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Expediting Recovery: Lessons and Challenges from the Great East Japan Earthquake to War-Torn Ukraine

Mikio Ishiwatari [1,*], Akiko Sakamoto [2] and Mikiyasu Nakayama [2]

[1] The Graduate School of Frontier Sciences, The University of Tokyo, Kashiwa 2770082, Japan
[2] Global Infrastructure Fund Research Foundation Tokyo, Tokyo 1050001, Japan; a.sakamoto@gif.or.jp (A.S.); nakayama@k.u-tokyo.ac.jp (M.N.)
* Correspondence: ishiwatari1219@gmail.com

Abstract: The ongoing war in Ukraine poses an uncertain future, highlighting the need to prioritize reconstruction efforts even before the war ends. Japan's recovery mechanisms have developed based on the experiences and lessons learned from natural disasters such as the Great Kanto Earthquake in 1923 and from war damage by World War II. This study aims to draw practical insights and lessons from the 2011 Great East Japan Earthquake for Ukraine's postwar recovery and help achieve rapid and high-quality results. This study reviews the literature, policy documents, and reports on recovery from the disaster. It was found that streamlining environmental impact assessments, land use regulations, and land acquisition could accelerate recovery. Engaging the private sector promoted the reconstruction of critical infrastructure and housing projects. This Japanese case study highlights the importance of ensuring sustained commitment and avoiding setbacks in the recovery process by establishing legislative, planning, and institutional frameworks, as well as financial mechanisms. Protecting human health is paramount, even if more resources are needed to manage hazardous materials. Applying these valuable lessons to Ukraine requires careful consideration, including leveraging foreign investments to supplement limited domestic resources and establishing effective governance structures that promote transparency, accountability, and coordination.

Keywords: housing reconstruction; land use regulation; public–private partnership

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1. Introduction

The ongoing war in Ukraine, which began in February 2022, continues to present an uncertain future, with the potential for protracted conflict. The need to consider Ukraine's reconstruction as a component of comprehensive support is paramount, even before the cessation of the war [1]. The task of rebuilding Ukraine's infrastructure and society is not only a pressing national priority but also a significant global challenge [2–4].

Japan has begun to support Ukraine's reconstruction by drawing on their experience in recovery, particularly from the Great East Japan Earthquake and Tsunami (GEJE) that occurred in 2011. To strengthen support, it is necessary to identify lessons from the GEJE that are useful for reconstruction in Ukraine. The Japanese Reconstruction Agency signed the "Memorandum of Cooperation for Promoting Sustainable Urban Reconstruction and Continuing Cooperation" with the Ukrainian government in April 2023. Policymakers, government officials, and experts have visited the Tohoku region to study the reconstruction experience.

Japan, having confronted and overcome extensive post-disaster and postwar recovery challenges, offers a wealth of experience and knowledge. Recovery mechanisms have

developed based on the experiences and lessons learned from natural disasters such as the Great Kanto Earthquake in 1923 and from war damage by World War II [5]. These include land pooling and development programs to provide high-quality urban environments with roads, parks, and green belts and the swift construction of public housing. In particular, the recovery process following the GEJE showcased the ingenuity and resilience of countless experts, individuals, and organizations in tackling various issues [6]. Such invaluable insights can now be harnessed to inform and guide Ukraine's own recovery endeavors.

Among the primary challenges in recovery is achieving a delicate balance between swift and good-quality recovery [7]. Swift restoration of essential services and the rehabilitation of affected communities are of utmost importance to the residents. Simultaneously, aiming for good-quality recovery presents a unique opportunity to address pre-existing social and physical shortcomings while building resilient infrastructure for the future [8].

The arrangement of governance is critical for achieving a better quality of recovery [9–11]. Some legal frameworks governing regular infrastructure development, including environmental assessments, may inadvertently impede the expeditious progress of recovery efforts. Additionally, dilemmas related to striking a balance between individual rights and the collective public interest, particularly in cases involving land acquisition for infrastructure construction or large-scale population relocation, pose complex challenges. These universal issues, intrinsic to infrastructure development and population displacement, must be thoughtfully addressed.

This study aims to draw practical insights and lessons from the GEJE for Ukraine's postwar recovery and help achieve both swift and high-quality results. It undertakes a comprehensive analysis of the strategies employed in reconciling the imperative of the "swiftness of recovery" with the pursuit of "high-quality recovery" following the GEJE. It mainly covers policy, financing, housing, infrastructure, and environmental issues. This study could provide useful information to decision makers and stakeholders involved in Ukraine's postwar recovery, ultimately contributing to the nation's resilience and long-term sustainable development.

2. Comparative Analysis of Recovery from Disasters and Wars

This section reviews the recent literature to compare and contrast the complexities of recovery from both disaster and war. Although the literature that comprehensively addresses these issues is limited, it is clear that they are important in shaping recovery efforts.

Disasters tend to be localized events, and affected areas can be supported by neighboring areas and the national government. Conversely, wars often affect large areas, span entire countries, and affect all sectors of society [12]. Governments coping with the loss of conflict-weakened institutions and personnel often face challenges related to inadequate public revenues and a lack of capacity to effectively rebuild and manage infrastructure. As a result, there is an urgent need to strengthen various administrative, financial, and procurement capacities [13–15]. In addition, where social, economic, political, and administrative institutions have been destroyed by war, reconstruction tends to be carried out through less than perfect democratic governance. This is because the establishment of democracy is a lengthy process [16].

This lack of reconstruction capacity highlights the important role of external assistance. A notable example is the success of reconstruction efforts in Western Europe after the Second World War. These countries used aid programs such as the US Marshall Plan to rapidly rebuild heavily damaged transport, water, and electricity infrastructure [17].

While infrastructure rehabilitation following natural disasters simply means repairing damaged facilities, infrastructure development in post-conflict settings not only provides the basis for a sustainable economy but also plays an important role in promoting broader

nation-building goals. Basic public services such as water, housing, health, and education are essential for promoting security, good governance, economic development, and social welfare [18]. In particular, housing reconstruction in post-conflict settings requires careful management to avoid pitfalls that undermine state institutions and perpetuate forms of economic and social exclusion [19].

3. Methodology and Recovery in Ukraine and After GEJE

3.1. Methodology

This study conducts a review of the relevant literature, scholarly articles, policy documents, reports, and studies related to recovery from the GEJE and analyzes policy frameworks, strategies, implementation processes, and outcomes. Government documents cover legislations and by-laws, evaluation and progress reports of the recovery and auditing agencies, and technical guidelines of infrastructure and environmental ministries. Data related to construction timelines, costs, and project outcomes are examined to gather statistical evidence and identify factors influencing the speed and quality of recovery efforts.

A virtual seminar, which 39 experts and practitioners attended, was conducted to receive feedback on the initial findings in May 2023. The contents of discussions were codded and categorized into seven areas: (i) approaches and institutions, (ii) specific issues, (iii) engaging the private sector, (iv) assistance from other countries for Ukraine, (v) issues of swift recovery, (vi) the use of Japanese recovery experience, and (vii) local contents with differences from Japanese situations. This categorization is used for examining issues in the Discussion Section.

3.2. Recovery in Ukraine and After GEJE

This subsection examines damage and recovery from the war in Ukraine and from the GEJE by reviewing the recent literature. The scale of damage costs resulting from the war in Ukraine and the GEJE is comparable, amounting to approximately USD 152 billion and USD 120 billion, respectively [20,21]. Likewise, the estimated recovery costs for the war in Ukraine and the budgets spent on GEJE recovery efforts are also on a similar scale, with figures reaching USD 486 billion and USD 270 billion, respectively [20,22].

However, the impacts on national economies differ significantly due to variations in the scales of their economies. In the case of Ukraine, the estimated recovery costs account for a staggering 280% of the country's GDP, indicating the immense challenge faced by the nation. Conversely, Japan's budget allocation for GEJE recovery efforts accounts for approximately 7% of its GDP (Table 1). The figures for Ukraine are increasing as the war continues, exacerbating the economic strain on the country.

Table 1. Comparison between Ukraine and GEJE recovery.

	Ukraine	**Great East Japan Earthquake**
Damaged cost	USD 152 billion	USD 120 billion (excluding damage by nuclear accident)
Recovery cost	USD 486 billion	USD 270 billion (until FY 2020)
(Ratio to GDP)	(280%)	(7%)

Source: data from [20–22].

3.2.1. Damage and Recovery in Ukraine

The Ukraine government, in collaboration with the World Bank, the European Commission, and the United Nations, conducted a rapid damage and needs assessment, estimating the cost of reconstruction and recovery at USD 486 billion [20]. Direct damage to buildings and infrastructure has surpassed USD 152 billion, with the housing sector alone accounting

for 37% of the total damage, followed by transport at 22%, energy at 7%, and agriculture at 7%. This significant damage has resulted in a 29% decline in Ukraine's gross domestic product, pushing 1.7 million Ukrainians into poverty. The war has affected the complex, inter-related, and multidimensional effects on the environment, health, and well-being [23]. Shumilova et al. [24] examined damage on water resources and water infrastructure and identified 49 cases impacted for the first three months, including the disruption of water supply, water transfer interruption, and water pollution due to military actions, as well as 15 potential impacted cases. An estimated 3.7 million people are internally displaced within Ukraine and approximately 6.1 million have fled to Europe and elsewhere outside the country. Asbestos exposed by the destruction caused by the war is a major health hazard associated with reconstruction. Until recently, Ukraine was a major consumer of Russian asbestos, and the construction industry used asbestos extensively. Although asbestos is relatively safe when encased in adhesives and cement, the mass destruction of buildings has resulted in millions of tons of health-threatening asbestos-contaminated debris.

While recent studies have proposed various recovery approaches, there are limited studies examining the lessons that can be derived from other disasters to inform the recovery efforts in Ukraine. Postwar Ukraine can be considered more like post-World War II Europe as opposed to Iraq or Afghanistan. This is because the labor force is better educated, the various institutions are functioning, and the resource curse is relatively unlikely. In addition, refugees are likely to return to Ukraine once the conflicts are over [25]. Bergmann and Romanyshyn [26] recommend that international donors should prioritize reconstructing infrastructure for basic needs of education, health, energy, housing, and transport. Also, they suggest establishing a governance mechanism between the Ukrainian government and international partners to manage recovery projects. To attract foreign investment, Ukraine needs to enhance its legal system and physical infrastructure for the movement of people and goods [27]. Recovery efforts should include not only infrastructure, but also various areas including mental health and psychosocial services and science and technology [28,29].

Reconstruction requires an understanding of local contexts, particularly land use and housing policies, which are key to the rebuilding of homes and cities. Ukraine, like other countries of the former Soviet Union, has implemented agrarian reforms that (i) introduced private ownership of agricultural land that had been considered state property, and (ii) partially converted agricultural land that had been used collectively by agricultural enterprises to individual use [30]. The country has formulated laws, by-laws, and regulations and arranged government institutions to promote economic and societal benefits [31]. Similarly, the country has promoted mass giveaway privatization via its housing policy for decades. Sukhomud and Shanaider [32] emphasized that the country should strengthen the mechanisms of renting in the tenure structure, since the war has devastated a huge volume of housing.

3.2.2. Damage and Recovery After GEJE

In the aftermath of the GEJE, triggered by a 9.4-magnitude earthquake off the Tohoku coast, Japan experienced cascading effects caused by earthquake, tsunami, and nuclear accidents in various sectors. The economic damage amounted to JPY 16.9 trillion or USD 120 billion, making it the costliest disaster in the country's history [21].

The Japanese government established a ten-year recovery period until FY 2020 and allocated a budget of JPY 38.2 trillion JPY (approximately USD 270 billion) to facilitate the recovery process [22]. Rehabilitating public facilities and houses accounts for the largest share, followed by management of the nuclear accident and allocation to local governments (Figure 1).

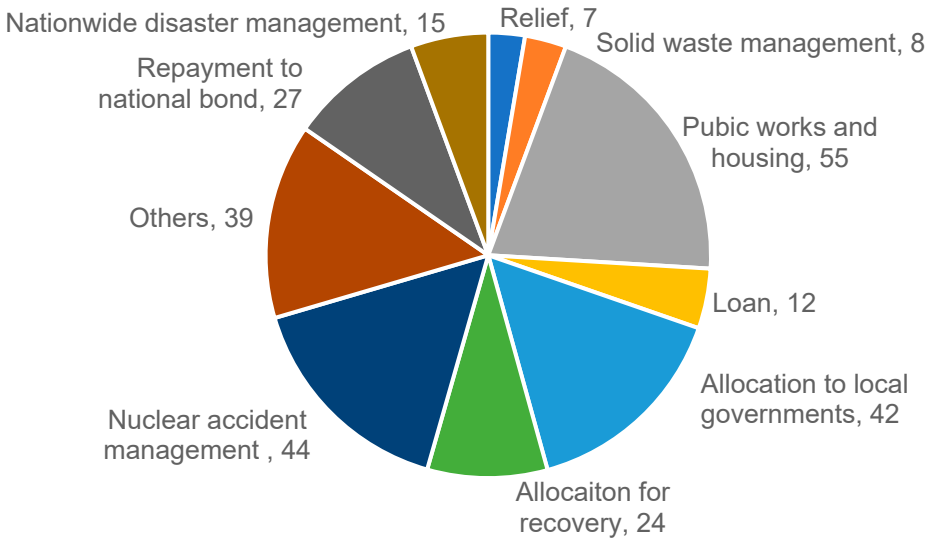


Figure 1. Details of recovery budget for GEJE (in USD billion). Source: data modified from [22].

Japan had developed mechanisms for rehabilitating infrastructure damaged by disasters before the GEJE (Figure 2). On the day of the disaster, companies started rehabilitation works, such as assessing damages and reopening roads, according to instructions from government offices based on simple pre-agreements [33]. This allowed them to skip ordinarily procurement procedures. The national government covers most rehabilitation costs, considering the limited financial capacity of local governments. Finance and line ministries jointly conducted appraisals for rehabilitation works and immediately approved budgets for rehabilitation. Experts outside disaster areas supported offices in disaster areas to promote rehabilitation works. Retrofitting works substantially decreased damage from disasters.

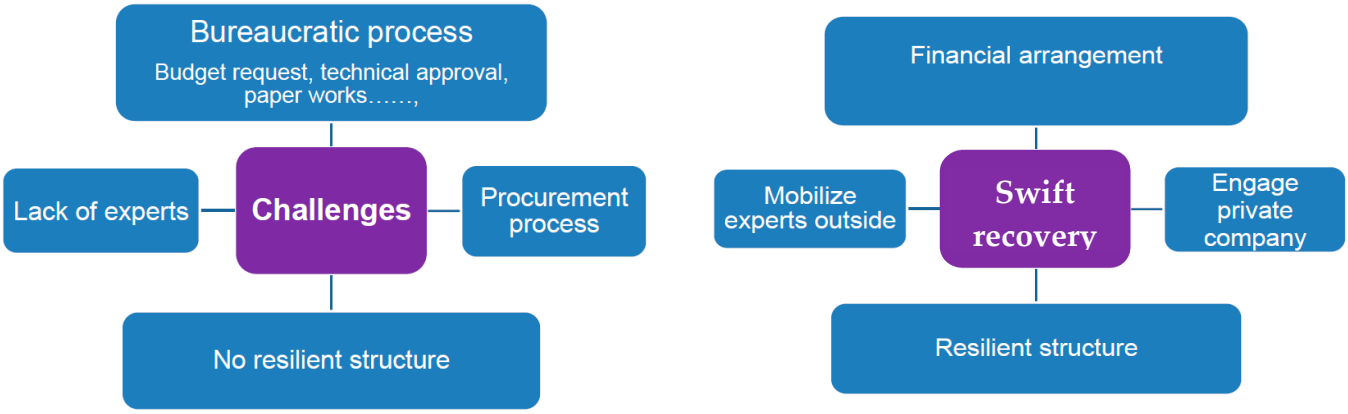


Figure 2. Japanese rehabilitation mechanism: challenges (**left**) and solutions (**right**). Source: authors.

During the GEJE, these already established rehabilitation mechanisms functioned well. The government reopened expressways within one day, national highways within one week, the Sendai airport within 4 days, and seaports within 13 days [21].

4. Key Strategies and Policies

This section examines the key strategies and policies implemented for recovery from the GEJE that are useful for Ukraine's postwar recovery.

4.1. Planning and Financial Arrangement

During the GEJE, Japan had already established reconstruction mechanisms based on lessons learned from past natural disasters and war damage. Government agencies had created a high-quality urban environment with wide streets, parks, and green belts through land pooling and other land development schemes and quickly provided housing in the form of public apartments following disasters [5]. The country further developed legislation, planning, institution, and financing schemes to promote recovery efforts from the GEJE. Japan enacted the Basic Act on Reconstruction in Response to the GEJE in June 2011, and the national government formulated a basic recovery policy [21]. Accordingly, the prefecture and municipality governments formulated their recovery plans until October and December 2011, respectively. The Recovery Agency headed by the Prime Minister was established in February 2012 to formulate recovery policies and coordinate a wide range of recovery works. The agency's period was originally set at 10 years and was extended for a further 10 years until 2031. The substantial financial commitments and innovative funding mechanisms employed supported recovery efforts. The government sourced revenue from various channels, including recovery national bonds, the general account, recovery funds from the Tokyo Electric Company, special recovery income tax, and special recovery corporate tax (Table 2).

Table 2. Revenue for GEJE recovery in JPY trillion (USD billion).

Recovery income tax	3.1 (22)
Recovery corporate tax	2.3 (16)
General account	10.3 (74)
Recovery national bond	17.4 (124)
Recovery from TEPCO	4.2 (30)
Total	37.3 (266)

Source: data from [22].

The special income tax, which imposed a 2.1% tax increase, was introduced to distribute the recovery costs among all citizens over a 25-year period, until 2037. The government issued recovery national bonds of JPY 17.4 trillion, or USD 124 billion, which accounted for nearly half of national budgets, to finance recovery costs that could not be covered by spending cuts, non-tax revenues from the sale of government assets, and financial surpluses. The government established a special account for recovery budgets to ensure transparency in the flow of government funds and to manage the redemption of recovery national bonds [34].

4.2. Special Reconstruction Zone

Following the unprecedented scale of damage caused by the GEJE, the government introduced special reconstruction zones as a means of facilitating the recovery process. These zones allow for the implementation of special measures and innovative solutions without being bound by past cases or existing legal and regulatory frameworks. This flexibility enables local communities to realize their own ideas and initiatives that best suit their unique circumstances and needs [35].

One key feature of special reconstruction zones is the establishment of a streamlined and efficient one-stop service. This service serves as a central hub for managing various procedures related to tax relaxations, financial support, and deregulation. It simplifies administrative burdens and ensures that local governments can access the necessary support

swiftly and efficiently. By leveraging underutilized land resources and streamlining administrative procedures, these zones foster a resilient and sustainable recovery process [36].

Land use regulations became flexible to promote a diversified and resilient local economy. Specifically, agricultural, forestry, and park lands that may have been restricted under current legislation could be repurposed for commercial, industrial, or other productive uses. This unlocked the potential for economic growth and job creation in the affected areas. For instance, lands previously limited to industrial, commercial, or agricultural activities could flexibly accommodate the construction of factories, shops, restaurants, and housing at any categorized lands [37].

Local governments could develop housing relocation sites within designated development-regulated areas. This could effectively address the housing needs of affected communities while adhering to development regulations and spatial planning considerations [38].

To expedite the recovery process, special measures have been implemented to accelerate land acquisition processes. Approval procedures for compulsory purchase have been shortened, and documentation requirements have been simplified. These measures reduce administrative barriers and enable efficient land acquisition, allowing for timely implementation of reconstruction projects [36].

4.3. Environmental Impact Assessment

The Environmental Impact Assessment (EIA) Law aims to appropriately reflect the results of an EIA for projects that are large in scale and have a significant degree of environmental impact. In the evaluation process, the implementation organizations of large-scale projects specified in the law must hear the opinions of local governments, related organizations, residents, and other stakeholders. For recovery projects following the GEJE, even large-scale projects do not need to assess their environment impacts at a full scale because of the following reasons [39].

(i) Originally exempt from application: The EIA Law covers 13 programs that are subject to evaluation, but it does not include the construction of tsunami dikes and coastal forests as programs to be evaluated. In addition, the law does not apply to environmental pollution by radioactive materials.
(ii) Rehabilitation projects: Disaster rehabilitation projects are explicitly exempt under the EIA Law. This is because these projects directly involve human lives.
(iii) The government's interpretation for exemption: The government interpreted that the application of the EIA Law was exempt for installing thermal power plants in the service areas of Tokyo and for Tohoku Electric Power companies to compensate for the lost electricity supply capacity caused by the disaster. Power companies took voluntary measures to protect the environment, such as pollution and noise. Power companies constructed power plants at 12 locations in Tokyo, Nigata, and other prefectures without undergoing the full EIA process [40].
(iv) Simplified methods: The act for recovery special zones after the GEJE stipulates that the methods of assessing environmental impacts are simplified for the projects of land pooling and railways [41]. Instead of conducting a year-long survey by project implementers, municipal governments assess environmental impacts based on desktop surveys. The three separate reports at scoping, draft report, and final report stages are integrated into one specific impact assessment report, streamlining the process.

4.4. Housing Reconstruction Strategies

Japan employed a series of innovative approaches and resource mobilization strategies to successfully rehabilitate approximately 350,000 damaged houses in the aftermath of

the GEJE [42]. Housing reconstruction played a vital role in restoring communities and enhancing resilience against future tsunamis.

Regulating new housing construction in at-risk areas and relocating houses to safe and elevated grounds were key strategies employed. These measures ensured that new housing developments were situated in safer locations, minimizing the risks associated with future tsunamis. Around 46,000 houses were successfully relocated, offering residents a fresh start in secure environments [43].

Local governments played a crucial role in facilitating the housing reconstruction process. They were responsible for relocation and land pooling programs, which allowed affected families to participate in collective relocation efforts. These programs aimed to consolidate land resources for new houses in safer areas. Through these initiatives, over 20,000 houses were relocated [22] (Table 3). The process of completing relocation sites typically required an average of 5 years, involving the building consensus in affected communities, the identification of suitable locations, the development of the sites, and the purchase of the original lands in at-risk areas. Most programs were completed within 10 years [44]. For those who did not participate in the relocation and land pooling programs, some 24,000 households sought new housing independently.

Table 3. Programs of housing rehabilitation.

Programs	JPY Billion (USD Billion)	Unit Number
Public apartment	834 (5.96)	29,653
Resettlement	285 (2.04)	8838
Land pooling	525 (3.75)	11,987

Source: data from [22].

Local governments constructed approximately 30,000 units of public apartments (Table 3). These apartments were primarily allocated to vulnerable families, including low-income groups and the elderly, who had lost their homes and were unable to afford the construction of new houses. These apartments were provided with subsidized rents according to their incomes. The provision of public apartments offered a vital lifeline for those in need, ensuring that they had a place to stay and rebuild their lives [44].

Local governments embraced public–private partnerships (PPPs). Through public invitations, local governments selected private companies to handle land acquisition, building design, and construction as integrated packages. This collaborative mechanism facilitated efficient utilization of resources and expertise, contributing to the timely completion of housing projects. Additionally, local governments formed partnerships with local associations composed of businesses and contractors to construct public apartments within the affected communities. This collaboration not only accelerated housing reconstruction efforts but also served to revitalize the local economy, which had suffered significant setbacks in the wake of the disaster [45].

To accelerate the relocation process, several measures were adopted. Temporary lifting of land use regulations permitted the construction of relocation sites in urbanization control and farmland areas. Streamlined documentation procedures and shortened timeframes for land acquisition were implemented. Financial support ranging from JYP 5 to 15 million was provided by local and national governments to assist house owners in constructing their new houses [46].

4.5. Infrastructure Reconstruction

4.5.1. Tsunami Dike

The government regarded constructing tsunami dikes as a crucial aspect of recovery from the GEJE. The dike structure and alignments have an impact on recovery planning including the regulation of development activities in at-risk areas and land heightening projects. Government organizations took measures to accelerate recovery efforts. As of March 2021, tsunami dikes were completed at 537 sites in three prefectures, which accounts for 92% of the total number of planned sites (583) [22]. The total planned dike length was 400 km, with a total project cost of JPY 1.5 trillion. The following measures were taken to accelerate construction.

(i) Decision on dike heights: The government took a top–down approach, involving experts and government offices in determining tsunami dike heights within half a year after the tsunami. In some areas, local communities objected to the construction plans for individual dikes, highlighting the need for effective communication and collaboration between government agencies and local communities in the recovery process [47,48]. Based on consultation with local communities, government offices revised their plans in Kesennuma, Shiogama, and Otsuchi [49–52]. Plans at 197 sites, which account for 30% of 621 sites in total, were revised [53].

The government determined dike heights as soon as possible, because the tsunami dikes were a crucial aspect of recovery planning. In July 2011, four months after the tsunami, the government announced the methods for determining the heights of these dikes and released the calculated height figures for each community in September and October of the same year [54]. The dike heights are targeted to protect against tsunamis that occur once every few decades to once every one hundred and a few decades to protect people's lives and assets. But these heights are lower than the once-in-a-thousand-year tsunami that struck in March 2011. Protecting human losses from tsunamis overtopping dikes would be achieved by urban planning, land use regulations, and evacuation. Local governments have prohibited constructing houses in at-risk areas and constructed evacuation routes and shelters. Dikes are covered on three sides by concrete, the seaward side, the city side, and the upper part, to delay the collapse of the dikes when a tsunami overtops them [55].

(ii) Economic analysis: The government offices did not conduct economic analyses for dike construction, which is a common practice for Japanese public works. This decision was justified by categorizing the construction works of tsunami dikes as disaster rehabilitation projects, even for newly constructed ones [56,57]. Yamamoto and Onuki [58] conducted a benefit–cost analysis on a dike project constructed in Otsuchi city after the GEJE and estimated that the benefits of reducing tsunami damage were lower than the construction costs. MLIT [59] conducted a re-evaluation of a dike project in Miyagi prefecture and estimated a 1.2 benefit–cost ratio. Furthermore, the Auditing Agency [22] highlighted that there are no assets protected by a dike constructed in Minamisoma city.

(iii) Environmental impact assessment: Constructing tsunami dikes did not require an assessment of environmental impacts. The EIA Law covers 13 programs that are subject to evaluation, but it does not include the construction of tsunami dikes. This is because affected areas with tsunami dikes are considered relatively small.

4.5.2. Highway Construction

A total 550 km of recovery highways, including Sanriku Coastal Highway of 359 km, was completed in 10 years. This is swifter than expected considering that highway construction takes 14 years in Japan on average. This is because a PPP was introduced to accelerate

project implementation. The project promotion PPP could shorten the preparatory works to one to two years, normally taking six years on average [60]. This PPP is a method of utilizing capabilities of the private sector to efficiently and swiftly implement preparatory works, such as surveying, design, site selection, public information meetings, and consultations with related organizations, which government offices have traditionally carried out. The PPP does not entail a specific design or survey work, but rather the outsourcing of overall management according to the stage of progress.

4.6. Managing Hazardous Materials

While various measures were adopted to accelerate recovery, the Japanese government prioritized protecting human health and implemented specific measures to manage hazardous materials. In particular, major measures cover treating radioactive materials from the Fukushima nuclear accident and asbestos used for buildings.

4.6.1. Radioactive Material

Japan enacted the Act on Special Measures concerning the Handling of Radioactive Pollution in 2011 in response to the radioactive pollution caused by the Fukushima nuclear accident. The primary objective of this act is to swiftly mitigate the impacts on people's health and the surrounding environment resulting from the release of radioactive materials. The MOE has the responsibility of treating two main categories of waste.

(i) Waste Contaminated with Radioactive Materials: MOE is tasked with the management and treatment of approximately 450,000 tons of waste contaminated with radioactive materials as of 2023 [61]. To ensure safe disposal, the ministry contains and isolates the radioactive waste, minimizing the potential for further contamination and exposure.
(ii) Waste in Polluted Areas: The MOE is responsible for managing approximately 802,000 tons of waste generated in polluted areas [61]. This waste includes materials such as soil, vegetation, and debris that have been contaminated with radioactive substances. Proper handling and disposal of this waste are crucial to prevent further dispersion of radioactive materials and to minimize risks to human health and the environment.
(iii) Monitoring: To ensure the effectiveness of these measures, government offices are monitoring the air dose rate and water quality of radioactive materials at waste management facilities. This ongoing monitoring aims to assess the levels of radiation and the overall environmental impacts. Through the safe management and treatment of contaminated waste and rigorous monitoring of radioactive materials, the government aims to minimize the long-term impacts on both the local population and the environment [62].

4.6.2. Asbestos

To prevent asbestos scattering and exposure, the manual formulated by the MOE states that local government officials and emergency damage assessors should confirm the presence or absence of an asbestos scattering risk when assessing the damage levels of an affected building. If a risk is identified, the assessor must inform the building owner about the need for asbestos scattering prevention measures [63].

The MOE formulated a disaster response manual in 2007 based on lessons learned from the Great Hanshin-Awaji Earthquake in 1995 to prevent scattering and exposure of asbestos in the event of a disaster. The manual describes emergency measures to be taken by building owners, such as covering buildings with plastic sheets to prevent asbestos from scattering, wetting surfaces with water or chemicals, and prohibiting entry with ropes.

It provides guidance on asbestos scattering prevention measures during the processes of demolition and intermediate and final disposal [64].

However, in reality, it was difficult to identify the status of asbestos exposure at the time of the emergency damage assessment of buildings after the GEJE [43]. The MOE revised the manual to state that local governments should identify the status of asbestos exposure with their information [65].

5. Discussion

The recovery efforts implemented after the GEJE offer valuable insights for Ukraine as it grapples with the challenging task of rebuilding war-torn areas in (Figure 3). This section examines the findings in the above sections according to seven categories identified in the remote seminar conducted in May 2023.

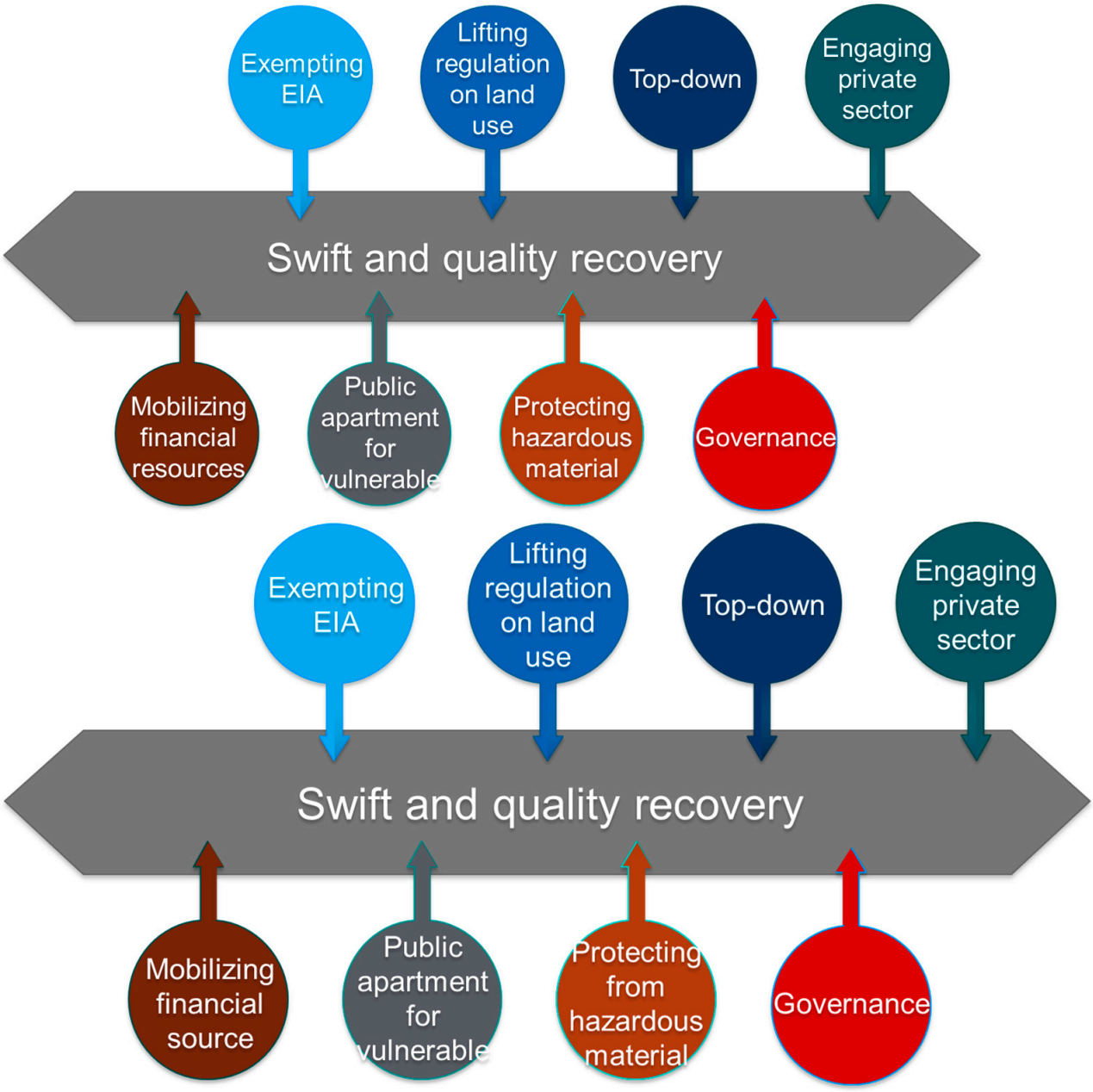


Figure 3. Concept of swift and high-quality recovery. Source: authors.

5.1. Approaches and Institutions

Successful recovery requires a long-term commitment from a range of stakeholders, including governments at all levels, the private sector, local communities, and taxpayers [66]. It is important to recognize that the recovery process is gradual and complex, often spanning several years or even decades. To ensure sustained commitment and prevent regression, it is imperative to establish legislation, planning and institutional frameworks, financial mechanisms, and monitoring systems.

Drawing from the experiences of Japan, the Ukrainian government can prepare mechanisms such as institutions and financial arrangements for rehabilitating infrastructure by referring to successful practices implemented during the post-GEJE recovery period (Figure 2). However, arranging financial sources for recovery projects can be a challenge, particularly in the early stages when the full extent of recovery may not be confirmed.

5.2. Specific Issues

Based on the approaches and institutions to be arranged, the following aspects are recommended:

(i) EIA: Streamlining EIAs can speed up the recovery process. EIAs often take a long time to conduct, including field surveys throughout the four seasons. This may hinder rapid reconstruction. In Japan, the waiver of EIAs has allowed electric companies to swiftly restore electricity, which was threatened by the disaster. However, other measures are needed to protect the environment. Power companies have voluntarily taken measures to protect the environment from pollution and noise.

(ii) Hazardous material: While managing hazardous materials may prolong recovery efforts and necessitate additional resources, safeguarding human health is paramount. The Japanese government managed hazardous materials, prioritized public health, and minimized the potential long-term impacts of radioactive pollution and asbestos exposure on affected communities. The government implemented measures on the ground and continuously updated guidelines and protocols.

(iii) Land use: Lifting land use regulations could facilitate the construction of relocation sites. In Japan, local governments could explore appropriate sites in safe and higher grounds that were previously restricted due to urbanization control and farmland designations, ensuring the resilience of reconstructed communities.

(iv) Housing: Housing reconstruction is crucial for avoiding social inequality or exclusion. By ensuring that everyone had access to adequate housing, regardless of their financial circumstances, the local governments demonstrated their commitment to creating an inclusive and equitable recovery. In Japan, local governments provided vulnerable people, such as low-income groups and the elderly, with public apartments as they could not afford to buy rehabilitated houses.

5.3. Engaging the Private Sector

Fostered collaborations between the public and private sectors can also accelerate reconstruction efforts. During the war, government agencies in Ukraine have weakened their capacities. Engaging private developers, engineering consultants, and construction companies can leverage their expertise, resources, and efficiency to execute not only an emergency response but also various infrastructure rehabilitation. In Japan, the government used the private sector, in particular, for public apartment and highway construction projects.

5.4. Assistance from Other Countries

In Japan, financing for recovery was mobilized domestically through measures such as increased taxation and the issuance of national bonds, in addition to regular financial

sources. Financial assistance programs, grants, or low-interest loans could support homeowners in rehabilitating housing. Ukraine, on the other hand, needs to rely heavily on foreign investments from both public and private sectors due to the significant impact on the national economy [67]. Recovery budgets in Japan accounted for approximately 7 percent of GDP, while Ukraine's recovery needs are estimated to be around 280 percent (Table 1). Furthermore, the war has damaged the whole country and government capacities to implement recovery works. Thus, assistance from other countries is essential, just as the United States succeeded in supporting reconstruction efforts in Western European countries devastated by the Second World War.

5.5. Issues of Swift Recovery: Governance Arrangement

Involving the affected communities in the planning and decision-making processes is crucial for incorporating the local context into facility designs. Balancing swift decision-making with the incorporation of communities' preferences and needs poses a trade-off. In Japan, while a top–down approach enabled the determination of tsunami dike heights within six months following the tsunami, it was challenging to reflect the cultural, social, and economic aspects of the local context.

Governance poses a significant challenge, with Japan scoring high (90.87) in the percentile ranks of "control of corruption" in the Worldwide Governance Index, while Ukraine's ranking is considerably lower (24.52). The country should establish governance arrangements that guide and govern the recovery process, ensuring transparency, accountability, and effective coordination among various stakeholders. Given that relaxing regulations and involving the private sector may bypass regular procedures, ensuring good governance is crucial for managing finances effectively. The country has continued to implement anticorruption reforms and has developed its anticorruption ecosystem from scratch. However, further efforts are needed for Ukraine to become an EU member state.

While Japan has well-developed institutional arrangements for reducing impacts and recovering from disasters, Ukraine has limited recovery capacity and experience with governmental organizations. Ukraine needs to start from the very beginning to build up institutions and mechanisms for recovering.

5.6. Use of Experience of Japanese Recovery Experience

Japan could use its experience of post-conflict assistance to support recovery in Ukraine. Japan has established its aid approach by focusing on socio-economic reconstruction based on the principle of "do no harm" through assistance in South Sudan, East Timor, Afghanistan, and other conflicted areas. It has supported reconstructing infrastructure, such as water supply, bridges, and highways, and taken a step back from political interventions [68,69]. Rehabilitated infrastructure could support socio-economic reconstruction from war and conflicts.

The East Asian region in which Japan is located is becoming more and more security-conscious, and Japan's support is a strategic effort to internationally reinforce the principle that aggression will not succeed. Cultural exchanges and humanitarian efforts to help affected people in Japan have strengthened bilateral relations. Kiev and Kyoto have been sister cities since 1971 and have jointly held ballet performances and various cultural commemorations. Japan is emerging as a cultural soft power, with anime, manga, and traditional art spreading across the globe, spawning subcultures, and societies.

5.7. Local Contexts with Differences from Japanese Situations

While Japan's experience in post-disaster recovery offers valuable lessons, it is crucial to recognize that the implementation of strategies and policies must be tailored to Ukraine's unique context. Factors such as cultural norms, societal values, governance structures,

and existing legal frameworks should be carefully considered when adopting specific approaches and measures. Ukraine's transition from the Soviet system has deeply influenced its current institutional frameworks, property rights, and governance structures.

Several measures for land and housing development are recommended based on the lessons learned from the GEJE. It should be noted, however, that the land use and housing policies in Ukraine are different from the policies in Japan. These policies have a historical background in the communist system of the Soviet period. Land development for housing must be compatible with agriculture, as agriculture is an important sector in Ukraine. Ukraine's agricultural sector plays a crucial role in both its national identity and economic security, often called the "breadbasket of Europe". In addition, its current housing policy emphasizes the ownership system through privatization. Although the rental system of public apartments helps to protect the socially vulnerable, such as the elderly or low-income groups, there is a need for a change in housing policies. People in two countries have different cultural attitudes toward collective housing solutions and property rights.

Ukraine's reconstruction priorities and security concerns are affected by ongoing geopolitical tensions with Russia. Ukraine faces the challenges of political uncertainty and regional security concerns, in contrast to Japan's relatively stable political environment during post-GEJE reconstruction.

6. Conclusions

This study has provided a comprehensive examination of the innovative approaches employed to expedite the recovery process and ensure the quality of programs following the devastating GEJE. Japan has developed mechanisms for rapid and high-quality recovery from natural disasters and war damage and further developed them in recovering from the GEJE. Through the analysis of strategies, policies, and challenges faced during recovery efforts, valuable insights and lessons have emerged that could be useful for recovery efforts in the ongoing war in Ukraine.

Exempting EIA procedures, temporary lifting of land use regulations, and streamlining procedures for land acquisition have proven to be essential in minimizing delays and ensuring swift progress in recovery efforts. These measures facilitated the efficient allocation of resources, expedited the decision-making process, and reduced administrative burdens. The current housing and land use policies in Ukraine, which are rooted in the Soviet communist system and emphasize agricultural production and ownership, need to be modified to protect vulnerable groups.

Top–down approaches in decision-making proved effective in certain aspects of the recovery process. However, it is important to recognize the trade-off between swift recovery through top–down decision-making and the importance of community participation in ensuring a high-quality recovery process. The management of hazardous materials requires various resources, but the most important aspect is to protect human health.

The involvement of the private sector emerged as a key driver in accelerating recovery programs. Collaborating with private companies and leveraging their expertise and resources proved instrumental in expediting the reconstruction of critical infrastructure and housing projects. This partnership between the public and private sectors not only contributed to the prompt completion of projects but also helped revitalize the local economy, which had suffered significant setbacks in the aftermath of the war.

Transferring these lessons to the context of the ongoing war in Ukraine requires careful consideration. Firstly, Ukraine should seek foreign investments for major recovery resources, recognizing the differences in domestic financial resources between Japan and Ukraine. Secondly, governance need to be strengthened to facilitate the lifting of regula-

tions and encourage private sector involvement. Creating an enabling environment that promotes transparency, accountability, and coordination would enhance the efficiency and effectiveness of recovery initiatives in Ukraine.

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