The Development of Sustainable Water Environment Policies in Dalian and the Potential for International Cooperation

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***Abstract*—This paper examines the development of water environment policies in Dalian, Liaoning Province, China. It analyzes a broad range of initiatives including the protection of drinking water sources, restoration of major rivers, remediation of black and odorous water bodies, construction and renovation of wastewater treatment facilities, implementation of the Sponge City concept, promotion of reclaimed water usage, and countermeasures against industrial water pollution. These measures are not only crucial for improving the urban ecological environment but also directly impact public health and the stability of urban life. Through a phased approach, Dalian has achieved tangible progress in enhancing its water environment. Furthermore, the paper highlights the significance of international cooperation, particularly with Kitakyushu City in Japan, which has provided technological exchange and public-private collaboration frameworks. This cooperation has contributed to the realization of Sustainable Development Goal 6 (clean water and sanitation for all) and serves as a model for city-to-city partnerships aimed at sustainable urban water governance. The study concludes that further institutionalization of water resource management, citizen engagement, technological innovation, and the sharing of international best practices are essential for the advancement of more resilient and sustainable water environment policies in Dalian and other growing cities across Asia.**

***Keywords*—water environment policy, sustainable urban management, Sponge City, Japan-China intercity cooperation, reclaimed water utilization**

I. Introduction

One of the central issues in urban policy in the 21st century is the sustainable management of the water environment. In particular, major cities in China that have undergone rapid urbanization and industrialization face a complex set of challenges, including the stable supply of water resources to support daily life and industrial activities, water quality conservation, and the efficient treatment of urban wastewater. Dalian, located in Liaoning Province, is one such city. This paper examines the current state and future prospects of water environment policies in Dalian.

As a strategic coastal city in northeastern China, Dalian has played an important role in various sectors such as economy, trade, tourism, and industry. However, as the city has expanded, it has come to face multiple and interconnected water-related challenges, including water shortages, aging infrastructure, excessive groundwater extraction, and water pollution. These issues go beyond the environmental sector alone, exerting a serious impact on public health, the sustainability of industrial activities, and the livability and attractiveness of the city. Addressing them requires a comprehensive and integrated approach.

This study reviews the major water environment policies implemented in Dalian over the past decade, including the protection of water sources, restoration of river systems, remediation of black and odorous water bodies, construction and renovation of wastewater treatment facilities, implementation of the Sponge City [1] concept, and regulation of industrial wastewater. It also analyzes how these measures have been institutionalized and integrated into local communities and urban life.

Furthermore, this paper pays special attention to the potential for international cooperation in shaping Dalian's water policies. Notably, Kitakyushu City in Japan, which once suffered from severe water pollution but has since gained global recognition as an environmental model city, has actively expanded into the water business sector. Kitakyushu and Dalian have already built a track record of cooperation through technical training and public-private partnerships, providing a strong foundation for deepening collaboration. Therefore, by analyzing Dalian's case in light of such partnerships, particularly with Japan's advanced examples, this paper aims to derive more universal insights into urban environmental governance.

The structure of this paper is as follows. Section II outlines the natural water systems and wastewater treatment infrastructure of Dalian, clarifying the current physical and environmental foundations. Section III analyzes the present water-related challenges such as shortages and pollution, as well as the policies addressing them. Section IV discusses future prospects for building a sustainable urban water environment, focusing on four key policy pillars. Finally, Section V explores the potential for international collaboration – especially with Kitakyushu-as a model for sustainable intercity cooperation centered on water governance.

II. Current Status of the Water Environment in Dalian

Dalian is a coastal city located in Liaoning Province in northeastern China, situated at the southern tip of the Liaodong Peninsula. Geographically, it is surrounded by the Yellow Sea to the east and south and the Bohai Sea to the west, facing the Shandong Peninsula across the sea. These geographical characteristics have historically positioned Dalian as a strategic hub for transportation, trade, and military operations along China's eastern coast. The total area of Dalian spans approximately 13,000 square kilometers, and the population, encompassing both urban and rural regions, is estimated at around 7 million. Today, the city has established itself as a key center for economic activity, trade, port logistics, industry, and tourism in northern China [2].

Dalian's climate falls under the temperate continental

monsoon zone, with distinct seasonal changes. Precipitation varies considerably by season, with the majority concentrated in the summer due to the East Asian monsoon and typhoon effects. In contrast, winter and spring are characterized by prolonged dry periods, resulting in a significant reduction in river flow. Consequently, many rivers in the city are seasonal, lacking a stable year-round flow. These hydrological characteristics present important constraints in water resource supply, management, and urban planning.

In terms of its natural water system, Dalian has more than 200 rivers belonging to the eastern catchments of the Yellow Sea and Bohai Sea. Among the major rivers are the Biliu River, Fuzhou River, and Dengsha River. These waterways play a critical role in draining stormwater and providing irrigation to both urban and rural areas. The city has developed a relatively advanced waterway network that accommodates regional variations in topography and climate, forming a water infrastructure closely integrated with natural features.

Historically, these natural water systems have functioned as indispensable infrastructure for urban development and living environments. Water resources have been utilized for diverse purposes, including industrial operations, domestic consumption, and agricultural irrigation. However, rapid urbanization and industrialization in recent years have led to increased wastewater volumes and deterioration in water quality. As a result, the natural hydrological systems have become overstressed, necessitating the urgent development of artificial drainage and wastewater treatment infrastructure.

Dalian has made remarkable progress in recent years in developing its drainage and wastewater treatment facilities. These systems are now recognized as essential infrastructure to support the city's rapid growth and increasing population density. The total length of the municipal drainage pipeline network has reached approximately 5,000 kilometers, effectively covering the entire city. This includes around 1,953 kilometers of stormwater pipelines, 1,611 kilometers of sanitary sewers, and 1,436 kilometers of combined sewer systems. The existence of this extensive network has significantly reduced flood risks during heavy rainfall and enabled hygienic treatment of both domestic and industrial wastewater [3].

Focusing on the city center, the stormwater pipelines extend approximately 265 kilometers, the sanitary sewers 189 kilometers, and the combined sewer lines 863 kilometers [4]. This composition reflects the legacy infrastructure in older districts, where combined sewer systems were historically employed. With urban redevelopment and rising demand, Dalian is shifting towards a separate sewer system that distinguishes between stormwater and sanitary wastewater. In newly developed areas-such as the High-Tech Zone, Changxing Island Development Zone, and Huayuankou Economic Zone-stormwater and sewage separation has been implemented from the planning stage, establishing sustainable water infrastructure from the outset. These developments demonstrate Dalian's ongoing efforts to modernize and upgrade its urban systems in line with environmental conservation goals.

The city currently operates a total of 32 wastewater treatment plants, of which 29 meet China's top-tier "Class A Effluent Discharge Standard" [4, p. 2]. These facilities boast a combined daily treatment capacity of approximately 1.7 million tons, covering not only household sewage but also industrial effluent. This has played a major role in maintaining public sanitation and protecting water quality in public water bodies. In addition, Dalian has established a dedicated sludge treatment facility with a daily capacity of around 600 tons. This facility processes sludge through dewatering and volume reduction, and there are ongoing efforts to reuse the processed solid waste as a resource, contributing to a circular economy model.

In summary, Dalian is actively working to protect its natural water systems while modernizing its urban drainage and wastewater infrastructure in a coordinated manner. The integration of infrastructure development with environmental policy ensures the long-term stability of water resource management and urban sustainability. Moving forward, further advancement in comprehensive water management-carried out in partnership with the local community-will be essential to sustaining both ecological and urban development.

III. Water Environment Issues and Policy Responses in Dalian

A. Water Environment Challenges in Dalian

As a coastal city in Liaoning Province in northern China, Dalian hosts a diverse range of industries including manufacturing, trade, and tourism. However, it is also confronted with serious water environment challenges. The rapid pace of urbanization and industrialization has led to a convergence of complex problems such as limited water resources, aging infrastructure, excessive groundwater extraction, and deteriorating water quality – all of which pose substantial risks to the city's sustainable development.

First and foremost, Dalian receives relatively limited annual precipitation and is classified as a water-scarce region due to its geographical and climatic conditions. The growing population and increasing demand for industrial water have made water shortages a persistent issue. During dry seasons, water scarcity can become particularly acute, threatening the stability of urban life and industrial operations. Thus, securing reliable water sources and ensuring their efficient use has become a pressing policy priority [3, p. 2].

Another major concern is the high rate of water leakage. Many sections of Dalian's water distribution network are aging, and the leakage rate remains high. This not only leads to the loss of valuable water resources but also causes drops in water pressure and disruptions in supply, thereby affecting residents' quality of life. In some cases, leaks can also become entry points for contaminants, posing public health risks. Therefore, early detection and repair of leaks, along with systematic pipeline replacement, are urgently needed.

Water pollution is also a growing issue. As urban development has progressed, the volume of domestic and industrial wastewater has surged, outpacing the expansion of sewer infrastructure and wastewater treatment capacity in some areas. This has resulted in eutrophication in rivers and lakes, the spread of foul odors, excessive algal blooms, and the emergence of "black and odorous" water bodies. Such environmental degradation not only harms aquatic ecosystems but also negatively impacts residential living

conditions and the tourism sector [5].

In addition, excessive groundwater extraction presents another critical problem. To compensate for surface water shortages, groundwater has been over-utilized for years, exceeding sustainable withdrawal limits. As a result, Dalian has experienced land subsidence and saltwater intrusion, undermining the long-term reliability of groundwater as a source. Land subsidence poses structural risks to buildings and infrastructure, requiring careful management within the context of urban planning [6].

These water-related problems are deeply interconnected, making isolated responses insufficient. For instance, water scarcity increases dependence on groundwater, which in turn accelerates land subsidence. High leakage rates reduce overall supply efficiency and exacerbate shortages. Meanwhile, the discharge of untreated wastewater deteriorates surface water quality, limiting the potential for water reuse. Consequently, Dalian needs an integrated water management strategy that addresses resource conservation, infrastructure renewal, water quality protection, and groundwater management in a coordinated manner.

To achieve this, the city must enhance its capacity for data collection and real-time monitoring, formulate sustainable water resource management plans, upgrade and modernize existing facilities, and establish technical partnerships with more advanced cities. In particular, cooperation with cities such as Kitakyushu in Japan – renowned for its successful water environment restoration – can offer valuable policy models, capacity-building opportunities, and practical insights into resource efficiency.

B. Major Measures for Water Environment Improvement in Dalian

In recent years, the Chinese government has positioned water environment improvement as a national strategic priority and has been strengthening both institutional frameworks and implementation capacity. In 2014, the "Regulations on Urban and Town Drainage and Wastewater Treatment" were officially promulgated and implemented, providing a foundational institutional structure for drainage and sewage management. This was followed in 2015 by the release of the "Action Plan for Prevention and Control of Water Pollution", which laid out clear policies to fundamentally prevent and improve water pollution. These policy developments respond to significant water-related challenges in China and play a vital role in achieving the vision of a "Beautiful China" characterized by blue skies, green mountains, and clear waters [7].

In line with these national policies, Dalian City formulated its own "Water Pollution Prevention and Control Project Plan" in February 2016 [4, p. 3]. The plan aims to strengthen water pollution measures, ensure water security, and address the urban water shortage crisis. It prioritizes improving the water environment and ensuring a healthy living environment for citizens. Dalian has mobilized citywide efforts to implement the following six key initiatives:

① Strengthening the Management of Water Sources Dalian has 13 urban drinking water source sites, including the Biliu River Dam and Yingna River Dam, which are essential for supporting both residential life and industrial activities. The Biliu River Dam, in particular, is a major source of stable year-round water supply. To ensure water quality and supply safety, the municipal government has imposed strict protective measures on these water sources. All enterprises discharging wastewater within protected zones have been shut down, and livestock operations impacting water sources have been reduced, relocated, or environmentally rehabilitated. Ecological resettlement programs have also been gradually implemented for affected residents. Furthermore, afforestation and riverbank greening projects have been carried out near major water sources, contributing to long-term ecological restoration and water quality stability.

② Restoration of Major Rivers Dalian's six major rivers, including the Zhuanghe, Fuzhou, Dengsha, and Dasha Rivers, are crucial for regional ecosystems and provide water for residential, industrial, and agricultural use. In recent years, water quality in parts of the Fuzhou and Dengsha Rivers has exceeded permissible limits. To address this, the city has launched comprehensive measures, including dredging of riverbeds to remove organic matter and heavy metals, and systematic garbage collection along riverbanks. Livestock operations contributing to pollution have been identified and regulated. The city has also implemented a "block zoning" method to divide river basins into sections for phased treatment. Under the "River Chief System", administrative officials are assigned to specific rivers to ensure clear accountability and rapid response, thereby advancing water quality improvements and ecosystem restoration [8].

③ Elimination of Black and Odorous Water Bodies Since 2015, Dalian has prioritized the elimination of black and odorous water bodies, especially in six major rivers flowing through central urban areas. These rivers had suffered from prolonged inflows of untreated domestic and industrial wastewater, leading to severe water degradation. With significant investment, the city targeted 21 discharge outlets and introduced measures such as sewage separation and advanced treatment systems [9]. These efforts have significantly improved water quality by cutting off pollution at the source. From 2018, efforts have expanded to include riverside greening, ecological restoration, and park development, transforming polluted water zones into public recreational spaces. This initiative is a symbolic achievement in Dalian's environmental policy, contributing to the vision of a "beautiful and livable hometown".

④ Construction and Renovation of Wastewater Treatment Facilities To accommodate rapid urbanization and population growth, Dalian has accelerated wastewater infrastructure development. Thirteen new treatment plants have been built, particularly in coastal areas such as Suoyu Bay and Dalian Bay, equipped with modern technologies and compliant with strict effluent standards. In addition, 12 existing facilities, including the Malan River and Chunliu River plants, have undergone upgrades to increase capacity and enhance nutrient removal capabilities. These new and upgraded facilities have significantly expanded the city's ability to collect and treat sewage, reducing the incidence of untreated discharge and contributing to public sanitation and water quality protection.

⑤ Promotion of Sponge City Development Dalian was selected in 2016 as one of China's second-round pilot cities for the national "Sponge City" initiative [10]. The concept

promotes next-generation infrastructure that allows urban environments to absorb, store, infiltrate, and purify rainwater. This reduces flood risk, enhances water reuse, and improves the urban climate. Dalian has translated this vision into policy through the "Central District Sponge City Master Plan" and draft guidelines for sponge city construction management. Practical measures include permeable pavement, greenbelts, rain gardens, and water storage facilities, particularly in public buildings and redevelopment zones. These efforts aim to raise rainwater management capacity and ecological quality citywide [4, p. 3].

⑥ Special Measures for Pollution-Prone Industries To address industrial sources of water pollution, Dalian has implemented targeted regulations. It has conducted surveys to identify high-risk industries and created a "Key Polluting Enterprises List" [4, p. 4]. Companies on this list are mandated to upgrade wastewater treatment, revise production processes, and manage hazardous substance discharges. Regulatory enforcement has been strengthened with administrative guidance, penalties, and shutdown orders for violators [11]. As a result, water quality has steadily improved, with over 85% of major river sections now classified as good. Previously black and odorous zones have largely been eliminated, and 100% of central water sources now meet high-quality standards. These improvements have significantly boosted the reliability of drinking water and the urban environmental quality. Dalian continues to shift toward an eco-friendly development model guided by the principles of "Nature, Ecology, and Green Growth".

These six strategic pillars demonstrate Dalian's commitment to comprehensive and sustainable water environment management, setting a model for other cities in China and beyond.

IV. Future Prospects for the Sustainable Development of Water Environment in Dalian

Based on China's overall strategy for building an ecological civilization, Dalian City has positioned water environment improvement as a key component of its sustainable urban development. Future water policies must go beyond pollution control and infrastructure development to embrace a comprehensive approach centered on harmony between humans and nature, aimed at enhancing quality of life and citizens' satisfaction and well-being. This section outlines four key pillars for ongoing and future water environment development efforts.

① Phased Water Environment Improvement and the Creation of Ecological Rivers Dalian has already made significant progress in its first phase of water environment improvement, especially by eliminating the majority of black and odorous water bodies in the city center. These efforts have enhanced sanitation and landscape quality for urban residents. However, these achievements are only the beginning. The second phase will need to focus on eliminating remaining polluted water bodies in suburban and rural areas. Ultimately, the third phase must aim to restore ecosystems and further improve water quality in already-treated areas. This involves transforming water bodies into sustainable ecological rivers where fish and aquatic plants can thrive. By creating natural river spaces with clear streams and scenic landscapes, Dalian can elevate its environmental quality, promote public health, and conserve biodiversity.

② Strengthening Comprehensive Sewer Collection and Treatment Systems To realize a sustainable water environment, Dalian must establish a complete sewer collection and treatment system throughout the city. This requires accurate assessment of the current drainage infrastructure, systematic upgrades of aging pipelines, and expansion into newly developed areas. With wastewater volumes fluctuating due to urban development and population growth, a long-term infrastructure strategy is essential. Wastewater treatment facilities must also be newly constructed, expanded, or upgraded according to regional needs. The adoption of space-saving, energy-efficient technologies and the addition of advanced treatment functions to existing facilities are crucial for optimizing the use of limited urban space and financial resources. These measures will enhance the overall sewage treatment rate and ensure system stability during rainy seasons and extreme weather events. Advanced sewer management is vital not only for environmental protection but also for improving the quality of urban life.

③ Full Implementation of Sponge City Principles and Integrated Infrastructure Development Dalian has embraced China's "Sponge City" initiative as a path to achieving both urban growth and water sustainability. A Sponge City is an urban model that absorbs, stores, infiltrates, purifies, and reuses rainwater to restore the natural water cycle. Dalian plans to develop infrastructure based on principles of planning-led, ecology-first, site-specific adaptation, and unified construction. Practical implementations include permeable pavement, greenbelts, artificial and natural water retention facilities, rooftop greening, and rainwater harvesting systems. The goal is to absorb and utilize over 70% of rainfall on-site, reducing urban flooding risk and simultaneously promoting water reuse and ecological restoration. The Sponge City concept is gaining importance as a new urban strategy that facilitates coexistence between the city and nature.

④ Promoting Water Conservation, Reuse, and Utilization of Non-Traditional Water Resources for Dalian, where water scarcity is a pressing issue, the efficient use of reclaimed water is a critical strategy. Reclaimed water, obtained through advanced treatment of wastewater, is a reliable alternative water source. It is widely applicable in non-potable uses such as agricultural irrigation, industrial cooling, urban landscaping, and road cleaning. To further promote its use, Dalian is improving treatment technologies and expanding distribution networks. The city is also actively institutionalizing and introducing technologies for collecting and using non-traditional water sources like rainwater. These initiatives are building a regional water reuse system tailored to local conditions. The benefits include alleviating water shortages, improving ecological environments, mitigating urban heat islands, and strengthening climate resilience. Moving forward, Dalian will advance sustainable urban water resource management centered on water conservation and cyclical utilization.

V. Prospects for Water Environment Development and International Cooperation in Dalian – Focusing on Partnership with Kitakyushu City

Dalian City has long placed the construction of an ecological civilization at the core of its urban policies, actively working to realize a livable environment characterized by "clear water and blue skies". In response to the complex challenges associated with urbanization and industrialization – such as water quality deterioration, insufficient sewage treatment capacity, and low rates of reclaimed water utilization-the city has implemented a range of measures in recent years. These include protecting water sources, constructing and upgrading sewage treatment facilities, and introducing sponge city initiatives. The results have contributed to improved public sanitation and enhanced urban landscapes, steadily advancing the city toward sustainable urban development.

In addition to these domestic efforts, Dalian has also proactively sought to elevate its water environment policies through international cooperation. Among such collaborations, its partnership with Kitakyushu City, Japan, stands out as a symbolic example. Once a major heavy industrial city, Kitakyushu faced severe pollution problems but achieved dramatic environmental recovery starting in the 1980s through stricter regulations on industrial discharge and comprehensive sewerage development [12]. As a result, the city was designated an "Environmental Model City" by the Japanese government in 2008 and was recognized in 2018 as Japan's first and Asia's first OECD "SDGs Model City", receiving global acclaim [13].

Since the establishment of a sister-city relationship in 1979, Dalian and Kitakyushu have maintained over four decades of exchanges. In the field of water environment, multi-faceted cooperation has been developed, including technology transfer, personnel training, and policy collaboration. Specifically, Kitakyushu has hosted numerous technical training programs for Dalian officials and engineers, allowing them to experience Japan's advanced environmental practices. Experts from Kitakyushu have also visited Dalian to conduct field assessments and provide technical advice on wastewater treatment and reclaimed water use. Moreover, companies headquartered in Kitakyushu—such as TOTO, Nippon Steel Chemical & Material, and Yaskawa Electric [14] – have cooperated with Dalian by supporting the installation of water-saving equipment and energy-efficient treatment systems, under a public-private partnership framework [15].

This form of city-to-city collaboration has evolved beyond traditional models of aid or one-way technology transfer, toward a co-creative partnership aimed at achieving the Sustainable Development Goals (SDGs) [16]. For instance, in implementing its sponge city plan, Dalian has drawn valuable insights from Kitakyushu's early experiences with green space development, permeable pavements, and rainwater storage systems. Furthermore, the two cities share common challenges-such as aging infrastructure and climate adaptation-which they are addressing through technology exchange and joint research, thereby exploring the creation of innovative urban models [4, p. 5].

Looking ahead, Dalian should continue to expand these international collaborations and strengthen its urban diplomacy centered on water environment improvement and ecosystem conservation. Under China's Belt and Road Initiative, city-level environmental technology cooperation has become a vital strategic pillar. Dalian's achievements and networks position it as a potential regional leader in this domain. By leveraging its partnership framework with Kitakyushu, Dalian can extend its technology dissemination and policy support to other cities in Southeast and Central Asia facing similar environmental challenges.

Moreover, Dalian's private sector and research institutions must strive to enhance their global capabilities through international certification, multilingual communication, and human resource internationalization. The city government, for its part, should develop systems that support the expansion of environmental businesses into emerging markets and establish integrated frameworks for project-based international cooperation involving both public and private sectors.

In summary, the cooperation between Dalian and Kitakyushu transcends traditional friendship-based exchanges. It embodies multi-dimensional values such as sustainable urban development, water resource conservation, and the construction of international environmental partnerships. The experience and outcomes of this collaboration can serve as a transferable model for other cities and are likely to be recognized as a pioneering practice in urban environmental governance in the Asia-Pacific region.

VI. Conclusion

This paper has examined the current state, challenges, and future prospects of water environment policy in Dalian City. Historically, Dalian faced a wide range of complex water-related issues due to rapid urban expansion and industrial development. However, in recent years, supported by national-level policy initiatives and proactive local government efforts, the city has begun to show steady signs of improvement.

Notably, the conservation of water sources, dredging and rehabilitation of major rivers, comprehensive remediation of black and odorous water bodies, the construction and upgrading of wastewater treatment facilities, and the introduction of the sponge city concept aimed at urban flood mitigation represent a comprehensive model of water environment improvement, addressing both hard (infrastructure) and soft (governance and planning) aspects. These initiatives have not only contributed to local improvements but have also been supported by legal reforms, monitoring systems, and enhanced public engagement, all of which have laid the foundation for further progress.

Equally noteworthy is that Dalian's water policies are not being evaluated solely within the context of local problem-solving. Instead, they are increasingly framed within international cooperation frameworks. Among these, the city-to-city partnership with Kitakyushu, Japan, stands out as a model of bidirectional collaboration – not merely a one-way transfer of technology or funding, but a joint initiative involving local governments, private companies, and experts from both sides. Through such cooperation, water-related business has been promoted, forming a nexus between public policy and economic benefit. These

developments are particularly significant in the context of the Sustainable Development Goals (SDGs), especially Goal 6: "Ensure availability and sustainable management of water and sanitation for all".

To build a more sustainable water environment, Dalian will need to focus on several key areas: 1) institutionalizing scientific, evidence-based water resource management and policy evaluation; 2) strengthening consensus-building through public participation and information disclosure; 3) fostering innovation and large-scale application through public-private partnerships; and 4) leveraging international urban networks to inherit best practices and export institutional models.

Dalian's experience holds great potential as a reference case for other Asian cities confronting similar water environment challenges. It is hoped that the analysis and proposals presented in this paper will provide valuable insights for researchers, practitioners, and policymakers involved in water resource management and urban infrastructure development, contributing to the creation of better cities and environmental futures.

CONFLICT OF INTEREST

The author declares no conflict of interest.

REFERENCES

[1] H. Li, *et al.*, "Sponge City construction in China: A survey of the challenges and opportunities," *Water*, vol. 9, no. 9, 2017.

[2] City of Kitakyushu. [Online]. Available: https://www.city.kitakyushu.lg.jp/contents/01300112.html

[3] J. Zhang, *et al.*, "Optimal allocation model for water resources coupled with ecological value factors – A case study of Dalian, China," *Water*, vol. 14, no. 2, p. 8, 2022.

[4] City of Kitakyushu and Japan International Cooperation Agency, "Sewerage for SDGs goal 6 in Asian growing cities," in *Proc. Symposium in Kitakyushu*, 2018, p. 2.

[5] J. Wang, *et al.*, "Health risk of heavy metals in drinking water sources of water-carrying lakes affected by retreating polder: A case study of Luoma Lake," *Water*, vol. 16, no. 18, p. 2, 2024.

[6] Y. Wang, "Investigation and analysis of water environment of Dalian," *IOP Conference Series: Earth and Environmental Science*, vol. 189, p. 7, 2018.

[7] Xi focus: Building a beautiful China. [Online]. Available: https://english.news.cn/20230422/dfa1d4284377403fb6384ce4a51c3ff3/c.html?utm_source=chatgpt.com

[8] Zhuanghe City in Dalian makes all-out efforts to reduce total nitrogen in rivers discharging into the sea. [Online]. Available: https://www.cenews.com.cn/news.html?aid=1440806&utm_source=chatgpt.com

[9] X. Cao, *et al.*, "Wave effects on water exchange capacity in the Dalian Bay: A numerical study," *Journal of Marine Science and Engineering*, vol. 13, no. 2, pp. 1–17, 2025.

[10] Y. Peng and K. Reilly, "Using nature to reshape cities and live with water: An overview of the Chinese Sponge City programme and its implementation in Wuhan," *Grow Green*, 2021.

[11] J. Guo, *et al.*, "Impacts of meteorological conditions on water quality: Case study of Dalian Port, China," *Regional Studies in Marine Science*, vol. 85, no. 1, 2025.

[12] OECD Green Growth Studies. Green growth in Kitakyushu, Japan. [Online]. Available: https://www.oecd.org/content/dam/oecd/en/publications/reports/2013/05/green-growth-in-kitakyushu-japan_g1g2d103/9789264195134-en.pdf?utm_source=chatgpt.com

[13] M. A. Memon, *et al.*, "Inter-city environmental cooperation: The case of the Kitakyushu initiative for a clean environment," *International Review for Environmental Strategies*, vol. 5, no. 2, pp. 531–540, 2005.

[14] Institute for Global Environmental Strategies, "Actions for a sustainable society: Collaboration between Asia and the city of Kitakyushu," p. 21, 2018.

[15] M. Kojima, "Toward regional cooperation of local governments in ASEAN," *ERIA Collaborative/Support Research Report*, IDE-JETRO, 2019.

[16] M. Gu, *et al.*, "The evaluation and optimization method of major events-driven polluted coastal zone renewal: A case of the polluted coastal zone in the Dalian Barracuda Bay Stadium Area," *Frontiers in Environmental Science*, vol. 11, no. 1, 2023.