

**Complementary Role of Green and Gray Infrastructures:
Evaluation from Disaster Prevention, Environment, and Social and Economical Benefit**

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[Abstract]

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Coming the age of depopulation and frequent natural disaster due to climate change, cost effective disaster prevention system is urgently needed to be developed. Hybrid infrastructure (HBI); the integration of grey and green infrastructure (GI), is expected to play an important role for disaster prevention and mitigation, environment conservation and economic progression, simultaneously. This study aimed to conduct comprehensive evaluation for HBI potential by the interdisciplinary collaborative research team including engineering, ecology, and environmental economics that indicate important natural and social conditions to identify high potential areas for HBI implementation at national level.

Flood and tsunami simulation model demonstrated that the current configuration of coastal dunes, coastal forest and paddy fields has a sufficient GI functional role for disaster mitigation. We proposed an urban and community development scenario based on zoning plan to the local government and our approach found to be directly linked to sustainability and activation of local society by ensuring disaster prevention, nature conservation and living environment.

Compared species abundance, diversity and composition among various water body types, we confirmed that flood-control basins had GI functions to conserve wetland species diversity. Water retention functions provided by Kushiro Wetland NP also demonstrated a significant role of disaster risk reduction, particularly in the future under the climate change scenario. The public preference survey showed importance of knowledge level to link positive perception toward GI. A trial of covering sand on sea embankment successfully restored connectivity of coastal ecosystem as HBI.

Focused on the uncertainty that GI inherently poses, we evaluated functions and economical benefit of HBI by developing theoretical model for optimal HBI and empirical analysis for public preference. According to the analysis, correlations between cost and benefit, utilities except disaster control, respondent attributes, HBI knowledge level and experience of disaster influenced HBI preference, providing important parameters as considerations for actual political actions.

Toward HBI implementation into the society, we explored framework and indicator needed to identify high potential areas for HBI at national level. Using identified suitable natural conditions and socially acceptable indicators for implementation, we focused on paddy fields to evaluate HBI potential areas across the country. The national survey of the public preference showed the coincidence between quality of nature and happiness, indicating the importance of HBI potential is not only for disaster reduction and ecosystem conservation but also for quality of local community life.

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