THAMMASAT REVIEW
PRINT ISSN: 0859-5747 ONLINE ISSN: 2630-0303
Volume 27 No 2 (July-December) 2024 [Page 431-454]

Toward Resilient-Communities through Machizukuri on Post-Recovery Disasters: An Analysis of the Social-Ecological Actions in Kumamoto, Japan

Reni Juwitasari *, Yuki Miyake, Wanwalee Inpin, Sawang Meesaeng and Maya Dania

School of Social Innovation, Mae Fah Luang University, Thailand

Received 10 June 2024; Received in revised form 27 November 2024
Accepted 3 December 2024; Available online 16 December 2024

Abstract

In this paper, we employ a social-natural capital analytical framework to empirically characterize the socio-ecological actions conducted by the Japanese model of bottom-up governance, *Machizukuri*, in disaster recovery. Taking two case studies of disaster occurrence in Kumamoto Prefecture, a salient agricultural Khusyu area, we analyze the Machizukuri movement for the 2016 earthquake and 2020 devastating flooding in semi-structured interviews with six stakeholders obtained by purposive sampling technique. The results revealed that Machizukuri is an essential grassroots function from “city-making” to “disaster recovery.” In addition, Machizukuri is subsumed into two functional types: a) an institution or soft infrastructure, especially in providing community space, and b) a social and volunteer movement. The case of establishing a short-term project activity to reduce disaster, even a long-term project for climate change impacts. In the short-term project, the activity focuses on immediate disaster response and trauma healing, while in the long-term project, the activity highlights museum construction and local people’s economic revitalization, along with engaging natural capital in rice field terraces conduction for flooding and another cascading disaster, landslide to preserve water quality. Consequently, the more-than-human role has significantly reduced disaster risk and mitigated climate change. However, there remains a vivid gap in the earthquake recovery process in which communications between the local government and residents must reduce the controversies of town planning or design to create sustainable cities.

Keywords

Machizukuri, Resilient-Communities, Social-Natural Capital, Disaster Risk Reduction, Recovery

*** Corresponding author**: reni.juw@mfu.ac.th **DOI**: 10.14456/tureview.2024.30

Introduction

Post-disaster recovery is often overlooked in disaster management despite being essential for long-term restoration and improvement (Moatty & Vinet, 2016). Post-disaster recovery focuses on reshaping the social, economic, physical, and natural environment through pre- and post-disaster efforts (Rouhanizadeh, Kermanshachi, & Nipa, 2020). Effective recovery supports resilience and sustainability as per United Nations Office for Disaster Risk Reduction (UNDRR) objectives, but mismanagement can increase vulnerability and hinder sustainable development (Monteil, Simmons, & Hicks, 2020). Social capital plays a key role in efficient disaster recovery, serving as a foundation for achieving sustainable futures (Taylor, Tharapos, & Sidaway, 2014).

Social capital, particularly community networks, facilitates faster recovery by enabling collective actions based on shared experiences and preparedness (Nakagawa & Shaw, 2004). Social capital fosters trust and participation in recovery efforts, which promotes social learning and adaptability (Cretney & Bond, 2014). Moreover, the practical integration of social capital with natural capital, the stock of locally available natural resources, strengthens resilience by encouraging collective actions that incorporate environmental recovery (Auer et al., 2020). For instance, local communities, as social capital, working in agriculture manifest their investment in natural resources as natural capital, with their connection in governing them, especially soil health, in order to provide both human and biodiversity habitat aiming to ensure the basic needs of a safer place from disaster and climate change (Kenny, 2017). Thus, social capital is essential for fostering resilient, sustainable communities.

Machizukuri (まちづくり) is an informally institutionalized Japanese approach to town or community building requiring dialogue between members of the community and between the community and government, which originated in the 1960s. 'Machizukuri', literally means ‘town making’. Machizukuri initially focused on large-scale, top-down urban development and has evolved into a grassroots movement emphasizing community engagement in planning and decision-making (Kusakabe, 2013; Hein, 2002). This approach shifted after the 1995 Hanshin Awaji Earthquake, when Machizukuri became a model for community-based disaster recovery, emphasizing local participation in rebuilding and resilience (Mavrodieva et al., 2018). It now integrates physical, social, and structural elements to transform vulnerable communities into resilient ones (Okada et al., 2018).

Japan is one of the most disaster-prone countries in the world. It frequently faces earthquakes, tsunamis, and other natural disasters. One example of the impact of such natural disasters is Kumamoto Prefecture, an agricultural hub known for its high-quality groundwater (Morimura et al., 2019). The prefecture was hit by two major earthquakes in April 2016, with magnitudes of 6.5 and 7.3 (Sakai et al., 2018). The region was previously considered low-risk and was less prepared for such disasters (Onuma, Shin & Managi,

2017). Additionally, the Kuma River basin in Kumamoto is highly susceptible to flooding, with the most severe flooding recorded since the 1960s (Ridwan, Homma, & Liu, 2022). Ineffective flood management has led to recurring infrastructural damage and economic losses (Lummen, Nakajo & Yamada, 2014). Despite the previous state of unpreparedness, in Kumamoto Prefecture, local initiatives have proven crucial in accelerating recovery, particularly through temporary housing and agricultural recovery efforts (Tanaka & Itsukushima, 2021; Izumi et al., 2022). Social capital has proven a key resource in transforming vulnerability into resilience during crises.

As previously stated, Machizukuri has become a community movement in Japan, and is found at all levels of Japanese cities, towns, villages, and neighborhoods. As a community-based phenomenon, Machizukuri is manifested and used differently based on the situation and circumstances. This study seeks to investigate the holistic perspective of Machizukuri practices in two case studies of tectonic and climatic disasters in Kumamoto. As Machizukuri is a human-dominated movement, disaster recovery initiatives reflect the social capital function. However, social capital and natural capital cannot be separated for disaster risk reduction and a resilient community. This study addresses the following two primary questions:

1. How is the Machizukuri as social capital function and its relation with natural capital, implemented in case of earthquake and flooding in Kumamoto?

2. To what extent can Machizukuri be successful in building resilient communities in Kumamoto?

Conceptual Framework

Machizukuri and Disaster Recovery

Machizukuri is internationally recognized as a key example of Japan's local governance movement. Initially rooted in the top-down Toshikeikaku or "city-making" concept, Machizukuri has evolved into a community-centered approach, particularly in disaster management. Government resources are often insufficient during crises, and officials tend to overlook the connection between hazard response and community livelihoods (Schneider, 2002; Swaish et al., 2021). Thus, disaster management requires coordinated efforts between the government and local communities.

Machizukuri shifts the decision-making power to local communities, empowering citizens to participate in planning and development (Seadon, Kobayashi, & Maki, 2015). This grassroots approach fosters a sense of ownership and long-term investment in communities (Tagore-Erwin, 2018). Machizukuri also brings together diverse stakeholders—local businesses, tourism associations, universities, and city halls—to promote community revitalization (Bui & Saito, 2022). The approach emphasizes the integration of socio-cultural

and environmental resources, fostering stronger social connections to achieve sustainable community development (Kusakabe, 2013).

In terms of disaster management, Machizukuri balances physical and social aspects, contributing to both disaster risk reduction and community resilience (Okada et al., 2018). It emerged as a significant framework following the 1995 Great Hanshin-Awaji Earthquake, with communities like Mano and Soni showcasing successful, proactive post-disaster recovery through public participation (Nakagawa & Shaw, 2004). This model has further evolved into disaster prevention initiatives, promoting collaboration between municipal governments and local communities under the mantra "Community creation by working together" (Swaish et al., 2021). Machizukuri continues to serve as a powerful example of social capital for disaster recovery and prevention, evolving from "city-making" to "disaster recovery" and ultimately to "disaster prevention."

Despite the success of Machizukuri in Kumamoto, several debates have emerged regarding the sustainability and scalability of such community-driven recovery models. One significant challenge is the reliance on volunteerism and informal networks, which, while effective in the short term, may struggle to maintain momentum over the long term without institutional support (Bennett et al., 2016). Critics argue that although Machizukuri fosters strong community ties, the lack of governmental infrastructure and formal funding mechanisms can leave these initiatives vulnerable, particularly in the face of recurring or more severe disasters. Importantly, the communal rebuilding process encouraged residents to actively participate in reconstructing their environment. Local residents collaborated with authorities to design new evacuation routes, ensuring that the infrastructure was better prepared for future disasters (Saito et al., 2022). This participatory approach was crucial because it fostered a sense of ownership and responsibility among the community members, who felt that their voices were heard and their needs addressed.

In link to debates persist about Machizukuri's scalability and sustainability. Grassroots initiatives, while culturally sensitive and locally effective, often lack the financial and technical support needed for long-term recovery, particularly with slow-onset disasters like climate change (Hein, 2002; Bosman, 2007; Bennett et al., 2016). Additionally, communication gaps between local governments and communities can lead to misaligned priorities, especially after rapid-onset disasters (Saito et al., 2022). Therefore, the balance of power between the government and the local community has significantly urged for a vis-à-vis and mutual understanding.

Socio-Natural Capital for Disaster Risk Reduction

Social-natural capital integrates human (social) and environmental (natural) resources, both crucial for resilience in disaster recovery. Social capital—networks, trust, reciprocity, and cooperation—enables communities to mobilize quickly, relying on mutual aid

and volunteerism to support faster recovery and reduce vulnerability (Aldrich, 2012; Cretney & Bond, 2014). It is a key element in community-based disaster risk reduction (CBDRR), where local knowledge and stakeholder involvement enhance preparedness and recovery efforts (Manyena et al., 2011).

Natural capital includes ecosystems that provide protection, such as forests mitigating landslides and wetlands acting as natural flood buffers (Leslie et al., 2015). In Kumamoto, restoring rice terraces post-disaster not only supported the local economy but also improved water management and ecological resilience, reducing future flood risks (Shirahama et al., 2016). Limited research exists on fully integrating natural capital into recovery frameworks despite the promising outcomes of initiatives like the rice terrace restoration in Kumamoto (Shirahama et al., 2016).

Despite the attention on social capital, the role of natural capital in disaster recovery is underexplored, especially regarding integrating ecosystems into recovery strategies (Skrimizea & Parra, 2019). This gap is critical given the growing impact of climate-related disasters, which require both social and environmental adaptive capacities (Smit & Wandel, 2006).

The Sendai Framework for Disaster Risk Reduction (SFDRR) stresses the need to incorporate both social and natural capital into disaster governance to reduce vulnerability and build resilience (UNISDR, 2015). Japan's Machizukuri model exemplifies this by combining community participation with environmental stewardship, creating holistic recovery strategies that enhance resilience to both immediate and long-term climate risks (Ridwan et al., 2022; Bui & Saito, 2022). This conceptual framework is illustrated in figure 1.

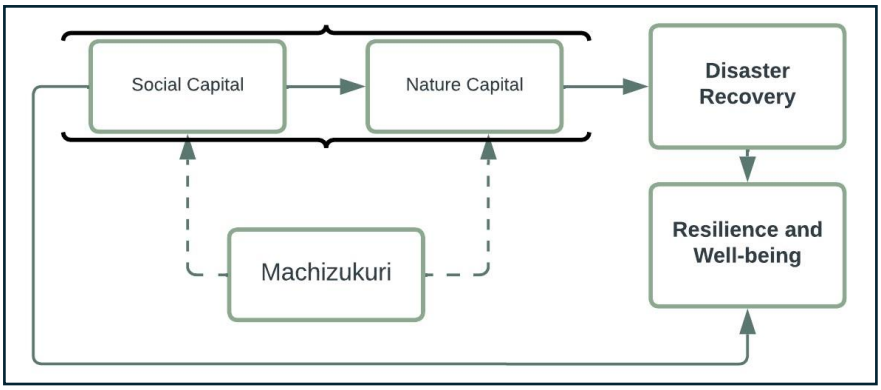

Figure 1 Conceptual Framework

This study's conceptual framework centers on Machizukuri, a community-driven urban planning approach that integrates social-natural capital to enhance disaster recovery. Social capital—community networks, trust, and volunteerism—facilitates rapid disaster response and resource-sharing during crises (Aldrich, 2012), which has become an important

factor of disaster recovery in this study. Similarly, natural capital mitigates disaster risks by improving water management and preventing soil erosion (Saito et al., 2022) also becomes one of the factors in the disaster recovery process in this study. These efforts not only rejuvenated agriculture but also reduced the community's vulnerability to future disasters (Shirahama et al., 2016). While community empowerment drives these initiatives, the framework underscores the need for stronger institutional support to scale and sustain them, especially in the context of climate change (Ridwan et al., 2022). By integrating social and natural capital, Machizukuri supports both immediate recovery and long-term climate change adaptation to enhance resilience and obtain well-being (UNISDR, 2015).

Research Methodology

Research Design

This study adopts a qualitative research design utilizing a multisite case study approach to examine the role of Machizukuri in disaster recovery in Kumamoto Prefecture. By focusing on two distinct disaster events—the 2016 earthquake and the 2020 flooding—the multisite case study design allows for a comparative analysis of how Machizukuri addresses different types of disasters (Yin, 2018). The Kumamoto Prefecture, known for its agricultural landscapes and rural communities, experienced two major disasters that provide a compelling case study for understanding how Machizukuri integrates both social and natural capital in disaster recovery. The 2016 earthquake, which had magnitudes of 6.5 and 7.3, and the 2020 flooding caused by heavy rains highlight how local communities, with minimal external aid, implemented adaptive strategies for both rapid-onset (earthquake) and slow-onset (flooding) disasters.

This comparative analysis allows for a deeper exploration of how Machizukuri adapts to different disaster dynamics, particularly in terms of its use of social capital (e.g., community networks and mutual aid) and natural capital (e.g., environmental restoration efforts such as rice terrace rehabilitation). The multisite design further ensures that the findings are not limited to a single disaster type, thereby offering broader implications for disaster recovery strategies.

Sampling Methods and Participants

To capture the diversity of experiences in the two disaster contexts, purposive sampling was employed to select participants with direct involvement in disaster recovery processes in Kumamoto Prefecture. Purposive sampling is appropriate for qualitative research because it allows for the selection of participants who possess specific expertise, knowledge, or experiences relevant to the research objectives (Etikan, Musa, & Alkassim, 2016). A total of six stakeholders were selected from various sectors to provide a

comprehensive view of the Machizukuri recovery process which are two local government officials involved in disaster recovery planning and policy implementation, two community leaders who played key roles in organizing Machizukuri-based recovery efforts, two representatives from non-governmental organizations (NGOs) who focused on environmental rehabilitation and community empowerment. This diverse group of participants was chosen to ensure that the study captures multiple perspectives on how Machizukuri facilitated the integration of social and natural capital in both rapid and slow-onset disaster recovery.

Data Collection

The primary method of data collection was semi-structured interviews, which provided a flexible yet structured approach to gathering qualitative data while ensuring that specific research themes related to social capital, natural capital, and disaster recovery were consistently explored across all interviews (Kallio et al., 2016). Each interview lasted between 60 and 90 minutes and was conducted either in person or via video conferencing due to logistical constraints caused by the COVID-19 pandemic.

The interview guide was structured around key topics, including 1) community participation in the Machizukuri movement during post-disaster recovery, 2) the role of natural capital, such as the restoration of rice terraces, in post-disaster environmental strategies, 3) stakeholders' perceptions of the effectiveness of institutional support for Machizukuri initiatives, and 4) challenges faced during long-term recovery and climate adaptation efforts in the wake of both disasters. All interviews were conducted in Japanese, and professional interpreters were used when necessary. With participants' consent, the interviews were audio-recorded and later transcribed for analysis.

Data Triangulation and Analysis

To enhance the validity and reliability of the findings, the study employed data triangulation, combining primary data from the semi-structured interviews with secondary sources. These secondary sources included government reports, academic studies, and NGO documentation on the recovery efforts following the Kumamoto earthquake and flooding. Triangulation was used to cross-verify the data obtained from interviews, ensuring that the insights gathered were corroborated by multiple sources (Fusch, Fusch, & Ness, 2018).

The thematic analysis method was used to analyze the interview transcripts. The thematic analysis allows for the identification and interpretation of key themes that emerge from qualitative data, helping to structure the findings in relation to the study's objectives (Braun & Clarke, 2006). During this process, the interview data were coded into themes such as 1) the role of social capital in community mobilization and volunteer efforts, 2) the integration of natural capital into long-term environmental resilience strategies and 3) the

challenges and limitations of institutional support for community-driven recovery. The combination of interview data and secondary sources provided a comprehensive understanding of how Machizukuri facilitated both immediate recovery and long-term resilience-building.

Limitations

While the multisite case study design provides a robust framework for comparative analysis, the study is limited by the relatively small sample size of six participants. Although this sample size offers rich, in-depth qualitative insights, it may not capture the full range of experiences related to Machizukuri across the broader population of Kumamoto Prefecture. Additionally, the reliance on secondary data for triangulation, while enhancing the credibility of the findings, is subject to the quality and availability of the external sources used. Future studies could expand the sample size and incorporate additional stakeholders from other regions to further generalize the findings.

Findings

Contextualizing Machizukuri in Kumamoto

The Machizukuri model in Kumamoto is a distinctive framework that embodies the principle of mutual aid and fosters community engagement. One key informant articulated this approach, noting that Machizukuri has been designed around the concept of "help-to-help each other and get to know each other." The informant explained,

> *"As simple as we live in the social environment, if one neighbor gets sick, the people will help to take care as Japanese society is more individualistic."*

This sentiment underscores how Machizukuri functions as a volunteer-driven movement that fosters social cohesion and creates a strong sense of community, which can be especially crucial during disaster recovery. Through volunteer activities, such as community cleaning, organizing activities for children and the elderly, and supporting neighbors in need, Machizukuri strengthens interpersonal relationships and ensures that community support systems are in place when disasters strike.

This social dimension of Machizukuri is not only limited to volunteerism but also reflects a broader cultural shift within the community. As described by the informant, Machizukuri encourages individuals to move beyond the individualistic tendencies common in contemporary Japanese society, fostering a sense of collective responsibility. By creating spaces for community engagement and interaction, the model helps to bridge social gaps and enables residents to form stronger bonds, which become critical during disaster events when trust and cooperation are essential for effective recovery.

The evolution of Machizukuri in Kumamoto has seen it gradually transition from a purely volunteer-based movement to a model that also supports local government efforts in addressing grassroots problems. One informant elaborated on this shift, noting that

> *"Machizukuri has evolved gradually in Kumamoto, which supports local government Yakuba in tackling grassroots problems, such as the earthquake recovery process."*

By partnering with local governments like the Yakuba, Non-Profit Organizations (NPOs), and other stakeholders, Machizukuri facilitates more structured and coordinated recovery efforts. This partnership allows for greater community input in government-led recovery plans and ensures that local perspectives are integrated into broader policy frameworks. In the aftermath of the 2016 earthquake, for instance, Machizukuri played a pivotal role in ensuring that local needs were addressed in the recovery efforts, highlighting its capacity to bring grassroots voices into institutional processes.

A particularly noteworthy aspect of Machizukuri is its ability to integrate multiple stakeholders into its operations. According to one informant,

> *"Machizukuri, in fact, has integrated many stakeholders, such as local government, higher education institutions, Non-Profit Organizations (NPOs), and other local people."*

This integration of stakeholders is a critical strength of Machizukuri, as it enables a multifaceted approach to disaster recovery and community development. By engaging actors from various sectors—governmental, educational, non-profit, and community-based—Machizukuri fosters collaborative solutions to complex problems.

For example, higher education institutions have contributed expertise in areas such as disaster preparedness and risk assessment, while NPOs have brought valuable experience in community mobilization and resource distribution. This broad-based collaboration ensures that recovery efforts are comprehensive and well-coordinated, addressing both the immediate needs of disaster-affected populations and the long-term sustainability of the community. In addition, Machizukuri also plays a central role in promoting sustainable urban development. One of the informants described such a result:

> *"Machizukuri makes these stakeholders strongly connected to aim for a prosperous and sustainable city. For instance, we promote Kumamoto in the global economic community. Still, within the Kumamoto area, we enhance our strength in maintaining the environment of quality of water and reducing the risk of climate-based disasters, like flooding."*

Promoting Kumamoto on the global economic stage reflects the community's ambition to attract international investment and foster economic growth while simultaneously enhancing local resilience to environmental challenges. The focus on maintaining water quality and mitigating climate-related risks, such as flooding, showcases how Machizukuri integrates disaster risk reduction (DRR) into broader urban planning efforts. By ensuring that natural resources are preserved and managed sustainably, Machizukuri not only helps protect the community from future disasters but also contributes to long-term economic stability.

Machizukuri's Function as Social Capital in Relation to the Earthquake and Flooding Response in Kumamoto

In addition to its institutional role, Machizukuri has proven to be a highly effective social and volunteer movement driven by the collective action of local residents. The findings from this study, particularly through semi-structured interviews with community leaders and NGO representatives, underscore how social capital—comprised of community networks, mutual trust, and the mobilization of volunteer groups—emerged as a central force in the success of Machizukuri during the disaster recovery processes following the 2016 Kumamoto earthquake and 2020 flooding. Machizukuri's social dimension demonstrates how grassroots mobilization can be rapidly deployed to provide immediate relief and recovery support, significantly mitigating the impacts of disasters.

The 2016 Kumamoto earthquake clearly demonstrated the effectiveness of volunteerism as a fundamental component of Machizukuri. In the aftermath of the earthquake, local residents, organized through preexisting community networks, rapidly mobilized to provide immediate relief efforts. This grassroots response was particularly important in the early phases of recovery when government resources were still being deployed. As one community leader noted:

> *"We didn't wait for external help; the community knew what needed to be done and acted immediately. Everyone had a role—whether it was clearing debris or comforting neighbors who had lost their homes.*

One of the most striking findings was the speed and efficiency with which these volunteer efforts were organized. Community leaders emphasized that the presence of strong social ties allowed for rapid coordination, with local groups organizing themselves into teams based on immediate needs. These teams operated not only to address physical damage but also to provide emotional and psychological support to affected families.

The 2020 flooding in Kumamoto further amplified the volunteerism aspect of Machizukuri, showcasing how community mobilization extends beyond immediate relief to

include the restoration of natural capital. Volunteer groups were once again at the forefront, playing a critical role in the rehabilitation of the region's agricultural systems, particularly the rice terraces, which had been severely damaged by floodwaters. Stakeholders, particularly NGO representatives, highlighted how local volunteer groups were crucial in organizing manual labor for terrace reconstruction, contributing significantly to natural flood defenses. By engaging community members in the physical restoration of these natural resources, the Machizukuri movement ensured that disaster recovery efforts were both socially and environmentally sustainable. One NGO representative explained:

> *"The restoration of the rice terraces wasn't just about bringing back agriculture; it was about rebuilding our natural defenses. The community understood this and worked tirelessly to ensure that we would be better prepared for the next flood."*

The strengthening of social capital through these volunteer initiatives also had significant long-term implications. By fostering strong interpersonal relationships and community cohesion, Machizukuri ensured that the community was better prepared for future disasters. The involvement of local residents in both the physical reconstruction and natural capital restoration efforts created a sense of empowerment and self-reliance. This aligns with the concept of community-based disaster risk reduction (CBDRR) (Manyena et al., 2011), where resilience is built from the ground up through the proactive involvement of the local population in disaster preparedness and recovery efforts. As one community leader explained:

> *"The spirit of volunteerism is embedded in our recovery process. Each time a disaster happens, we learn more about how to organize ourselves, how to protect each other, and how to recover faster. This knowledge is passed down from generation to generation."*

In addition, one of the significant findings of this study is how Machizukuri's social and volunteer movement proved adaptable to both rapid-onset disasters (such as earthquakes) and slow-onset disasters (such as flooding). The ability to leverage social networks and local resources allowed the community to effectively respond to both types of disasters, albeit in different ways.

The findings demonstrate that Machizukuri, as a social and volunteer movement, is deeply rooted in the collective action and social capital of local residents. The movement's ability to mobilize volunteer groups, foster mutual trust, and engage the community in both immediate and long-term recovery efforts was key to its success in both the 2016 earthquake for disaster relief and the 2020 flooding managing natural capital. By focusing on social cohesion, volunteerism, and the restoration of natural capital, Machizukuri has not only

facilitated effective disaster recovery but also laid the groundwork for long-term resilience and environmental sustainability. The adaptability of Machizukuri to different types of disasters further underscores its role as a flexible, community-driven model for disaster recovery, capable of addressing both immediate relief and future risk reduction.

Machizukuri in Building Resilient Community in Kumamoto

According to the document of Kumamoto Four-Year Recovery and Reconstruction Strategy from Kumamoto Prefecture in 2020, Machizukuri has manifested in the Town Development support system. Machizukuri has a role as a critical institutional framework that provides essential soft infrastructure for both city-making and disaster recovery, which is established in the two basic goals of Kumamoto Recovery and Reconstruction Strategy, as follows: 1) creating a disaster-resistant Kumamoto where the people can continue to live in conditions of stability, with aspirations and self-confidence, and 2) revitalization and development of enduring and sustainable industries that support Kumamoto and the creation of attractive employment. This recovery and reconstruction strategy involves thirteen measurements, which defines Machizukuri in this context. Measurement number 1, “creates a community where family and local community pillars thrive; measurement number 2, “creates a safe and secure living and learning environment,” and measurement number 5, “creates bases, towns, and tourist areas to be the most characteristic area in the region.”

The "soft infrastructure" in Kumamoto refers not just to the physical spaces themselves—such as community halls, evacuation centers, and other shared communal areas—but also to the intangible aspects of community engagement, education, and social cohesion that these spaces facilitate. This infrastructure was observed to be particularly vital in the context of disaster preparedness and response. As one government official explained:

> *"These spaces are not just physical structures; they are the heart of the community during crises. They provide a place for people to come together, receive support, and plan for the future."*

Beyond the immediate recovery period, these community spaces also served as platforms for disaster education and preparedness activities. Several interview participants emphasized the role of regular disaster education programs hosted in these centers, which were designed to equip the community with knowledge about future risks, such as earthquakes, floods, and landslides. These education programs ranged from drills and simulations for residents to more structured educational efforts aimed at schoolchildren. In particular, the construction of a local disaster museum emerged as a noteworthy initiative that serves both educational and economic functions. One community leader highlighted how this museum provides educational content on disaster history, offering lessons from past events like the Great Hanshin Earthquake and more recent local disasters.

Additionally, the results show that these community spaces were key to hosting multi-generational engagement activities, where the knowledge of older generations was passed down to younger generations, further strengthening the community's collective capacity for disaster risk reduction (DRR). One community leader explained:

> *"The disaster museum and education programs ensure that younger generations do not forget the lessons from past disasters. We use these spaces to keep our history alive and make sure we are always prepared for what comes next."*

Similarly, Machizukuri's soft infrastructure was predominantly focused on disaster preparedness and played a role in long-term climate adaptation strategies. Several interviewees mentioned that local government support was instrumental in turning these spaces into hubs for environmental education and sustainability efforts. For instance, community workshops on flood risk management and natural capital restoration were held in these centers. This reflects Machizukuri's holistic approach to not only preparing for acute disasters like earthquakes but also addressing slow-onset disasters linked to climate change, such as increased flooding and landslides.

> *"In terms of flooding, the local government has displayed flooding level measurements to remind how high flooding was. In addition, the local government aligned with private sectors together disseminate the workshop on flooding risk management including empowering local people's knowledge on natural resources management".*

The results of this study affirm that Machizukuri, in its capacity as an institutional framework that provides essential soft infrastructure, is a critical driver of both disaster recovery and long-term resilience. The dual functionality of community spaces—offering both immediate post-disaster relief and long-term educational programming—positions Machizukuri as an effective model for integrating social cohesion, education, and economic revitalization into disaster recovery efforts. These community hubs, which serve as platforms for trauma healing, disaster preparedness, and climate adaptation, ensure that resilience-building is an ongoing process rather than a temporary response to disaster events. Through its institutionalized approach, Machizukuri lays a strong foundation for creating sustainable, disaster-prepared communities that can adapt to future risks.

Discussion

Machizukuri as A Mechanism: Institutional vs Volunteer Movement

The concept of Machizukuri, which translates to community-driven town planning, plays a pivotal role in advancing sustainable urban development and enhancing disaster resilience. Central to Machizukuri is the integration of grassroots participation with

institutional support, empowering communities to shape their environments actively. However, challenges arise when institutional frameworks fail to deliver timely and sufficient support to complement community-led efforts. The research underscores Machizukuri's strength in mobilizing local knowledge, building social capital, and improving disaster preparedness, particularly in response to rapid-onset events such as earthquakes (Evans et al., 2020). For example, the Kumamoto Recovery and Reconstruction Strategy (2020) highlights the effective application of Machizukuri principles, where community insights significantly informed and enhanced earthquake recovery planning. Despite these successes, the effectiveness of such initiatives often hinges on robust institutional mechanisms that address gaps in resource allocation, technical expertise, and policy alignment (Okada & Asano, 2019).

The interplay between institutional mechanisms and volunteer movements within the Machizukuri framework highlights the critical need for a bottom-up approach that prioritizes community input and allows for adaptive planning. Institutional mechanisms should actively support the foundational principles of Machizukuri, including community empowerment, environmental stewardship, and resilience-building, by fostering policy environments that enable local action and collaborative efforts. When local governments and communities fail to coordinate effectively, disaster recovery efforts can be delayed, and long-term sustainability goals compromised, especially in addressing climate change and related environmental challenges (Shaw & Izumi, 2014).

Volunteer movements, characterized by grassroots activism and collective community action, often act as drivers of resilience by cultivating local ownership and fostering adaptability. These movements provide cultural sensitivity and context-specific knowledge that enhance disaster recovery and urban planning efforts. However, their impact can be limited without institutional support to expand their reach and ensure alignment with broader sustainability objectives (Yoshihara & Tanaka, 2015). Collaborative efforts between volunteer initiatives and government institutions are essential for improving the efficiency and effectiveness of disaster recovery processes. Such partnerships also strengthen the adaptive capacity of communities, enabling them to tackle the long-term risks associated with climate change and urbanization more effectively.

However, in terms of institutional mechanisms, the communication gaps between local communities and government agencies were particularly evident in the approval of long-term environmental initiatives. Although Machizukuri facilitated volunteer-led efforts to restore natural ecosystems, these projects were often underfunded or lacked the necessary technical expertise due to the absence of institutional support. This mismatch between community-driven initiatives and governmental planning frameworks underscores the need for a more integrated approach that bridges local knowledge with institutional mechanisms.

The misalignment between local recovery efforts and governmental frameworks also reflects broader challenges in the town planning and design process. While Machizukuri emphasizes community-led planning and local decision-making, governmental planning often relies on top-down approaches that do not always align with the needs or priorities of the local communities. This misalignment creates controversies and tensions, particularly in the reconstruction of infrastructure and long-term environmental projects, which require coordination between multiple stakeholders, including government agencies, NGOs, and community members.

To address these controversies, the study suggests that reforms in town planning are needed to enhance communication channels and promote collaboration between local communities and government authorities. By integrating local knowledge of residents into governmental policies and ensuring that recovery strategies are flexible enough to accommodate community input, the recovery process can become more cohesive and efficient. The primary challenges to practical integration lie in coordinating recovery efforts across multiple stakeholders, leading to delays in large-scale projects that require infrastructure rebuilding or environmental compliance.

Machizukuri as Temporal Action: Short-term vs. Long-term Activity

While Machizukuri's short-term activities focus on immediate post-disaster recovery, for instance, trauma healing, its long-term initiatives emphasize disaster awareness, education, and economic revitalization, which are crucial for building sustainable resilience. By focusing on these areas, Machizukuri aims to instill a culture of disaster resilience that goes beyond reactive measures and equips communities to prepare for future challenges proactively. The incorporation of disaster education and the engagement of local institutions, including schools, are key aspects of this long-term strategy. For instance, in Koshi City, Kumamoto Prefecture, evacuation drill training has become a regular program held in Schools that collaborated with disaster prevention department from municipality. This ensures that the community develops a deep understanding of the long-term risks associated with disasters such as earthquakes, floods, and landslides.

Short-term response activities facilitated by Machizukuri provides immediate relief. For instance, the volunteers who assist in the disaster evacuation process alongside government officials. Local people took responsibility for several tasks, such as arranging the shelter and helping with food production in the public kitchen and providing toilet facilities as one of the government official informants mentioned.

In addition, the trauma healing workshops organized by Machizukuri were instrumental in helping affected families process their emotional trauma. These workshops offered mental health support by creating safe spaces where community members could

share their experiences and begin the healing process collectively. One of the key informants noted,

> *"These workshops were not only about psychological recovery; they were about rebuilding our sense of community solidarity in a time of immense distress."*

This approach aligns with findings in disaster psychology that emphasize the importance of collective trauma processing in post-disaster recovery. Research suggests that community-based mental health interventions can significantly improve psychological well-being and reduce the long-term effects of post-traumatic stress disorder (PTSD) in disaster survivors (Pfefferbaum et al., 2014). By focusing on group-based healing, Machizukuri created a platform for residents to re-establish trust and emotional connections, which were vital for the community's overall resilience to future stressors.

One of the consistent core long-term objectives of Machizukuri is to foster disaster awareness and education throughout the community, making disaster preparedness a part of daily life. The integration of disaster education into schools and educational institutions ensures that residents, from a young age, develop the knowledge and skills necessary to respond effectively to future disasters. According to Shaw et al. (2011), the inclusion of disaster education in school curricula is essential for building long-term community resilience, as it instills a disaster-prepared mindset and ensures that younger generations are well-equipped to handle future risks.

By engaging residents in disaster awareness programs, Machizukuri not only addresses the immediate needs of disaster recovery but also emphasizes the importance of long-term planning. These programs focus on educating the public about risk assessment, disaster mitigation, and environmental conservation, ensuring that communities are prepared for future disasters while also contributing to climate change adaptation. As one informant explained,

> *"Disaster education isn't just about teaching people how to respond in the moment; it's about embedding an understanding of disaster risk into everyday decision-making."*

A key example of Machizukuri's long-term strategy is its use of rice field terraces as both a disaster risk reduction measure and a tool for economic revitalization. Rice terraces serve multiple critical functions: they support agricultural recovery, act as natural flood defenses, and help reduce the risk of landslides and other cascading disasters (Yamada et al., 2011). According to Saito et al. (2022), terraced landscapes are highly effective at mitigating flood risks because they slow down water runoff and allow for better water absorption, thereby reducing the likelihood of downstream flooding and soil erosion. By

maintaining and restoring these terraces, Machizukuri not only promotes food security and agricultural productivity but also ensures that the community benefits from the ecosystem services these landscapes provide. One informant emphasized the importance of these long-term efforts, stating,

> *"Maintaining the rice terraces is not just about agriculture—it's about ensuring that our community has the natural defenses we need to withstand floods and landslides."*

The long-term sustainability of the community depends on this balance between economic activities and environmental stewardship. As noted by Cohen-Shacham et al. (2016), the effective management of natural resources is essential for ensuring that economic recovery is not only swift but also sustainable in the long term. Machizukuri's focus on natural capital highlights the role of ecosystems in supporting both economic development and disaster risk reduction. For example, the terraces' dual purpose—supporting agricultural production while simultaneously mitigating flood risks—demonstrates how natural infrastructure can serve as a sustainable economic asset.

Machizukuri's long-term focus on preserving natural infrastructure like rice terraces also contributes significantly to climate change adaptation. By protecting and restoring natural defenses, Machizukuri helps the community adapt to increasingly erratic weather patterns and climate-related disasters such as floods and landslides. According to the UN's Intergovernmental Panel on Climate Change (IPCC) (2019), integrating nature-based solutions into disaster risk management and climate change adaptation strategies is crucial for reducing vulnerabilities in disaster-prone regions.

By maintaining natural infrastructure, Machizukuri not only addresses the immediate risks posed by disasters but also ensures that the community is better equipped to adapt to long-term environmental changes. The terraces serve as a nature-based solution for flood risk reduction, while their role in preserving water quality contributes to broader environmental sustainability efforts. These initiatives reflect a proactive approach to disaster risk reduction that aligns with global trends in ecosystem-based disaster risk reduction (Eco-DRR) and climate resilience (Saito et al., 2022).

The More-Than-Human Role in Disaster Risk Reduction and Sustainable Development Goals

A key strength of the Machizukuri model in disaster recovery lies in its incorporation of natural capital and its engagement with the more-than-human theoretical concept: the human interconnection with natural systems. Likewise, Barrett et al. (2016) mentioned that more-than-human or non-human and nature interchangeably designate the non-human entities with whom humans are always in relation. For instance, people recognize nature as

an active agency for disaster risk reduction (Barrett et.al., 2016). This approach is particularly evident in the restoration of rice terraces, water management systems, and natural flood defenses, which played a vital role in both immediate recovery and long-term climate change mitigation. The integration of natural resources within the Machizukuri framework represents a proactive, ecosystem-based disaster risk reduction (Eco-DRR) approach, aligning with global trends emphasizing nature-based solutions for mitigating climate-related risks (Saito et al., 2022).

In detail, the restoration of rice terraces following the 2020 flooding in Kumamoto is an excellent example of how Machizukuri's community-led initiatives focused on ecosystem restoration, not only supported agricultural recovery but also provided natural flood defenses. These terraces, which help regulate water flow and prevent landslides, function as a critical element in the region's broader climate adaptation strategies. By reducing the risk of cascading disasters, such as landslides that often follow heavy rains or flooding, the restoration of these natural systems plays a key role in building resilience to future disasters.

The use of natural ecosystems within the Machizukuri model (with stronger bonds among community members) reflects a broader understanding of Eco-DRR, where communities work with the environment to mitigate disaster risks. The restoration of wetlands, forest cover, and natural water retention systems following disasters aligns with international frameworks like the Sendai Framework for Disaster Risk Reduction (UNISDR, 2015), which calls for the integration of ecosystem services into disaster risk management strategies. This proactive engagement with natural systems allows communities to address both short-term recovery needs and long-term environmental sustainability. As mentioned above, as a concluding result, the restoration of natural capital not only reduces disaster risks but also helps sustain local livelihoods, particularly in agriculture-dependent communities.

In addition, Machizukuri contributes to the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), and SDG 11 (Sustainable Cities and Communities).

Machizukuri contributes to SDG 3 through its emphasis on mental health and community well-being after disasters. Trauma healing workshops offer psychological support, helping communities recover emotionally from disasters. As key informants noted, these workshops promote community solidarity and reduce stress. Disaster preparedness drills also protect physical health by ensuring that residents are ready for future disasters, reducing the risk of injury and death (Pfefferbaum et al., 2014).

Machizukuri's long-term activities in natural infrastructure restoration directly support SDG 6. Rice terraces used for flood defense not only protect against landslides but also help preserve water quality by preventing erosion and filtering water. These terraces ensure clean

water access for agriculture and domestic use, aligning with SDG 6's goal of sustainable water management (Saito et al., 2022).

Machizukuri is closely aligned with SDG 11, which focuses on creating inclusive, safe, and resilient cities. For rapid-onset disasters like earthquakes, institutional Machizukuri helps rebuild critical infrastructure such as roads and bridges, ensuring resilient urban systems. For slow-onset disasters like climate change and flooding, the volunteer movement promotes environmental conservation and natural capital management, which reduces disaster risks and ensures sustainable urban growth. These efforts contribute to inclusive urban planning and help protect communities from future disasters (Coppola, 2015).

Conclusion and Recommendations

This study has demonstrated how Machizukuri—as both an institutional framework for rapid-onset disaster recovery and as a social and volunteer movement for slow-onset disasters—plays a vital role in disaster recovery and community resilience-building in Kumamoto. By integrating social capital, natural capital, and stakeholder collaboration, Machizukuri effectively addresses both short-term disaster impacts and long-term sustainability challenges. Through activities such as trauma healing, disaster preparedness drills, and the restoration of rice field terraces, Machizukuri not only enhances the community's ability to recover from rapid-onset disasters like earthquakes but also contributes to climate change adaptation and disaster risk reduction in the face of slow-onset disasters such as flooding and environmental degradation.

The results of this study highlight Machizukuri's alignment with several Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), and SDG 11 (Sustainable Cities and Communities). In the context of SDG 3, Machizukuri's efforts in mental health support and community well-being post-disaster have been crucial in addressing psychosocial needs. For SDG 6, the preservation and management of water resources through natural infrastructure like rice terraces demonstrates a proactive approach to sustainable water management. Finally, Machizukuri's contribution to SDG 11 is evident in its focus on resilient urban planning, environmental stewardship, and inclusive community engagement in disaster recovery efforts.

In conclusion, Machizukuri offers a comprehensive and sustainable model for disaster recovery, urban resilience, and community engagement. By continuing to strengthen stakeholder collaboration, expanding disaster education, and promoting environmental conservation, Machizukuri can serve as a global example of how local initiatives can contribute to building resilient, inclusive, and sustainable cities.

The are several recommendations from this study, as follows;

1. The study identified communication gaps between local communities and government agencies during the disaster recovery process. To overcome these barriers, governments should prioritize creating inclusive platforms that allow for participatory decision-making. This will help align community-led initiatives with top-down recovery policies, ensuring that recovery efforts are both effective and sustainable

2. Machizukuri's natural capital management, particularly the maintenance of rice terraces and water resources, plays a critical role in disaster risk reduction. There should be an increased focus on ecosystem-based disaster risk reduction (Eco-DRR) strategies, with additional institutional support to scale up these initiatives. Governments and local agencies should provide more funding and technical assistance to ensure the sustainability of these projects, particularly in the face of climate change.

3. Disaster education's role in creating a culture of resilience should be expanded to reach more schools, businesses, and local organizations. By embedding disaster awareness and preparedness into daily life, the community will be better equipped to respond to future disasters and adapt to climate-related risks.

Acknowledgment

This research is funded by the Sumitomo Foundation under Grant for Japan-related Research Project 2021, Reg. No. 21802018.

References

Aldrich, D. P. (2012). *Building resilience: Social capital in post-disaster recovery*. University of Chicago Press.

Auer, M. R., Twigg, J., Welle, T., Frankenberger, T., & Mock, M. (2020). Collective action and natural capital in disaster recovery. *Journal of Environmental Management*, 274, 111205. https://doi.org/10.1016/j.jenvman.2020.111205

Barrett, M. J., Harmin, M., Maracle, B., Patterson, M., Thomson, C., Flowers, M., & Bors, K. (2017). Shifting relations with the more-than-human: Six threshold concepts for transformative sustainability learning. *Environmental Education Research*, 23(1), 131-143.https://doi.org/10.1080/13504622.2015.1121378

Bennett, N. J., et al. (2016). Environmental stewardship: A conceptual review and analytical framework. *Environmental Management*, 58(1), 32-49. https://doi.org/10.1007/s00267-016-0704-3

Bosman, M. M. (2007). Grassroots initiatives in disaster recovery: Local perspectives on resilience. *Journal of Disaster Risk Reduction*, 4(3), 229-239. https://doi.org/10.1016/j.ijdrr.2007.07.004

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Bui, T., & Saito, Y. (2022). Machizukuri as a community-based disaster recovery framework. *Journal of Disaster Research*, 17(2), 123-132. https://doi.org/10.20965/jdr.2022.p0123

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (2016). Nature-based solutions to address global societal challenges. IUCN. https://doi.org/10.2305/IUCN.CH.2016.13.en

Coppola, D. P. (2015). Introduction to international disaster management. Elsevier.

Cretney, R. M., & Bond, S. (2014). 'Bouncing back' to capitalism? Grassroots autonomous activism in shaping discourses of resilience and transformation following disaster. *Resilience: International Policies, Practices and Discourses*, 2(1), 18-31. https://doi.org/10.1080/21693293.2013.872449

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11

Evans, P., Okada, A., & Shaw, R. (2020). *Community-based disaster resilience: Theory and practice in urban planning*. Springer.

Fusch, P. I., Fusch, G. E., & Ness, L. R. (2018). Denzin's paradigm shift: Revisiting triangulation in qualitative research. *Journal of Social Change*, 10(1), 19-32. https://doi.org/10.5590/JOSC.2018.10.1.02

Hein, C. (2002). Toshikeikaku and machizukuri in Japanese urban planning: the reconstruction of inner-city neighborhoods in Kōbe. *Japanstudien*, 13(1), 221-252.https://doi.org/10.1080/09386491.2002.11826881

IPCC. (2019). Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Intergovernmental Panel on Climate Change. https://www.ipcc.ch/srccl/

Izumi, T., Toyoda, Y., & Shimizu, M. (2022). Local communities' role in disaster recovery: Lessons from Japan. *Disaster Prevention and Management*, 31(4), 521-535. https://doi.org/10.1108/DPM-02-2022-0021

Kallio, H., et al. (2016). Systematic Methodological Review: Developing a Framework for a Qualitative Semi-Structured Interview Guide. *Journal of Advanced Nursing*, 72(12), 2954-2965.

Kenny, D. C. (2017). Modeling of natural and social capital on farms: Toward useable integration. *Ecological Modelling,* 356, 1-13. https://doi.org/10.1016/j.ecolmodel.2017.04.010

Kumamoto Prefecture. (2020). *Kumamoto Recovery and Reconstruction Strategy*. https://www.pref.kumamoto.jp/uploaded/attachment/113493.pdf

Kusakabe, E. (2013). Advancing sustainable development at the local level: The case of machizukuri in Japanese cities. *Progress in Planning*, 80, 1-65. https://doi.org/10.1016/j.progress.2013.02.003

Leslie, H. M., et al. (2015). Natural defenses in disaster risk reduction. *Ecological Applications*, 25(4), 971-987. https://doi.org/10.1890/14-0448.1

Lummen, N., Nakajo, M., & Yamada, H. (2014). Flood risk management strategies and challenges in Japan. *International Journal of Disaster Risk Reduction*, 8, 44-52. https://doi.org/10.1016/j.ijdrr.2014.01.003

Manyena, S. B., O'Brien, G., O'Keefe, P., & Rose, J. (2011). Disaster resilience: A critical review of definitions and implications. *Progress in Development Studies*, 11(3), 252-263. https://doi.org/10.1177/146499341001100303

Mavrodieva, A. V., Shaw, R., & Begum, R. A. (2018). Machizukuri and community resilience: Lessons from Japan. *Sustainability*, 10(9), 3081. https://doi.org/10.3390/su10093081

Moatty, A., & Vinet, F. (2016). Post-disaster recovery as a long-term process: Case studies in the French Alps. *Natural Hazards*, 84(3), 2113-2130. https://doi.org/10.1007/s11069-016-2538-9

Monteil, C., Simmons, P., & Hicks, D. (2020). Disaster recovery and the UNDRR framework. *International Journal of Disaster Risk Reduction*, 42, 101359. https://doi.org/10.1016/j.ijdrr.2019.101359Tayu

Morimura, N., Kido, M., & Ono, Y. (2019). Groundwater and water quality in Kumamoto Prefecture. *Water Resources Research*, 55(4), 3811-3825. https://doi.org/10.1029/2018WR024008

Nakagawa, Y., & Shaw, R. (2004). Social capital: A missing link to disaster recovery. *International Journal of Mass Emergencies & Disasters*, 22(1), 5-34.

Okada, N., & Asano, Y. (2019). Urban resilience and Machizukuri: Bridging local action and institutional frameworks. *Journal of Disaster Risk Reduction*, 12(4), 112-123.

Okada, N., Ye, Q., & Fang, L. (2018). Machizukuri and community resilience to disasters. *Journal of Disaster Research*, 13(3), 470-482. https://doi.org/10.20965/jdr.2018.p0470

Onuma, H., Shin, K. J., & Managi, S. (2017). Risk perception and social preparedness in Japan: Lessons from the Kumamoto earthquake. *Natural Hazards*, 88(2), 1397-1412. https://doi.org/10.1007/s11069-017-2915-0

Pfefferbaum, B., Nitiéma, P., Pfefferbaum, R. L., Houston, J. B., & Van Horn, R. L. (2014). Building resilience to mass trauma events. In S. N. Gold & T. M. Keane (Eds.), *The Wiley Handbook of trauma psychology: Trauma Practice* (pp. 481-492). John Wiley & Sons, Inc. https://doi.org/10.1002/9781118596854.wabt119

Ridwan, A. S. S., Homma, R., & Liu, H. (2022, February). Factor Affecting and Damage Mapping of Flood Inundation in Japan: A Case Study of Hitoyoshi City, Kumamoto

Prefecture, Japan. In IOP Conference Series: *Earth and Environmental Science* (Vol. 989, No. 1, p. 012032). IOP Publishing. doi:10.1088/1755-1315/989/1/012032

Rouhanizadeh, B., Kermanshachi, S., & Nipa, T. J. (2020). Long-term post-disaster recovery: Challenges and opportunities. *Journal of Infrastructure Systems*, 26(1), 04020003. https://doi.org/10.1061/(ASCE)IS.1943-555X.0000541

Saito, H., et al. (2022). Rice terrace restoration and disaster risk reduction. *Ecological Restoration Journal*, 44(3), 321-335. https://doi.org/10.3368/er.44.3.321

Sakai, S., Shimada, T., & Hashimoto, M. (2018). The 2016 Kumamoto earthquake: Analysis of ground motion and seismic impact. *Earthquake Engineering and Structural Dynamics*, 47(4), 913-930. https://doi.org/10.1002/eqe.2995

Schneider, R. O. (2002). Hazard response and community livelihood: Disconnect in disaster management. *Disaster Prevention and Management*, 11(1), 60-67. https://doi.org/10.1108/09653560210421629

Seadon, J. K., Kobayashi, M., & Maki, N. (2015). Community engagement in Japan: The role of Machizukuri in disaster preparedness. *Disaster Prevention and Management*, 24(4), 409-423. https://doi.org/10.1108/DPM-01-2015-0020

Shaw, R., & Izumi, T. (2014). Roles of institutions in building community resilience to disasters: Perspectives from Asia. *International Journal of Disaster Risk Reduction*, 10, 1-9.

Shaw, R., Takeuchi, Y., Gwee, Q., & Shiwaku, K. (2011). Disaster education: An introduction. *Community, Environment and Disaster Risk Management*, 7, 1-22. https://doi.org/10.1108/S2040-7262(2011)0000007004

Shirahama, Y., et al. (2016). Characteristics of the surface ruptures associated with the 2016 Kumamoto earthquake sequence, central Kyushu, Japan. *Earth Planets Space*, 68, 191. https://doi.org/10.1186/s40623-016-0559-1

Skrimizea, E., & Parra, C. (2019). Integrating natural capital into disaster recovery: Gaps and opportunities. *Journal of Environmental Planning and Management*, 62(4), 651-668. https://doi.org/10.1080/09640568.2018.1459492

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity, and vulnerability. *Global Environmental Change*, 16(3), 282-292. https://doi.org/10.1016/j.gloenvcha.2006.03.008

Swaish, P., Tanaka, T., & Hiyama, T. (2021). Community-based disaster risk reduction and Machizukuri in post-Kobe earthquake Japan. *Journal of Urban Planning and Development*, 147(1), 04020052. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000648

Tagore-Erwin, P. (2018). Civic engagement and community participation in Japan: The case of Machizukuri. *Japanese Journal of Political Science*, 19(2), 245-263. https://doi.org/10.1017/S1468109918000082

Tanaka, S., & Itsukushima, T. (2021). Local actions in disaster recovery: Insights from Kumamoto. *Journal of Disaster Research*, 16(5), 859-868. https://doi.org/10.20965/jdr.2021.p0859

Taylor, D., Tharapos, M., & Sidaway, S. (2014). Downward accountability for a natural disaster recovery effort: Evidence and issues from Australia's Black Saturday. *Critical perspectives on accounting*, 25(7), 633-651.https://doi.org/10.1016/j.cpa.2013.01.003

UNISDR. (2015). *Sendai Framework for Disaster Risk Reduction 2015-2030*. United Nations. https://doi.org/10.18356/40b5557e-en

Yamada, F., Kakimoto, R., Yamamoto, M., Fujimi, T., & Tanaka, N. (2011). Implementation of community flood risk communication in Kumamoto, Japan. *Journal of Advanced Transportation*, 45(2), 117-128. https://doi.org/10.1002/atr.137

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE Publications.

Yoshihara, T., & Tanaka, S. (2015). Volunteerism and governance in Machizukuri: Lessons from Japan. *Asian Journal of Urban Planning*, 8(2), 44-61.