Urban Hydro-meteorological Disaster Risk Reduction with Nature-Based Solutions

SUMMARY

Bandung City is prone to hydro-meteorological disasters such as flood, drought, and landslide caused by climate change and land conversion. Efforts to mitigate the disaster risk in Bandung City comprise structural and non-structural measures. Nature-based Solutions (NBS), an approach to address global challenges including hydrometeorological hazards through important roles of nature, can be utilized in optimizing ecosystem capacity to reduce disaster risk and increase urban resilience. This policy brief attempts to elaborate recommendations of NBS implementation in Bandung City to address hydro-meteorological disaster risk reduction based on its prospects and challenges.

The concept of Nature-based Solutions (NBS) was first introduced to emphasize the important roles of nature as an approach to mitigate climate change, water scarcity, food, and energy insecurity, poverty, and promote economic growth (IUCN, 2014). NBS aims to increase the resilience of cities and urban areas in tackling urban challenges, for example, socio-economic and environmental challenges, such as hydrometeorological hazards, reinforced by climate change impacts (Bush & Doyon, 2019). NBS intervention covers a variety of social, economic, and environmental co-benefits which consist of ten key benefits (Martin et al., 2019; Xing et al., 2017). The broad design, scope, and functionality of NBS are presented to address flood occurrence as a result of rapid climate change by releasing surface water into the drainage channel and creating sustainable water management to increase water absorption and contribute to the quantity and quality of groundwater (Andersson et al., 2017; Emilsson and Sang, 2017; Raska et al., 2017; Kabisch et al., 2016). Examples of NBS implementation for flood risk management are environmental restoration, creation of new ecosystems, rainwater harvesting combined with sustainable urban drainage systems (SUDS), building retention ponds, and reducing water pollutants (Davis & Naumann, 2017; Haase, 2017; Kabisch et al., 2016).

Hydro-meteorological Hazards in Bandung City

According to Indonesian Disaster Information Data (Data Informasi Bencana Indonesia/DIBI) in 2020, almost 90% of Bandung City area are highly susceptible to floods, proven by the fact that there were 271 flood occurrences recorded during the 2009-2019 period. Drought, as the opposite of flood, is also one of the problems that occurred in Bandung City in almost every dry season, that although the occurrence isn’t as frequent and severe as floods, it is predicted that in the next 50 years, the people of Bandung City could no longer use groundwater (Ranawati, 2019). Landslide is also one of the hydro-meteorological hazards in Bandung City especially in the prone areas such as Cidadap, Ujungberung, and parts of Coblong and Cibiru districts, with a total of 111 incidents reported from 2009 to 2019 by DIBI (2020).

Figure 1. Hydro-meteorological Hazards in Bandung City. (DIBI, 2020).

Hydro-meteorological Disaster Risk Reduction Strategy in Bandung City

Hydro-meteorological hazards faced by Bandung City such as flood, drought, and landslide, have emerged various strategies to reduce the disaster risks, consisting of structural and non-structural measures.
Structural measures are defined as any physical design and the use of engineering techniques that mitigate the potential impact of hazard and increase the systems’ resiliency (UNISDR, 2009). Examples of structural measures applied to mitigate flood risk in Bandung are Pagarsih sustainable drainage system (SUDS), retention lakes in Cieunteeung, Sinaraga, Rancabolang, Derwati, Bima, and Andir, A Million of Bio-pores Movement, rain barrels, and river normalization. Meanwhile, non-structural measures are more focused on the use of knowledge and practices to reduce disaster risks and impacts through policies and regulations, raising public awareness, training, and education (UNISDR, 2009). Citarum Watershed Action Plan and Tunas Nusa Community are two of the non-structural measures implemented in Bandung City.

Bandung City’s regulations and policies have also covered strategies to reduce flood risk, starting from the Regional Spatial Plan of Bandung and Detailed Spatial Plan and Zoning Plan which comprise the general strategy, to the detailed strategy documented in Bandung City Regional Policies, Mayor Bandung Regulations, and others. However, the NBS concept hasn’t been explicitly written as the umbrella of these strategies, although some of them could have been categorized as NBS already. Therefore, mainstreaming the comprehensive and multi-benefit NBS into the policies and city planning in Bandung City is expected to create synergy among the government, in optimizing ecosystem capacity to reduce the risk of flood and increase urban resilience, especially in dealing with climate change.

**Prospect and Challenges**

**Limitations**

Bandung City Government and citizen initiatives have made considerable efforts to minimize flood occurrence, such as urban drainage improvement, retention pond constructions, and learning garden programs. Unfortunately, its implementations in Bandung City are still facing several problems that hinder its effectiveness.

(1) **Unresolved Conflicts of Interests:** Flood risk reduction, which covers broad context, requires multi-sector involvement in its implementation to achieve the desired benefits. Unfortunately, this principle is often disrupted, thus, creating conflicts when each entity puts its interests above the interests of the wider community. Disaster risks are still not a major consideration in some development sectors and less prioritized either in planning or budgeting.

(2) **Project Financing:** Financial source is one of the most crucial points when implementing a project. Although the financial support for flood risk reduction action in urban-scale is possible through the national government grant and/or corporations’ social responsibility sectors, household scale interventions are still facing financial concern particularly for the low to middle income groups to pay the project implementation process.

(3) **Project Maintenance:** Flood risk mitigation and adaptation programs can never only start in the planning stage and end in the implementation stage. For those programs to be sustained, the maintenance process must be held continuously to avoid project damage. Thus, it requires all parties to be aware and participate in supporting the sustainability of existing projects.

**Challenges**

In addition to the limitations that hampered its effectiveness, Bandung City must also prepare for the upcoming challenges that potentially affect future flood risk reduction actions, including the intervention of NBS. The challenges vary as they can emerge from different aspects, such as rules and regulations, managerial roles, and communities.

(1) **Multi-level Regulations:** The sectoral development, including disaster risk reduction, must always be adapted to the most recent policies afterwards. The issuance of new regulations by the provincial or national government can most probably affect spatial planning at the city level. The local government must also oversee the alterations because those may have affected the budget
allocation. Since flooding in Bandung City is a multiregional problem, other municipal regulations must be synchronized with Bandung City’s ones to create a synergy of flood risk mitigation policies with surrounding areas.

(2) Project Planning: The duration for planning NBS projects might be longer since NBS is still a new concept in Indonesia. Although several of the conducted projects can be categorized as NBS practices, it still requires adjustments to ensure whether the projects have covered all the NBS principles or not.

(3) Land Use Permits and Land Capacity: Urban areas with limited land and extensive land utilization must always consider the land capacity for NBS implementation, especially when the community still has poor understanding and interest in vertical development for optimizing urban land-use allocation. Conflicts related to land-use permits with landowners also often occur when the NBS concept and cooperation mechanisms are not fully communicated.

(4) Post-implementation Stage: When NBS projects have been implemented, it demands the monitoring and evaluation schemes, including appropriate evaluation methods and indicators. The problem related to the unsustainability of its implementation is the lack of monitoring and evaluation, which causes malfunction and even fatal damage.

Implication and Recommendation

Responding to those limitations, challenges, and capacities, these following recommendations are proposed as adaptive measures to address NBS pre-implementation features for flood risks reduction:

**Recommendation 1: Integrate policy support by integrating NBS into policies and city planning documents.**

The concept of NBS should be associated with policies and city planning documents in order to create synergy among the government in maximizing ecosystem capacity to reduce flood risks and increase urban resilience, especially in dealing with climate change. In addition, with the chance of new regulations issuance at the top level to disrupt the city-level policy implementation, this integrated policy support is essential as it will provide the practical operation guidelines of NBS project implementation, which can also minimize risks and conflicts. Moreover, while there may be a requirement to adjust to policy transition, transition initiatives will always need an integrated policy mix for downscaling the regulation and thus upscaling the NBS benefits to the local level.

**Recommendation 2: Clear determination on the scale and functionality of NBS projects.**

It is advised to clearly determine the scale and functionality of NBS in the planning and decision-
making stages in order to enhance the intensity of NBS effectiveness and assessment. There are three types of NBS, which are: 1) low human intervention; 2) medium human intervention; and 3) high human intervention. Out of the three types of NBS, the programs that have been carried out are mostly hybrid NBS (high human intervention) or combining grey and green infrastructures, such as retention ponds and urban drainage channel upgrading, and bio-pores, as well as rain barrels at the community scale. Despite these programs having been implemented, they are still unable to resolve the urban inundation issues because NBS concepts in terms of scale and its potential co-functionality have not been well considered. Moreover, the unpredictability of flood occurrence, its type, and the uncertainty of the effects depend upon more variations and effective intervention of NBS at different scales. Hence, the functions and scalar concerns must be deliberated over planning instruments to avoid impacts on NBS program’s effectiveness.

Recommendation 3: Consider urban spatial planning and land capacity.
Addressing issues of land limitation and conflicts on land permits, NBS planning must consider the urban land capacity and be aligned with urban spatial planning. Wrong site selection for NBS, instead of being beneficial, will disrupt the core of NBS and even lead to more severe losses and damages. The synergy with urban spatial planning, including the site selection analysis must be taken into consideration since the different area characteristics and types of flood will require different NBS practices. Whereas, allocating private ground for NBS will require intense communication with landowners, strong community support and commitment, and being motivated by political and land market conditions to avoid conflicts. During these processes, cooperation mechanisms, clear benefits sharing, and possible incentives received by private landowners, must be well informed. More from the local government’s side, land consolidation policy can be one way to restructure and rearrange the land ownership, utilization, and acquisition efforts for development purposes - improving environmental quality and preserving natural resources through active community involvement and participation.

Recommendation 4: Establish a collaboration among multidisciplinary policy areas and stakeholders.

The collaboration is encouraged as it can complement NBS to be a more holistic approach in facing complex socio-economic and environmental challenges. Given that NBS is a new measure/technique and approach/concept, collaboration is needed for the introduction and familiarization of NBS to a broader society. Collaboration between the government and universities is possibly done through academic studies and community service activities, allowing the generation of fresh and creative ideas to enhance NBS practices while promoting Bandung’s cultural authenticity. Furthermore, this collaboration strategy will be one of the means to overcome the problem of NBS projects being costly, Bandung City’s image as a trade and tourist destination is a value to attract private sectors or investors for financing NBS projects. Along with this, partnership with business stakeholders can be favored by the well-maintained return on investment, how it boosts business practices, and how it leads to economic prosperity and human well-being.

Recommendation 5: Strengthen public understanding and commitment to participate
The Nature-based Solution concept can be implemented at various scales including the household scale, so that the opportunity for the community to participate is actually greater and helpful to accommodate inclusive involvement both in planning and implementation processes. Nonetheless, this opportunity must be filled with an adequate, deep understanding of the NBS concept, including how to develop the process - planning, implementation, monitoring, and evaluation. Therefore, ensuring public knowledge is required and this strategy can simply be covered within the process of socialization and training, as they are one of the measures to enhance public knowledge and understanding prior to the execution. Such processes can include the knowledge on technicalities in conducting the projects, the role of the public in supporting project sustainability, and/or the benefits of the expected project outcomes. Thus, along with the transferred public knowledge, the public is presumably able to work on the remaining managerial functions. Furthermore, a society with higher consciousness can initiate active participation and stronger commitment to contribute to the NBS programs and are even expected to be capable of creating disaster risk mitigation actions on their own.


ACKNOWLEDGEMENT

With funding from the Royal Academy of Engineering, this project aims to synthesize NBS knowledge across lower-middle income/upper-middle income countries with the concrete objective of applying this learning to Bandung, Indonesia.

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Funded by:

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