The water infrastructures in the region have been developed for agriculture. Then we gathered the various maps of the irrigation network and interviewed the officers of the organization of the Land Improvement District to create maps showing the water flow and pumping facilities in the region (Syu et

al., 2022).

In terms of use and management entities, we conducted a literature review and interviews to characterize the citizens' activities in Fukushima Lagoon and have organized the objectives (Uchiyama et al., 2021). The results showed that the objectives of citizen activities consisted of the maintenance of the natural environment itself and sharing its value with the urban residents who live not so far from the site and that there was a gradation in the participant's attitudes. We also created a booklet to show the overall picture of citizen activities, which had not been well shared among the groups (Figure-3).



Figure-3. A booklet index page showing citizen activities at Fukushima Lagoon with various objectives

Through these works to visualize the existing CbWI characteristics, various stakeholders can share a common understanding of the region and discuss the next step to create an image of the new value of the CbWI that will be realized by design actions.

## 5 Extraction of the Target Site Named as ‘Local Key Spots’ to be Designed

The water infrastructure that exists in the region is large in scale, and even if its characteristics are understood, it is difficult to inherit or change it in its entirety. Therefore, extracting target sites from these two perspectives is effective: important targets that constitute a feature, and effective results can be easily achieved through small-scale actions. We called such sites with high potential ‘local key spots’ and examined methods for their selection of CbWI.

We introduced the method of Historic Landscape Characterization (HLC) developed and widespread in the UK to identify and interpret the varying historic character. There are several characters for focus in the analysis we introduce the simplest aspect of spatial change and unchanged and create a time depth map using old maps of the Fukushima Lagoon watershed. The water network HLC map shows the sections of the waterway that build a century ago and its location unchanged in red color (Figure-4). We also focus on the relationship between the village and the waterway and categorize it into types and identified the sites where the type is unchanged (Nagasawa et al., 2022) (Figure-5). As a result, we extracted the site of the Furuoota River as the local key spot after the site visit of a few candidates from the map. The reason for the extraction is that the historic landscape is preserved and many self-built tentative facilities accessing

water and river walls that represent the community management are still alive but seem weakening. Moreover, the water level of the Furuoota River is controlled by the upstream water gate, which means the modern infrastructure enables such a historical landscape to be preserved. This combination of modern and historical water infrastructure evokes an understanding of the characteristics of CbWI in the region.

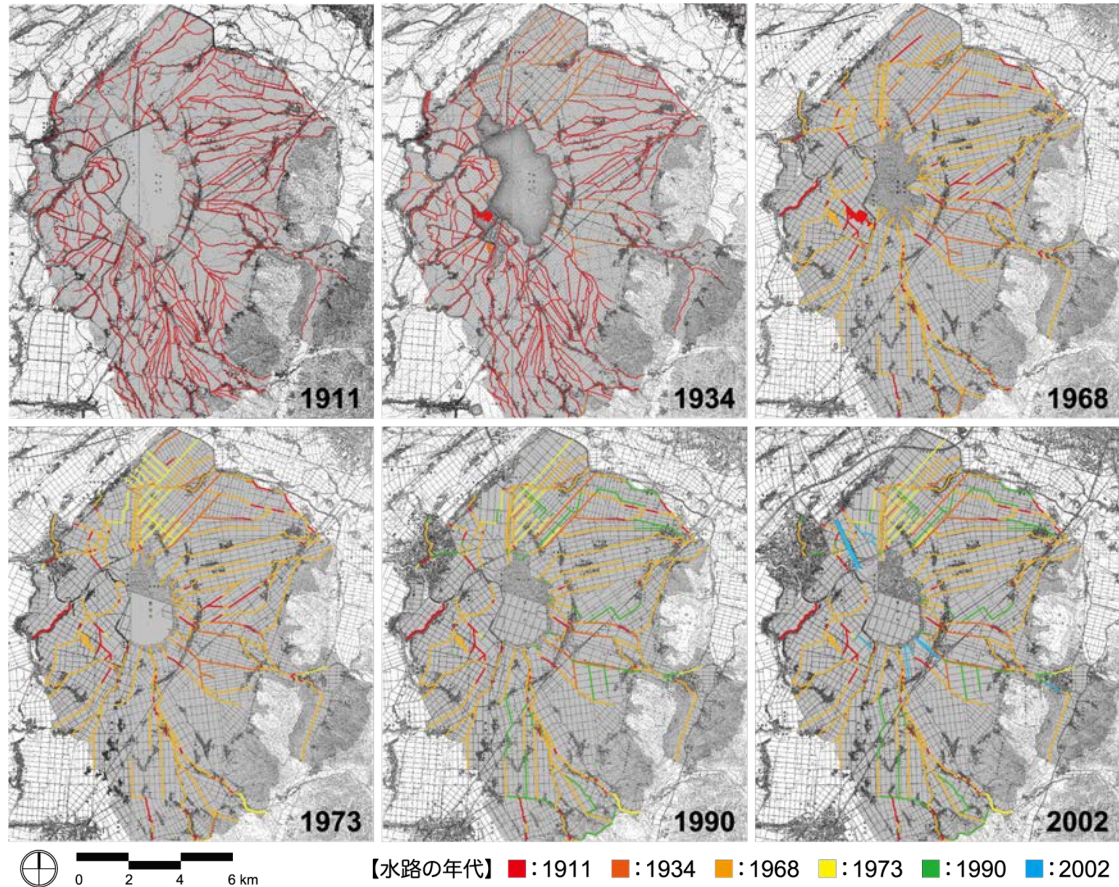


Figure-4. Water network transition in Fukushima Lagoon watershed

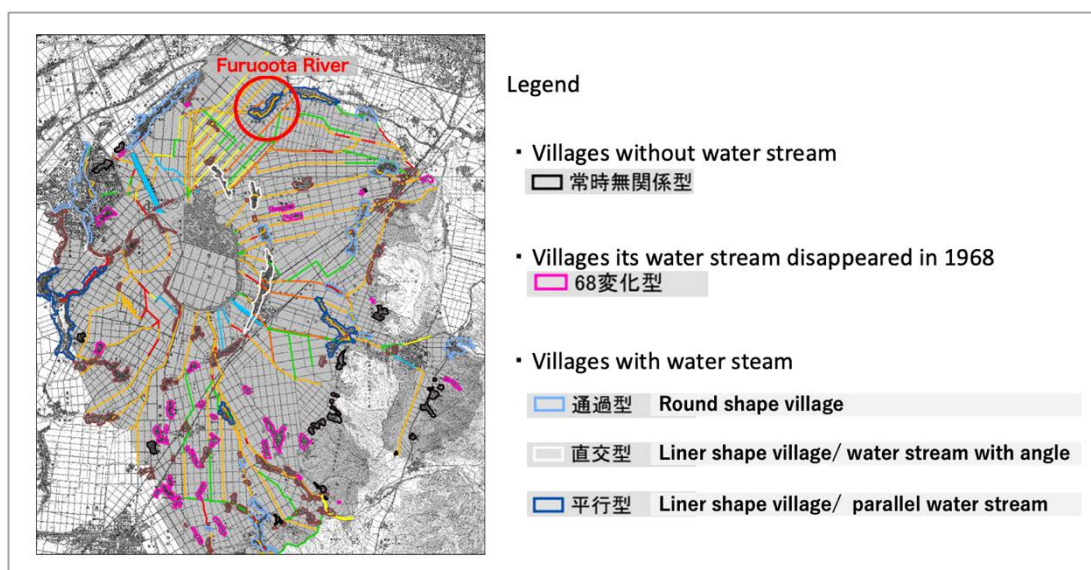


Figure-5. Types of the relation between the village and waterway and the target site location

## 6. The Design Action at the Target Site

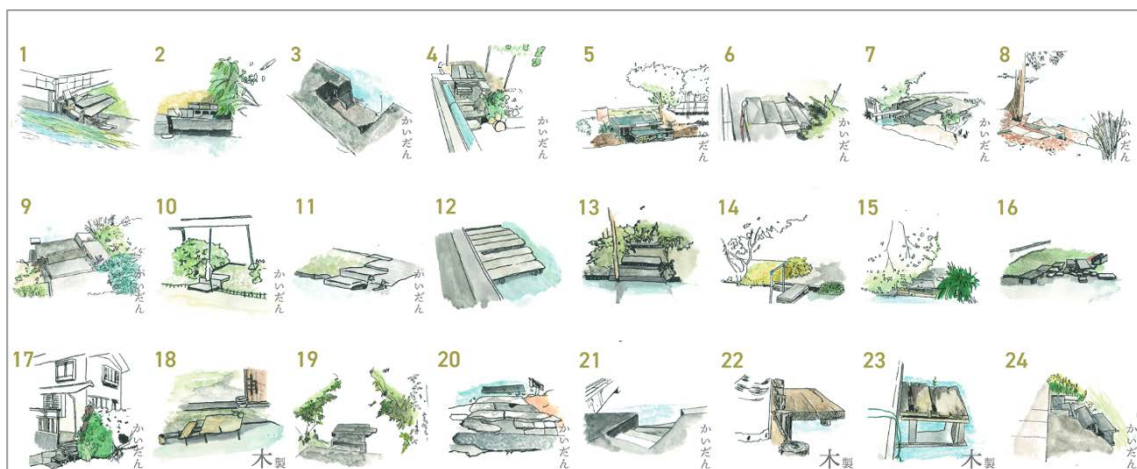
Our action research at the target site 2km along the Furuoota River (**Figure-6**) is going as follows.

First, we conducted a design survey of the condition of the revetment and the self-built devices for access to the water, called ‘kawado’, and the section that runs through the village. The results of the survey were illustrated (**Figure-7**) and summarized as the charming points of attraction and presented to residents. This led to a discussion with users, which is currently underway in June 2023 (**Figure-8**). In addition, we share the design survey results in the local elementary school program that has focused on mainly biological surveys to widen their interest. Based on the above, we are planning a social experiment for placemaking to explore new value experiences of waterfront use in 2023.

Through such multifaceted actions, we are attempting to generate new values for the local water system infrastructure. Residents also wish to preserve the historical environment of the Furuoota River, but their first image of the river is stereotypical, such as a masonry revetment, and they tended to rely on the power of the government. But their attitudes are changing gradually through joining our actions. Such a fixed form of preservation of their first image is not necessarily sufficient for the conservation of a sustainable built environment, so we are working together to consider the inheritance of historicity with the creation of new values that will enable management through the continued use of the river referring the former habits.



**Figure-6.** The overview of the target site along the Furuoota River



**Figure-7.** An example of the design survey of ‘kawado’ in the Furuoota River



Figure-8. Discussion on the usage and memories with residents with a large map (June 3, 2023)

## 7. Conclusion and Discussion

Our action research is still in progress, and the results have not yet been confirmed, but a concept of designing the value as a planning process for the sustainable preservation of the built environment and community is shown in **Figure 9**. The word ‘design’ here has a comprehensive meaning not only the physical design of something but also the creation of images and actions in a sequential process of planning and project (Manzini, 2009). Proactive actions sharing a common value by each stakeholder are essential in the process so the communication media should be intuitive and clear rooting the concrete sites. Our visual materials of illustrations and maps are effective in this sense.

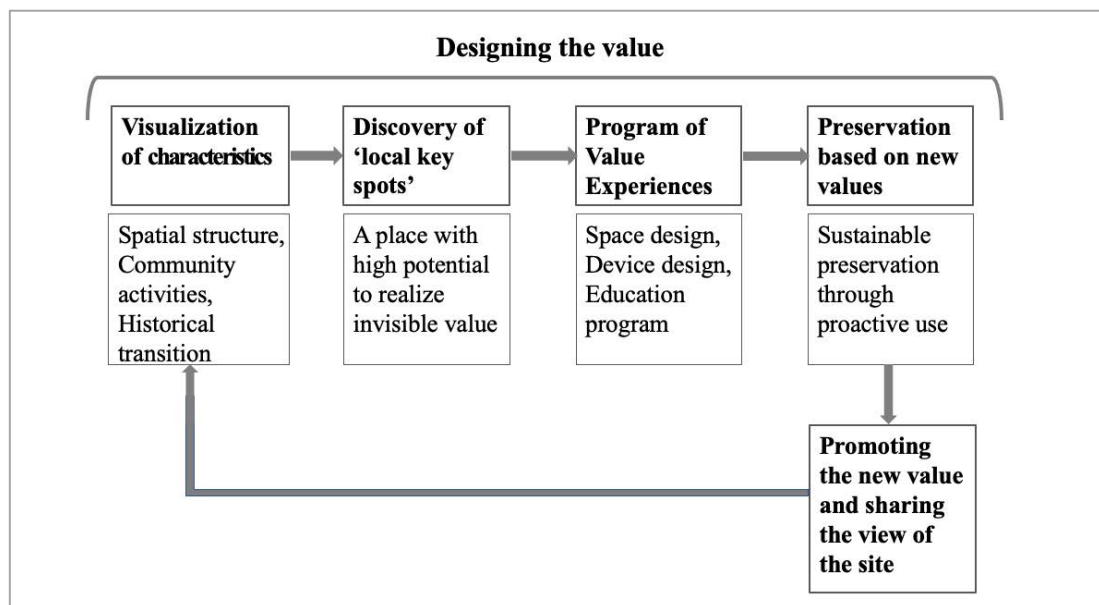


Figure-9. Concept of ‘designing the value’ as a planning process for the sustainable conservation of the built environment and community



Finally, the efficiency of focusing on water infrastructure is mentioned. Water infrastructures are basic and essential infrastructures for people living in the natural environment and make the landscape structure, especially in Asian countries where rice farming is dominant in wet climates (Yokota et al., 2020) (Oda et al., 2022). Consequently, the preservation of the built environment and landscape requires the preservation of the structures and space of water facilities beyond their appearance. At the same time, water infrastructures work as a system and serve as multipurpose that various scale and stakeholder involvement is required. Such nature of water infrastructure makes it an effective object to focus on the sustainable preservation of historic cities in changing social and climate conditions (Xiaodan et al., 2023). We will continue our action research in Echigo Plain and make the results developed design methodology applicable to other types of CbWI.

**Acknowledgment.** This work was supported by JSPS KAKENHI Grant Number 22H03894.

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