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Unraveling Urban Disaster Management: A Deep Dive into SETS Implications through a Case Study of Toyama City, Japan

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Abstract: This study uses the Social–Ecological–Technological Systems (SETS) framework to examine the urban disaster management strategies of Toyama City, Japan. The recent seismic shocks on the Noto Peninsula highlight the importance of implementing efficient disaster management. Toyama City has incorporated the United Nations' Sustainable Development Goals into its statutory planning frameworks and urban management policies. This synthesis promotes a cooperative approach to disaster resilience while effectively managing challenging limitations. However, we investigate how Toyama City's policy may be improved using policy direction evaluation and SETS allomorph coding. This extensive allomorph analysis of the city's urban planning and disaster management documents shows a dominant focus on social and technical elements, including emergency preparedness, policy, economic criteria, and infrastructure. Nevertheless, the results reveal a significant deficiency in ecological considerations, indicating an asymmetry in the existing policy framework. Our study emphasizes the need for a comprehensive disaster management strategy that considers social, technological, and ecological variables to improve the city's ability to support sustainable development and socio-hydrological challenges.

Keywords: urban disaster management; social, ecological, and technological systems (SETS); sustainable development goals (SDGs); Toyama City

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1. Introduction

Toyama City, in Northern Japan, is a notable and widely recognized example of a compact city in East Asia. The city has been afflicted by recurrent natural disasters like earthquakes, floods, and landslides. The recent seismic activity on the Noto Peninsula in January 2024, resulting in substantial property damage and loss of life, has underscored the imperative of implementing sustainable disaster management practices. The authorities in Toyama City are implementing several legally mandated management plans and enforcing laws for sustainable urban management that align with key aspects of the United Nations' Sustainable Development Goals (SDGs) [1]. This disaster management system encourages collaboration across many sectors in urban disaster management in Toyama City while also implementing complex restrictions [2]. Like other urbanized areas, Toyama City is facing substantial socio-economic instability, including a decrease in population and an increase in the proportion of elderly residents [3]. To address a significant decline in the local industry and economy, the city has expanded its social services to accommodate foreign workers coming from other regions [4]. Toyama City has implemented a distinctive global city strategy that distinguishes it from other Japanese municipalities [4]. Moreover, the city has made significant efforts to tackle social problems by integrating global SDGs into its disaster management policy [3]. Despite the success of its SDGs-based urban policy implementation, researchers have maintained a curiosity about shortcomings in Toyama City's urban disaster management.

For several years, Toyama City has implemented a comprehensive flood risk management program to mitigate the effects of flooding. It recently advocated a large-scale worldwide compact city project to develop a sustainable compact city that can respond to disasters and urban complexity, following the SDGs [4]. Hong and Tanaka [5] compared the flood control policies of major Japanese cities and discovered that Toyama City mostly prevents urban flooding through socio-hydrology. However, due to constraints in assessing the overall direction of disaster management in Toyama City, a visual map of the policy direction connected to the management and prevention of urban disaster in Toyama City was created by analyzing government documents based on the SDGs [4].

Toyama City expects these initiatives to have several benefits, including reducing urban sprawl, improving mobility and accessibility for its residents, promoting local culture and tourism, and supporting the global pursuit of the SDGs [6]. However, it has not always been effective in mitigating calamities, with floods and landslides in several areas of Toyama City in 2018 killing people and destroying property. To successfully regulate and alleviate this issue, the Compact City concept and the Safe & Environmental Smart Model Town Blocks in Toyama City were implemented in accordance with the principles of the UN Sustainable Development Goals [7]. This research examines the relationship between the SDGs, notably those regarding disaster management, and their negative influence on Toyama City's urban management strategy. This study's findings provide insight into future policy direction and trends.

2. Literature Review

2.1. UN SDGs for Toyama City

Toyama City played a prominent role in facilitating Japanese international exchange during the Westernization and globalization of Japan during the 19th century. After the Meiji Restoration social reform in 1868, Toyama Port experienced substantial expansion as a prominent commercial port by promoting trade with nations such as Russia [8]. Toyama Port was integrated into the network of seaports and land railway transit in the East Sea in accordance with the regional promotion philosophy [9]. Hence, the arrival of foreign goods, technologies, and ideas significantly impacted the city's economy, society, and culture, laying the groundwork for Toyama City's aspiration to become a cosmopolitan city of international significance (Figure 1).

Figure 1. Toyama City downtown (source: author).

The city's contribution to Japan's modern globalization and Westernization may be observed in its recent devotion to the SDGs [1], specifically SDG 9: Industry, Innovation, and Infrastructure and SDG 17: Partnerships. Toyama City's successful integration of SDGs into its city management statutory framework has resulted in effective municipal governance.

The Toyama City area faces issues such as population decline, birth rate decline, and the emergence of a multicultural and multilingual society (Table 1) [3]. The distinctive components in this area impact urban disaster management and prevention measures [10]. A municipal management platform specifically focusing on SDGs has been built, distinguishing it from platforms in other regions [3]. Toyama City's primary SDG aim is to enhance the well-being of its residents by cultivating robust community bonds, establishing a resilient and ecologically sustainable framework, and promoting itself as a vibrant center for innovation and local tourism [2].

Table 1. Population structure of Toyama City: years 1995 and 2020. (Source: Toyama, Japan Metro Area Population. http://www.demographia.com/db-japanpref.htm, accessed on 29 March 2024).

Ages	1995	2020
0–17	16.1%	14.6%
18–64	66.3%	55.2%
65+	17.6%	30.2%

The compact city of Toyama City is designed to concentrate services and population along railway lines, with the objectives of reducing CO_2 emissions and revitalizing the city center [4]. Toyama City's Safe & Environmentally Smart Model Town Blocks project intends to utilize renewable energy sources and promote active community engagement [6]. In 2008, the Japanese government officially recognized Toyama City as a model city for its commendable environmental efforts [11]. Moreover, in 2018, it was acknowledged for its involvement in the SDGs Future City Project. Toyama City is an active member of the 100 Resilient Communities Network, a global network of communities committed to enhancing their capacity to endure and recover from various difficulties [3]. Toyama City is dedicated to sharing knowledge and skills with other cities and actively contributing to global efforts to achieve SDGs [6].

Toyama City has incorporated SDGs into its overall policy to become a model for all cities in Japan [6]. To enhance the city's ability to recover from disasters, it has strategically positioned itself within the global city network and is currently building a disaster response system [10]. It has recently partnered with other Japanese municipalities, such as Kitakyushu, to create a plan for making cities sustainable and aligned with the SDGs by 2030 [6]. Additionally, it is actively focusing on building a sustainable urban transportation system to ensure the safety and well-being of its residents [12]. Toyama City's SDGs initiative aims to improve the management system of cities experiencing population decline and aging while providing a flexible and stable system to address any disasters that urban residents face [6].

2.2. Disaster Management of Toyama City

Toyama has a rich history, culture, and natural beauty [4]. Toyama City is Toyama prefecture's capital and largest city, with a population of approximately 407,229 and an area of over 1242 square kilometers as of 2023 [13]. It is prone to earthquakes and floods because it is located at the confluence of many important rivers, including the Jinzu and Sho [14] (Figure 2). Toyama City data show that the city's population demographics changed significantly between 1995 and 2020 [4]. The city's population in 1995 was estimated to be at 409,000. The population saw significant growth in 2008, reaching roughly 422,000 persons. Nevertheless, by the year 2020, the population had had a little decline, reaching around 413,000. These population trends offer useful insights into the demographic shifts in Toyama City during a 25-year period, as documented in the Population Statistics of Japan for the years 1995, 2008, and 2020. The gender ratio has remained steady despite a significant increase in the proportion of older people in the population [13]. The proportion of individuals 65 and older increased from 17.6% in 1995 to 30.2% in 2020, whereas the percentages of those aged 0–14 and 15–64 decreased from 16.1% and 66.3% in 1995 to 14.6%

and 55.2% in 2020, respectively [13]. Toyama City is aging rapidly, which may influence its social and economic development [15].

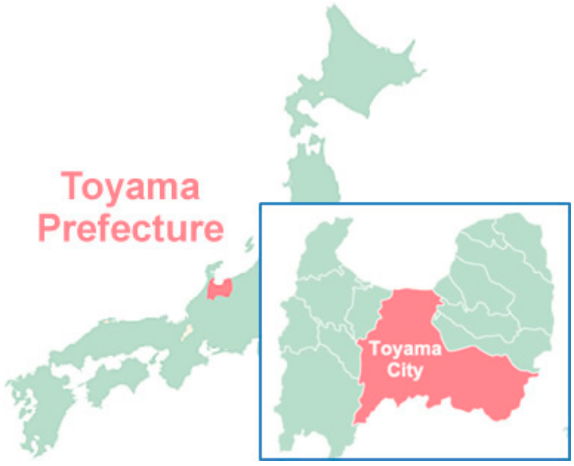

Figure 2. Geographical location of Toyama City (source: Toyama Prefecture).

Toyama City has a humid subtropical climate characterized by four distinct seasons and substantial rainfall [16]. The average annual rainfall is 2215 mm, and the mean temperature is 12.8 °C [17]. The city is often affected by typhoons, which can bring powerful winds and intense rainfall, which can hamper its attempts to combat climate change by developing net-zero energy communities and enhancing public transit [3]. Notwithstanding these endeavors, the severity of typhoons is an ongoing concern [18]. Toyama has a long history of proactive disaster management, dating back to the 1800s [3]. The city's ability to recover from adversity was strengthened by its reactions to calamities such as the Hōei earthquake and the Toyama flood, resulting in improved infrastructure and disaster prevention plans [19]. After World War II, the city prioritized contemporary urban planning and industrial growth [20]. In 2007, it became a member of the 100 Resilient Cities Network, demonstrating its dedication to effectively managing urban crises and responding to diverse challenges [10].

2.3. Socio-Hydrology

Comprehending the Social–Ecological–Technological Systems (SETS) framework necessitates a grasp of socio-hydrology [21]. Socio-hydrology is a multidisciplinary field that significantly impacts the management of disasters [22]. It offers a perspective that allows us to analyze how land use, urbanization, and population growth affect the frequency and intensity of floods [23]. Socio-hydrology has been crucial in developing Toyama City's flood risk control program [24]. This program employs a holistic and cohesive strategy that combines physical interventions, disaster readiness and response, controlled land utilization, and community engagement [5]. This strategy has several advantages: it not only increases public knowledge and understanding of flood hazards but also strengthens the community's ability to withstand and recover from floods and improves methods to reduce flood risks [3].

Socio-hydrology is employed to understand the course of sustainable urban disaster management in Toyama City because flooding has historically been the most serious urban disaster in the city [5]. Socio-hydrology provides a systematic method for studying the complex relationship between natural water systems and social systems by constructing SETS [24]. Socio-hydrology explicitly investigates the interplay between social systems and hydrology to comprehend how these interactions lead to urban disasters, including floods, droughts, typhoons, and earthquakes [25]. Disasters in urban settings are influenced by alterations in land use, rates of urbanization, and population dynamics [26]. Toyama City is now implementing sustainable disaster management and prevention measures that

consider the extensive utilization of space in urban areas, environmental shifts, and the increasing elderly and immigrant populations [10] (Figure 3).

Figure 3. Aging society and population shrinking in Toyama City (Dall.E, created 2024).

Toyama City is a coastal city where water systems not only provide resources but also cause disasters [27]. Thus, effective disaster management requires integrating social and hydrological factors [28]. Analyzing the relationship between social activities and these systems uncovers weaknesses and provides insights for developing measures to enhance resilience [29]. The insights provided by socio-hydrology about the influence of human activities on water-related disasters are crucial for urban planning, particularly in light of climate-change-induced alterations to water systems that heighten the risks of such disasters [30]. Socio-hydrology facilitates predicting and preparing for changes and establishing effective disaster management policies [5]. This approach focuses on understanding and solving the intricate connections between human societies and water systems [5].

The Social–Ecological–Technological Systems (SETS) framework is a comprehensive method designed to comprehend and tackle the intricate interplay of human societies, ecosystems, and technology systems in the realm of water resources management [21]. The SETS framework is not a quantitative model with explicit parameters to be computed but rather a conceptual framework that directs the examination of intricate systems.

The parameters S1, S2, S3, E1, E2, E3, T1, T2, and T3 are not numeric numbers but rather symbolic representations of distinct elements within the social (S), ecological (E), and technical (T) systems. For instance, S1, S2, and S3 might denote distinct social variables such as systems of governance, actions of stakeholders, and societal structures. Similarly, E1, E2, and E3 might denote distinct ecological aspects such as ecosystems, biodiversity, and ecological processes, while T1, T2, and T3 could indicate diverse technological factors such as infrastructure, engineering solutions, and technologies utilized in water management.

The parameters in the Social–Ecological–Technological Systems (SETS) framework (S1, S2, S3, E1, E2, E3, T1, T2, T3) were derived from a qualitative study of the data. Each parameter corresponds to a distinct topic or notion that has been found in the data pertaining to social, ecological, and technical issues.

The 'calculation' of SETS in this sense refers to a qualitative interpretation of themes or concepts, rather than a mathematical computation. We conducted a frequency analysis of terms associated with each subject or idea in the disaster management materials of Toyama City. The frequency of these keywords and their proportion of the overall number of keywords were utilized to assess the level of importance given to these aspects in the policy papers.

3. Research Design

This research aims to develop a comprehensive understanding of the basic principles of disaster prevention and management in the City of Toyama using socio-hydrology within the framework of SETS. Five significant statutory and governmental policy documents have been selected to assess the effectiveness of keyword allomorph analysis for this SETS analytical tool. The governmental statutory papers were selected based on their publication and execution in 2023. Table 2 provides precise definitions and requirements for each government document. The objective of our research team is to provide answers to the following inquiries:

(1) How do the UN SDGs and Toyama City's disaster management policy trend align?
(2) What strategies does Toyama City use to integrate the SETS and UN SDGs into its disaster management policy?

Table 2. Statutory documents of Toyama City. (These documents are statutory documents of the Toyama City Authority in 2023.)

Statutory Policy Document	Key Points from Agenda
Comprehensive Urban Plan	The plan aims to centralize services and population, cut CO_2 emissions, and rejuvenate the city center, positioning Toyama as an exemplary compact city.
Disaster Prevention Plan	The plan integrates multiple SDG targets, addressing demographic shifts, energy, industry, and community connectivity in a unified approach.
Flood Prevention Plan	The plan tackles natural disasters like floods, emphasizing the crucial role of multi-stakeholder partnerships in these efforts.
Development Knowledge of Toyama City	The document offers an in-depth account of Toyama City's sustainable evolution, encompassing a literature review, stakeholder interviews, and illustrative maps and diagrams with an external global view.
Toyama City the Sustainable Development Goals Report	The report details Toyama City's proactive SDG-aligned policies and planning, highlighting its commitment to environmental concerns in pursuit of sustainability.

Toyama City has received acclaim for its innovative approach to disaster management, which is firmly based on the principles of the SDGs [3]. An in-depth analysis of the city's Comprehensive Urban Plan, Disaster Prevention Plan, Flood Prevention Plan, Development Knowledge of Toyama City (DKTC), and Toyama City Sustainable Development Goals (TCSDG) documents reveals a deliberate focus on gauging and qualitatively measuring resilience and sustainability in terms of urban disaster management.

The Comprehensive Urban Plan, which delineates the city's long-term vision and strategic planning, is essential for comprehending its urban growth and disaster management approach. The Disaster Prevention Plan is the main framework for Toyama City's initiatives to avoid and address urban disasters. It offers a detailed overview of the city's efforts to reduce the impact of disasters and effectively respond to them. The Flood Prevention Plan primarily addresses flood management and is a crucial component of socio-hydrology. The DKTC thoroughly examines the city's growth path, including important background information for its disaster management techniques and socio-hydrological approach. The TCSDG report highlights the city's dedication to achieving the SDGs by 2030.

A study of the semantic allomorph content keywords with these documents provides additional evidence for their implied factors and trends toward disaster management and sustainability. The repeating terms, such as "compact", "resilience", "sustainability", and "community participation", indicate a significant connection with socio-hydrology concepts. Therefore, these records are not only pertinent but also indispensable for a thorough and perceptive examination of Toyama City's overall disaster management policies.

Keyword allomorph analysis involves examining the patterns and structures in a text by deconstructing it into its smallest meaningful parts, known as allomorph units. Then, the frequency and distribution of these allomorphs are investigated. Such analysis can offer a valuable understanding of the semantic and syntactic structures of the text, as well as the fundamental themes and concepts [31]. Keyword allomorph analysis is a valuable analytical method for studying Toyama City because it allows for extracting important allomorphs that characterize the city's approach to disaster management.

Hong and Tanaka [5] analyzed flood prevention government documents in Japanese cities using SETS, a methodology based on socio-hydrology. They reported that each prefecture in Japan generates new policy documents on many urban issues, including urban development, environmental planning, flood mitigation, and disaster prevention planning. Our team has developed a research analysis tool for the Toyama City case based on their prior study. The Dedoose qualitative research instrument was utilized to investigate this SETS framework. At first, our team gathered essential data and documents about government document files in accordance with the most recent legislation and policy requirements. The text resources were classified into allomorph units for further analysis. The SETS paradigm's coding matrix served as the basis for evaluating the urban disaster management units. The coding matrix was divided into three system categories: social, ecological, and technological. The social system includes social institutions, communication, and normative/economic aspects. The ecological system consists of ecosystem conservation, green infrastructure, and ecological services. The technological system encompasses technical design, engineering infrastructure, and analysis of climate change data. We employed the SETS analytical framework developed by Chang et al. [21]. This study's findings offer comprehensive knowledge of how the city approaches disaster management from a socio-hydrological perspective.

4. Results

The results of this research can offer direction for formulating forthcoming disaster management policies for Toyama City. The SETS coding matrix analysis quantitatively explains the city's urban planning policies and patterns. The text highlights a strong focus on social factors, namely those related to disaster preparedness, preventive policies, and economic benchmarks (S1: 6.25%, S3: 37.5%). Furthermore, technology infrastructure, namely engineering-related elements, is emphasized (T2: 31.25%). The analysis reveals significant deficiencies in the current policy, particularly in the areas of knowledge sharing, legislation and regulations, disaster preparedness exercises (S2), green infrastructure and advanced engineering technology (E2), and the implementation of disaster management warning systems, data simulations, website operations, risk management, and mapping (T3).

These findings indicate that Toyama City's present approach and patterns of emphasis in urban planning and disaster management strategies favor social and technical aspects. However, the overlooked areas require greater attention in future planning efforts. Toyama City should prioritize these domains and consider the social, technological, and ecological aspects to enhance the comprehensiveness and effectiveness of urban planning and disaster management. This approach can foster urban growth that is both environmentally sustainable and able to withstand challenges in the future.

The analysis of Toyama City's Disaster Prevention Plan with the SETS coding matrix shows a significant focus on social structures and communication (S1: 20.75%), as well as technical and infrastructural measures (T1: 16.98%, T2: 18.87%). This finding suggests that the city's current disaster management strategies are highly concentrated on these specific locations. However, information distribution, legal structures (S2: 7.55%), and socio-economic factors (S3: 5.66%) are assigned less importance, indicating room for development. The environmental categories (E1: 1.89%, E2: 3.77%, and E3: 11.32%) have different focuses, with the strongest emphasis on ecological services and improving water quality. These insights offer a comprehensive understanding of Toyama City's current disaster management policy, emphasizing its strengths and areas that require improvement.

The evaluation of Toyama City's Flood Prevention Plan for 2023 reveals a notable emphasis on technical and social factors, while ecological components receive less consideration. T3 achieved the highest grade, scoring 22.01%. This indicates a significant focus on utilizing technology for disaster alerts, risk management, and related tasks such as modeling disaster management data, managing websites, and making maps. The current strategy prioritizes social factors, such as disaster planning and information exchange, allocating 17.43% to S1 and 18.34% to S2. This signifies a holistic approach to catastrophe management encompassing institutions and communities. However, the ecological components (E1:0.91%, E2:0.91%, and E3:6.42%) receive low scores, indicating a potential area for development. Thus, improved integration of ecological components into the city's flood management plans is necessary. By enhancing efforts in ecological protection and implementing environmentally friendly infrastructure, the city can strengthen its resilience against floods while creating ecological benefits. Toyama City's flood management policy focuses on employing technological solutions and encouraging active public involvement. Nevertheless, integrating ecological concerns more fairly and justly might enhance future planning. Implementing this measure will not only enhance the city's capacity to endure floods but also promote sustainable urban development.

Applying the SETS coding matrix to Toyama's 2023 DKTC Plan provides significant insight into the city's policy direction and patterns. The data highlight a strong focus on social aspects in emergency planning, preventative strategy, institutional management, civic communication, and governance (S1: 35.47%). Furthermore, distributing knowledge, implementing rules and regulations, adopting disaster management techniques, and conducting disaster prevention drills account for 21.96% of the overall focus. The strategy prioritizes socio-economic criteria, financial fundraising, cost-benefit analysis, and insurance (S3: 11.49%). Regarding technology, there is a strong focus on infrastructure engineering in areas such as dams, levees, dykes, building rehabilitation, spatial remodeling, spatial system monitoring, and maintenance (T2: 14.19%). The plan incorporates technological advancement, implementation of building codes for disaster management, and advancement in construction materials (T1: 6.42%).

Additionally, it includes a warning system for disaster management, data simulation, website management, risk management, and mapping (T3: 5.41%). Nevertheless, the current plan fails to adequately address ecological concerns such as preserving natural habitats, managing green spaces, promoting healthy ecosystems, conserving the environment, establishing habitat corridors (E1: 2.36%), implementing green infrastructure, utilizing green engineering technology (E2: 2.36%), and enhancing ecological services and water quality (E3: 0.34%). The findings indicate that although Toyama's present vision plan prioritizes social and technological aspects, disaster management plans may be improved with a stronger emphasis on ecological concerns, leading to a more equitable and enduring strategy.

According to the TCSDG 2023 document, Toyama City scored 20.79, indicating its commitment to maintaining high social and economic standards (S3). Nevertheless, the modest rating of 3.96 for ecological services and water quality enhancement (E3) indicates an area for improvement. Toyama City's future disaster management plans should be improved by prioritizing ecological protection and technological innovation. Implementing this measure will not only enhance the city's ability to withstand and recover from disasters but also significantly contribute to achieving wider objectives of sustainable urban development.

To summarize, the SETS coding matrix findings for five statutory Toyama's 2023 disaster management plan documents reveal important policy directions and trends. The categories of S1 (18.95), S3 (16.74), and T2 (18.57) exhibit the highest scores, suggesting a significant emphasis on social emergency planning, prevention policy, institutional management, civic communication, governance, socio-economic standards, financial fundraising, cost-benefit analysis, insurance, and engineering infrastructure such as dams, levies, dykes, building renovation and remodeling, spatial system monitoring, and maintenance. Nevertheless, the ratings are relatively lower for E1 (3.67), E2 (3.39), and E3 (6.91), which are

related to ecological conservation, green space management, healthy ecosystems, environmental conservation, habitat corridors, green infrastructure, green engineering technology, and ecological services like water quality improvement. Thus, future strategies can improve in these areas.

Regarding technological aspects, the scores for T1 (10.51) and T3 (9.71) indicate a moderate emphasis on technical innovation, including implementing a building zoning code for disaster management, developing building materials, establishing a warning system for disaster management, simulating disaster management data, operating a website, managing risks, and mapping. The 2023 disaster management strategy of Toyama City primarily focuses on social and technological issues. Nevertheless, future iterations would benefit by prioritizing ecological components.

5. Discussions

Through an extensive analysis of the allomorph-level keywords in several governmental statutory planning documents from Toyama City, we identified the subsequent directions of the disaster management policy. The SETS coding matrix findings provide quantitative evidence of the importance of several socio-hydrological factors in Toyama City's current disaster management strategy and patterns (Figure 4). The values represent the frequency or significance of each category in the studied texts. As our study shows, the SETS coding matrix and the UN SDGs are all-encompassing frameworks specifically created to address intricate and interrelated problems. Both exhibit several parallels.

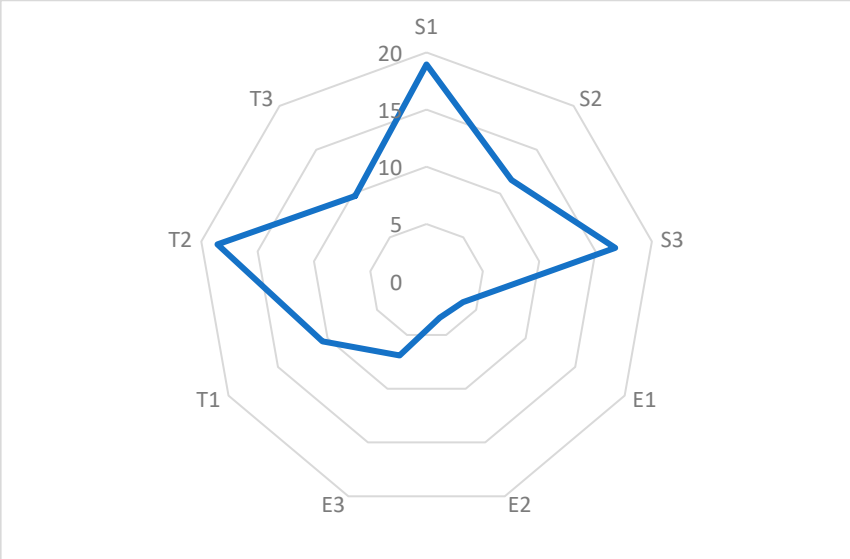

Figure 4. Disaster management policy trends of Toyama City through SETS.

The social dimensions (S1, S2, S3) of the SETS matrix are closely related to many SDGs, such as Goal 1 (Eradicating Poverty), Goal 2 (Eliminating Hunger), Goal 3 (Promoting Health and Well-being), Goal 4 (Advancing Quality Education), and Goal 5 (Achieving Gender Equality). The SETS matrix and the SDGs emphasize the pivotal role of social policies, economic norms like insurance, and institutional management in achieving sustainable development. The disaster management policy inclinations of Toyama City mostly focused on social education and global well-being. The ecological aspects (E1, E2, E3) align with many SDGs that emphasize environmental sustainability, including Goal 13 (Climate Action), Goal 14 (Life Below Water), and Goal 15 (Life on Land). Both frameworks prioritize ecological protection, green infrastructure, and ecological services. The technological components T1, T2, and T3 align with Goal 9 (Industry, Innovation, and Infrastructure) and Goal 11 (Sustainable Cities and Communities). The SETS coding matrix and the SDGs have a common objective of attaining sustainable development by implementing a comprehensive

strategy that encompasses social, economic, technical, and ecological aspects. To ensure policies are comprehensive, fair, and aligned with global sustainability goals, cities like Toyama City may develop disaster management plans considering the SETS matrix and the SDGs.

This study's findings highlight the substantial impact of social variables, particularly emphasizing community-related aspects. Infrastructure engineering and maintenance are vital in the city's disaster management strategy. Toyama City's disaster management strategies demonstrate a significant dependence on technology and infrastructure, with a noticeable lack of attention to ecological concerns. Therefore, increased focus on ecological conservation and management is needed to develop sustainable urban disaster plans that align with SDGs.

Toyama City's urban disaster management strategy, influenced by UN SDGs 3 and 9, aims to create a vibrant, sustainable urban environment following a compact city model. The city has added light rail, trams, buses, and bikes to revitalize its public transportation, encouraging population migration to areas near these services, supported by incentives like subsidies and housing loans. This compact city model reduces CO_2 emissions, enhances mobility, and enriches cultural life, contributing to the SDGs. Toyama's disaster risk program aligns with SDGs 3 and 17, emphasizing community collaboration and communication, with measures like public education on disaster preparedness, clear evacuation plans, and regular strategy assessments to effectively manage risks like floods and tsunamis. Toyama City has implemented several urban stream management strategies to decrease the risk of inland and coastal floods, which pose the greatest threat to the city's floodwater control efforts. The regional authorities have implemented a system of levees, reservoirs, and canals to modify and control the path of floods [5]. This infrastructure receives periodic inspections and maintenance to ensure the efficacy of flood management. This includes maintaining river channels, constructing flood embankments and levees, and implementing gates and other hydraulic structures, as outlined in SDGs 9 and 11. Toyama's flood risk management program is executed through a comprehensive and synchronized strategy integrating physical interventions, disaster readiness and response, limited land use planning, and community engagement. The objective is to reduce the likelihood of flooding and alleviate its consequences on the urban area and its inhabitants through efficient communication with the local population, aligning with SDG 17. The efficacy of Toyama City's flood response program is evidenced by the recent lack of notable flood calamities despite the region's vulnerability to floods.

The Disaster Prevention Department of Toyama City actively gathers and disseminates disaster data to reduce the effects of urban disasters. The urban land use plan reallocates floodwater for agricultural uses, while stringent construction controls in flood-prone regions and environmentally friendly infrastructure such as rain gardens successfully control precipitation management. Robust disaster response systems, encompassing early warning systems and training exercises, bolster community resilience. Toyama demonstrates its dedication to the SDGs by providing multilingual disaster materials and assistance to immigrant populations. Implementing the SDGs in disaster management improves the ability to withstand and recover from disasters, decreases susceptibility to harm, safeguards the natural surroundings, and advances economic and social advancement, creating worldwide harmony and sustainable growth.

Based on Table 3, Toyama City's disaster management policy should incorporate green infrastructure and ecological protection to improve sustainability in line with the SDGs. The SETS paradigm proposes an increased consideration of ecological factors (E1, E2, E3) in mitigating the vulnerability to disasters. Implementing ecosystem-based solutions, such as managing wetlands, forests, and coastal systems, can reduce the effect of natural disasters and enhance socio-economic resilience. Moreover, these ecosystems provide advantages such as cleansing water and air, ensuring food security, and contributing to biodiversity protection. Emphasizing the importance of environmental protection and

ecosystem services is crucial for achieving a well-rounded and sustainable strategy for urban disaster management.

Table 3. Results heat-map of the allomorph coding analysis for disaster management policy trends of Toyama City (Percentage of Codes).

SETS	Comprehensive Urban Plan	Disaster Management Plan	Flood Prevention Plan	DKTC	TCSDG	Average
S1	6.25	20.75472	17.43119	35.47297	14.85149	18.95207
S2	0	7.54717	18.34862	21.95946	9.90099	11.55125
S3	37.5	5.660377	8.256881	11.48649	20.79208	16.73916
E1	6.25	1.886792	0.917431	2.364865	6.930693	3.669956
E2	0	3.773585	0.917431	2.364865	9.90099	3.391374
E3	12.5	11.32075	6.422018	0.337838	3.960396	6.908201
T1	6.25	16.98113	11.00917	6.418919	11.88119	10.50808
T2	31.25	18.86792	14.6789	14.18919	13.86139	18.56948
T3	0	13.20755	22.01835	5.405405	7.920792	9.710419

The urban disaster management strategy of Toyama City was a comprehensive approach which can be clearly categorized based on the Social–Ecological–Technological Systems (SETS) framework. However, it distinguishes itself by placing significant importance on the integration of sustainability principles, which is notably influenced by the United Nations Sustainable Development Goals (SDGs) 3 and 9. In contrast to comparable studies [5,21] examined in SETS analysis, the strategy implemented by Toyama City exhibits a thorough congruence with the Sustainable Development Goals (SDGs). This is achieved through the utilization of compact city models, sustainable transportation initiatives, and robust disaster risk reduction programs [6]. By implementing this strategic alignment, not only are immediate disaster risks mitigated, but broader socio-economic and environmental goals need to be also advanced, promoting resilience and sustainable development [32]. Although certain investigations conducted within the SETS framework may concentrate on particular facets of social, ecological, or technological systems, Toyama's strategy should emphasize the interdependence of these elements and the criticality of incorporating environmental factors into policies governing disaster management [21]. Therefore, the approach taken by Toyama City is a significant case study that can contribute to the advancement of knowledge and application of SETS principles in the context of urban disaster management.

Integrating environmentally friendly and ecologically conscious elements is crucial for urban disaster management in Toyama City [33–35]. Its urban districts, characterized by their aging and globalized population and infrastructure, might benefit from implementing environmentally friendly solutions such as green roofs, green walls, and urban forests [36,37]. These actions enhance ecosystems to withstand and recover from disturbances and adjust to the effects of climate change [38,39]. Furthermore, they provide economic benefits by reducing expenses associated with disaster recovery and offering services like carbon sequestration [40,41]. Toyama City's commitment to the SDGs may facilitate global collaboration, mitigate the impact of disasters, and promote long-term sustainable development [42,43].

6. Conclusions

The compact city model of Toyama has significant implications for Japanese society regarding disaster prevention and management. Toyama also benefits from exchanging ideas and best practices with other cities pursuing similar goals and visions. Toyama City has been praised for its novel approach to disaster management, which is strongly anchored in pursuing SDGs [3]. A thorough examination of Toyama City's statutory documents demonstrates a strategic emphasis on resilience and sustainability [4].

The present study showed common ground between UN SDGs and SETS by analyzing Toyama City's disaster management strategy. We analyzed five governmental disaster management documents in Toyama City by adopting the SETS tool. The SETS coding matrix analysis provides a comprehensive understanding of the current disaster management policies and patterns in Toyama City. The analysis reveals a significant focus on social (S1, S2, S3) and technological (T1, T2, T3) factors, specifically linked to emergency preparedness, preventative policy, economic standards, and engineering infrastructure. Nevertheless, the lack of consideration for ecological issues (E1, E2, E3) indicates a deficiency in the existing policy approach. Thus, a more equitable disaster management plan that equally considers the social, technological, and ecological factors is needed. Addressing this demand will facilitate a more complete and sustainable disaster management plan, thereby enhancing the city's ability to withstand and overcome socio-hydrological challenges. This work not only adds to the growing body of research on socio-hydrology but also offers significant insights for policymakers and researchers involved in disaster management in Toyama City.

Toyama City's disaster management strategy within the compact city framework should focus on enhancing urban resilience by minimizing the risk and impact of natural hazards through green infrastructure and ecological preservation. Future policy studies on Toyama disaster management should focus on incorporating these ecological issues into the city's disaster management strategy to guarantee a holistic solution to socio-hydrological challenges. Key ecological initiatives include bolstering public transportation to lessen reliance on private vehicles, relocating residents to safer zones with better amenities and reduced disaster risk, and creating net-zero-carbon neighborhoods utilizing renewable energy to lower emissions and bolster energy independence. These measures can fortify the city against disasters while advancing sustainable urban living.

Although our research primarily focuses on Toyama City, it provides wider and more comprehensive insights. The SETS model may be universally applied to improve urban resilience. These research findings will be able to enhance comprehension of how cities may synchronize urban disaster management with the UN SDGs. The issues encountered by Toyama City are prevalent globally, rendering our identified tactics and solutions a relevant point of reference for other urban areas.

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