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Flood-Related Land Use Control in Japan: Reverse Zoning, Location Optimization Plan and Basin Flood Control

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ABSTRACT

In response to ever increasing hydro-meteorological risks, land use control has become indispensable for flood-related disaster risk reduction in urbanized parts of Japan. This study examines three major policy instruments: Reverse Zoning, Location Optimization Plans (LOP), and Basin Flood Control, and analyses the conditions under which they can function in synergy. Employing comparative case analysis, this research investigates reverse zoning in Kitakyushu City and Hiroshima Prefecture, LOP implementation in Toyama City and Hanamaki City, and the institutional framework of the 2021 Basin Flood Control-related Act. The findings reveal that while each policy addresses a distinct aspect of exposure control, spatial efficiency, and systemic coordination, their effectiveness is limited when implemented in isolation. The study underscores the importance of transdisciplinary approach (TDA), formalized through the River Basin Flood Risk Reduction Councils mandated by the Basin Flood Control-related Act, which enables collaboration among diverse stakeholders in developing and implementing flood risk management strategies. Especially, the integration of land use control for exposure reduction with infrastructure development and enhancing societal resilience is important for a comprehensive approach to disaster resilience. In conclusion, the coordinated implementation of reverse zoning, LOPs, and basin flood control under TDA is vital for building a resilient and sustainable urban environment. Ongoing collaboration and community engagement will be crucial for the success of these reforms in the face of increasing hydro-meteorological risks.

KEYWORDS: flood-related disasters, reverse zoning, location optimization plan, basin flood control, transdisciplinary approach (TDA)

1 INTRODUCTION

Since around the turn of the millennium, the impacts of climate change have become increasingly severe, with flood-related disasters occurring almost annually in Japan. Notable events include the 2004 season with over ten typhoons making landfall (Web-1), the 2014 August linear rain band (Web-2), the 2018 July Heavy Rains (Web-3), and the 2019 Super Typhoon Hagibis (Web-4). These events have highlighted the urgent need for proactive disaster risk reduction strategies, particularly in the realm of land use control.

A striking observation is that in many prefectures the population growth continues in flood-prone areas while their overall population declines. According to Nozawa et al. (2023), in urban planning area designated by prefectural governors by City Planning Act of 1968, the total population decreased by 719,000 in between 2010-2020 which was after Japanese total population peak out in 2008, while the total population in over 3m inundation risk areas designated by 2022 hazard maps increased by 289,000. According to Ministry of Finance material (Web-5), in 36 prefectures out of 47 prefectures in total, the total population decreased in between 1995 and 2015, among which 22 prefectures experienced an increase in residents living within flood inundation risk areas designated by 2012 hazard maps. Even in prefectures where both the total population and the population in risk areas decrease, the decline is less in

risk areas in percentage wise. Likewise, even where both increase, the increase is more in risk areas in percentage wise. These paradoxes are driven by two main factors: land price is lower in high-risk areas, and more people want to buy. The other is that local governments are reluctant to restrict development in risk areas due to concerns over depopulation and economic decline.

This situation exemplifies the difficulty of implementing effective land use regulation in democratic societies. While earlier efforts, such as the City Planning Act and compact city initiatives, aimed to guide urban development, their impact on disaster risk reduction has been limited. In response, Japan introduced a new policy framework in 2021: River Basin Disaster Resilience and Sustainability by All, commonly known as the Basin Flood Control policy.

This paper examines three key land use policies: reverse zoning, location optimization plans (LOPs), and basin flood control, and analyses the conditions under which they can function synergistically. The central hypothesis is that a Transdisciplinary Approach (TDA), involving collaboration across sectors and disciplines, is essential for the successful integration and implementation of these policies (Takeuchi et al., 2024).

2 METHOD

To identify the key factors for successful land use control in flood-prone areas, this study employs a comparative case analysis of three major policy instruments: reverse zoning, LOPs, and basin flood control. Case studies were selected based on differences in policy approach and the transferability of their experiences to other cities.

First, two cases of reverse zoning are examined: Kitakyushu City and Hiroshima Prefecture. These cases provide insights into the political, social, and administrative approaches of rezoning inhabited areas especially with respect to residents at sites.

Second, the study analyses LOP implementation in Toyama and Hanamaki Cities. These cases are selected for their contrasting approaches to compact city development and stakeholder engagement. The analysis focuses on their transit corridors as essential necessity, effectiveness of designating Residential Induction Areas (RIAs) and Urban Function Induction Areas (UFIAs), and the role of intersectoral collaboration.

Finally, the Basin Flood Control policy is assessed in terms of its institutional design and capacity to integrate the lessons learned from reverse zoning and LOPs. Particular attention is given to the role of River Basin Flood Risk Reduction Councils in facilitating TDA.

The findings from these cases are synthesized to evaluate the extent to which the three policies align with the principles of TDA and contribute to a coherent, resilient land use strategy.

3 REVERSE ZONING

"Reverse Zoning (gyaku senbiki)" is a land use policy based on City Planning Act of 1968 (Act no. 100 of 1968) and Ministry of Construction Ordinance in 1980 (Ministry of Construction, 1980) that allows previously designated urbanization promotion areas into urbanization control areas. Originally introduced in the 1980s to prevent inefficient urban sprawl, reverse zoning has gained renewed attention as a tool for disaster risk reduction in the context of climate change and depopulation (Nagasue et al., 2023; Asano and Yamaguchi, 2015).

3.1 Kitakyushu City

Kitakyushu City, located in Fukuoka Prefecture, has a long history of flood-related disasters, including the 1953 West Japan Flood and the 2018 July Heavy Rain, the latter caused 407 slope failures and 2 fatalities in the city (Web-6). In response, the city proposed a reverse zoning plan in 2018 to

reclassify approximately 1,157 hectares, which are home to around 35,200 residents and about 18,000 houses and buildings, as urbanization control areas (Web-7).

During around 280 extensive public briefings, however, the plan faced strong opposition. Residents expressed concerns over declining land price, lack of compensation, and even potential violations of property rights. As a result, the final plan, approved in 2024, was significantly scaled down to cover only 263 hectares, affecting 165 residents and 215 buildings (Web-8). This was despite the fact that the city adopted a gradual implementation strategy over 30 years, allowing current residents to remain while restricting new development.

This case illustrates the political and social sensitivity of reverse zoning. While the city's initiative was forward-looking and aligned with disaster risk reduction goals, the lack of financial support and limited public consensus hindered its full realization. At the same time, it demonstrated the importance of discussion with residents from the planning stage.

3.2 Hiroshima Prefecture

Hiroshima Prefecture experienced severe sedimentary disasters in 2014 and 2018. In August 2014, heavy rain caused by linear rain bands led to 77 deaths including 3 associated deaths, mainly due to landslides and debris flows in Hiroshima City's Asaminami and Asakita areas (JSCE Hydraulic Eng. Committee, 2015; CO Bousai, 2018). In response, the prefecture accelerated the designation of sediment disaster warning zones. As of September 2025, 47,879 zones, including 45,092 red zones were designated which was the highest number of sites in Japan (Web-9). About 10,000 of these are in urbanized areas (Web-10).

In July 2018, the West Japan Heavy Rain caused 231 deaths and missing persons nationwide (Web-11). Hiroshima Prefecture alone recorded 114 death and missing, including 87 from sedimentary disasters where 79 due to debris flows (MLIT, 2019). These events prompted the prefecture to consider reverse zoning.

In 2020, Hiroshima launched its "Safety, Pride, Challenges: Hiroshima Vision," aiming for a disaster-resilient urban structure. In 2021, it introduced a three-step reverse zoning concept: (1) immediate zoning in 800 uninhabited sites; (2) within 20 years, restrict new settlements in 5,000 fringe zones; (3) within 50 years, relocate all residents from 10,000 red zones (Web-12). A detailed plan was proposed in FY2024, followed by public hearings and approval in 2025.

Implementation begins with uninhabited areas. For populated zones, the focus is on early warning systems and voluntary relocation through support programs. While the approach may appear cautious, it is wise to prevent new settlements in undeveloped land and allow residents in red zones time to understand the risks and move voluntarily. Prefecture's follow-up reports are awaited.

3.3 Lessons Learned

These cases highlight the challenges of implementing reverse zoning in democratic societies. Key barriers include property rights concerns, economic disincentives, and limited public trust. Successful implementation requires long-term vision, transparent communication from the initiation stage, and supportive measures such as relocation assistance and land value compensation. Also, it suggests the importance of a rare opportunity window after experiencing sever disasters as people become acceptive to displacement.

Moreover, reverse zoning cannot function in isolation. Its effectiveness depends on integration with broader spatial planning frameworks, such as location optimization plans and basin flood control strategies. The next sections explore how such integration can enhance policy coherence and resilience outcomes.

4 LOCATION OPTIMIZATION PLAN (LOP)

The "Location Optimization Plan (LOP)" was introduced through the 2014 Amendment to the Act on Special Measures concerning Urban Renaissance (Act no. 36 of 2014). It aims to promote compact city development by designating RIAs and UFIAs, thereby concentrating population and services in safe, efficient zones while discouraging development in disaster-prone or low-density areas. As of July 2025, the number of cities tackling their LOPs was 935 among which 634 cities made their plans open to the public (Web-13).

For this enactment, studies of Tohoku Regional Bureau of Ministry of Land Infrastructure, Transport and Tourism (MLIT) and good practice of Toyama City must have played a considerable role as forerunners of the compact city concept. Toyama City's Light Rail Transit (LRT) was highlighted by OECD comparative assessment study (OECD, 2012) as a leading case of compact city and network under shrinking population by revitalizing public transportation, promoting residential concentration along transit corridors, and regenerating the city center.

4.1 Toyama City

Toyama City is widely recognized as a pioneering case of compact city development in Japan. Facing rapid population decline and urban sprawl, the city initiated its compact city strategy in 2002, centered around the introduction of a Light Rail Transit (LRT) system. The LRT served as a backbone for urban regeneration, connecting dispersed neighboring towns and encouraging residential concentration along transit corridors (Toyama City, 2024).

The city implemented a suite of supportive measures, including housing subsidies for relocation into RIAs, land-use incentives for developers, and the revitalization of public spaces in the city center. These efforts were coordinated by municipal departments such as urban planning, transportation and welfare that were supported by private sector partners as well as active participation of citizen groups by promoting LRT use. Here the leadership of Mayor Masashi Mori was important in aligning these actors under a shared vision (Fukayama et al., 2007).

Empirical studies (Fujioka & Sakakibara, 2023) show a modest recovery in population and service density within targeted areas since the LOP's implementation. Toyama's experience demonstrates that policy integration, strong leadership, and stakeholder collaboration are critical to the success of compact city strategies.

4.2 Hanamaki City

Hanamaki City in Iwate Prefecture stands out as the first municipality in the Tohoku region to launch a compact city initiative under the national LOP. Its role as an early model dates back to 2008, when it was selected as a focus area in the Tohoku-initiated Compact City Study Committee, established by the MLIT's Tohoku Regional Bureau to explore sustainable urban forms in shrinking regions (Tohoku-initiated Compact City Study Committee, 2024).

As a regional hub facing population decline and spatial dispersion, Hanamaki has taken structured steps to concentrate on urban functions and housing. It has designated RIA to guide new housing toward existing centers and UFIA to cluster services such as healthcare, education and commerce.

Although development outside the designated areas continues, empirical studies show some success in directing new construction within the target zones (Yamanashi & Ubaura, 2020). What makes Hanamaki notable is its effort to align spatial planning with long-standing practices of shared responsibility between local government and community groups. These include disaster response and infrastructure maintenance, such as snow removal and road upkeep in peripheral settlements (Yakushige & Hirota, 2014). While public participation in the initial planning phase was limited, this tradition of collaboration offers a foundation for more integrated governance.

Hanamaki's experience highlights the importance of combining formal planning tools with informal local capacities. As many regional cities struggle to implement compact city policies, Hanamaki provides insight into how spatial strategies can be grounded in existing social frameworks.

4.3 Comparative Insights

The contrasting experiences of Toyama and Hanamaki underscore the importance of implementation over policy design. Toyama's progress reflects strong mayor's leadership, cross-departmental coordination, private sector involvement and sustained civic support. In contrast, Hanamaki's efforts were shaped by early foresight and community cooperation, rooted in its participation in the 2008 Tohoku-initiated Compact City Study Committee.

Although institutional integration was limited and outcomes modest, these efforts represent a significant departure from inaction. Hanamaki's case suggests that even incremental steps, when grounded in local collaboration and long-term vision, can lay the foundation for more resilient urban futures. These findings reinforce the need for context-sensitive, participatory approaches in land use planning, especially in regions facing demographic and fiscal stress.

5 BASIN FLOOD CONTROL

"Basin Flood Control (Ryūiki Chisui)" is a basin-wide flood risk management policy that directs river and sewerage managers of Specified Urban Rivers and Basins designated by the Minister of MLIT to develop a river basin flood damage countermeasures plan and implement it in collaboration with all relevant stakeholders. This policy was introduced by "Act Partially Amending the Act on Special Urban River Inundation Damage Countermeasures, etc." (Act No. 31 of 2021), often referred to as the Basin Flood Control-related Act, which simultaneously amended nine related Acts concerning comprehensive flood-related disaster risk management, thereby making the policy jointly actionable.

The nine acts are on special urban rivers, rivers, sewerage, flood control, sediment disasters, city planning, finance to relocation, urban green space, and building standards. Thus, the Basin Flood Control-related Act seeks not only engineering approaches but also sociological measures, ensuring that diverse stakeholders work together to efficiently manage floods across entire river basins. Briefly, the Act directs river and sewerage managers of specified river basins:

(1) development of river basin flood damage countermeasures plan,
(2) establishment of River Basin Flood Risk Reduction Council,
(3) installation of infiltration and storage facilities,
(4) introduction of licensing regulation for actions interfering infiltration and storage functions in the basin,
(5) designation of retardation and storage ponds to be conserved,
(6) instruction of displacement of houses under high potential damage,
(7) designation of inundation prevention areas where any actions interfering inundation prevention are restricted, and
(8) provision of financial support for such works with subsidies from the central government.

Among these mandated actions, two stand out for their significance in land use and governance. That is, (2) establishment of *river basin flood risk reduction council* is particularly important as it institutionalizes multi-stakeholder collaboration, ensuring that river and sewerage administrators, local governments, academic experts, and community representatives jointly formulate and implement flood damage countermeasures plans. It is indeed pivotal to TDA. On the other hand, (7) designation of *inundation prevention areas* plays a connector to the LOP policy. Namely, areas designated as inundation prevention areas must not be included in RIA ensuring consistency between flood risk management and urban planning.

6 DISCUSSIONS

The comparative analysis of reverse zoning, LOPs, and basin flood control revealed both the potential and limitations of Japan's evolving land use policies for disaster risk reduction. While each policy addresses a distinct dimension, reverse zoning focuses on exposure control, LOPs on spatial efficiency and service provision, and basin flood control on systemic coordination of all control means, their effectiveness hinges on the degree to which they are implemented in concert.

Key Insights from Case Studies may be:

(1) Policy Design Alone is Insufficient:
- Kitakyushu and Hiroshima show that even well-intentioned reverse zoning plans can fail without public support based on collaborative engagement from the early stages.
- Toyama and Hanamaki demonstrate that the success of LOPs depends less on formal designation of zones and more on the quality of stakeholder collaboration, including citizen participation and interdepartmental coordination.

(2) Central Role of the Basin Flood Control-related Act
- Legal framework for land use regulation: The Act now serves as the central legal framework for land use regulation in flood-prone areas.
- Institutionalization of TDA: The compulsory establishment of *river basin flood risk reduction councils* mandates collaboration among diverse actors. These councils are empowered to coordinate flood risk management and regulate land use, integrating engineering, sociological, and urban planning measures across disciplines and sectors.
- Explicit linkage with urban planning: The designation of inundation prevention areas and their exclusion from RIAs under LOPs demonstrates how the Act places land use control at the heart of flood risk management.

This legal and institutional integration operationalizes TDA, transforming land use decisions from siloed, sectoral processes into inclusive, multi-stakeholder governance.

(3) Challenges and Future Directions
- Governance and implementation: The effectiveness of *river basin flood risk reduction councils* varies depending on local administrative capacity, political will, and the maturity of civil society engagement.
- Temporal mismatch: There is often a mismatch between policy cycles and the long-term nature of land use change, requiring adaptive governance frameworks.
- Cultural and institutional transformation: Achieving disaster-resilient, compact urban development requires not only legal alignment but also cultural and institutional transformation.
- Importance of leadership: Leaders' capacity is so important in political level, administerial level and communities' level. Without any of these, TDA for efficient and resilient land use is unachievable. Of course, it is only possible by people's awareness of risk.

Building trust, fostering dialogue, and empowering local actors are as critical as technical planning in achieving sustainable outcomes.

7 CONCLUSIONS

This study has examined the evolution and integration of Japan's land use policies for flood risk reduction, focusing on reverse zoning, LOPs, and the 2021 Basin Flood Control-related Act. Through comparative case analysis, several key conclusions emerge:

(1) Synergy through Integration:

While each of these policies addresses disaster risk reduction from distinct aspects, their true effectiveness is realized only when implemented in a coordinated and mutually reinforcing manner. Fragmented or isolated efforts are insufficient to address the complex, systemic nature of flood risk in contemporary Japan.

(2) Centrality of the Basin Flood Control-related Act:

The 2021 Act has become the cornerstone of land use regulation in flood-prone areas, uniquely institutionalizing the TDA. By mandating the establishment of *river basin flood risk reduction councils*, the Act ensures that diverse stakeholders collaborate in both planning and implementation, bridging the gap between engineering, sociological, and urban planning measures.

(3) Land Use Regulation as a Core Strategy:

The explicit linkage between the designation of inundation prevention areas and their exclusion from RIA under LOPs demonstrates a paradigm shift: land use control is now at the heart of Japan's flood risk management strategy. This legal and institutional integration is essential for preventing new development in high-risk zones and promoting resilient urban forms.

(4) Challenges Remain:

Despite these advances, significant challenges persist. Effective implementation depends on local administrative capacity, sustained political will, and the maturity of civil society engagement. Enlightened leadership supported by enlightened public is a common difficulty in democratic nations. The temporal mismatch between policy cycles and the long-term nature of land use change further complicates progress. Building public trust, fostering dialogue, and empowering local actors remain critical tasks.

(5) Lessons for Broader Application:

Japan's experience offers valuable lessons for other countries facing similar hydro-meteorological risks. The shift from siloed, top-down planning to collaborative, place-based governance, anchored in legal frameworks that prioritize not only infrastructure development and societal resilience building but also exposure control by land use regulation and stakeholders' collaboration, represents a promising direction for building resilient and sustainable urban futures.

In conclusion, the integration of reverse zoning, LOPs, and basin flood control under a shared vision of disaster-resilient, compact urban development marks a significant step forward. The institutionalization of TDA through the Basin Flood Control-related Act provides a robust platform for aligning diverse policies and actors. Continued efforts to strengthen collaboration, adapt governance frameworks, and sustain community engagement will be essential for realizing the full potential of these reforms in the face of escalating flood-related disaster risks.

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