SUPPLEMENTARY MATERIAL

Detailed discussion on the barriers to IFRM adaptation in Metro Manila, Philippines

Governance aspect barriers

G1 describes the fragmented governance in flood management and control in Metro Manila [1,2]. Major flood-control problems involving issues that affect the entire metropolitan region was originally handled by DPWH. However, the transfer of responsibilities from DPWH to MMDA resulted in the unclear delineation of tasks. Thus, the current setting has overlaps and gaps in responsibilities that hinder the effective and efficient use of resources for flood management [1,3]. Meanwhile, localized flooding associated with drainage basins of a few square kilometers are handled local government units (LGUs) usually through the construction of gutters and storm drains that direct rain into existing natural or artificial waterways. Nonetheless, flood control strategies of the 16 cities and 1 municipality of Metro Manila are fragmented because of ineffective decentralized governance and administrative boundary disputes [4,5]. Although it is very obvious that DPWH has more technical capacity and budgetary allocation than MMDA and LGUs, there is no clear demarcation and integration of function for flood mitigation infrastructure development. Apart from this, the responsibility for the regional IFRM adaptation has not been assigned to any agency. There is no clear demarcation and integration of function for flood mitigation infrastructure development, watershed conservation, and floodplain/potential flood risk area management. Moreover, the necessary non-structural measures to mitigate flood damage, namely, (1) the management of the river area with river channel; and (2) the management of floodplain area, are not explicitly mandated to any agency. Hence, this leads to the main question, as to who is really in charge of flood management in Metro Manila [1]?

G2 describes the lack of inter-agency communication and the lack of information exchange and communication on the local level. According to Porio [6] and Ishiwatari [2], local implementation of disaster preparedness has been uneven because of ineffective bureaucratic collaboration between the national government agencies and LGUs. The lack of communication is due to inefficient management, confusion over inter-agency cooperation on flood mitigation, and the lack of political will among government officials [5]. On the community level, on the other hand, most towns and city councils are not equipped with information regarding disaster warning and emergency evacuation, and the involvement of the community to planning or education is also lacking. The absence of stakeholder or community participation hinders the adaptation to proposed non-structural measures that are critical to the IFRM.

G3 describes the lack of funding emanated from the lack of national focus on flooding [5]. Flooding is not yet seen as a national problem because it does not constitute as a national problem. For this reason, the motivation to reduce flooding is only prominent on the local or household level [5,7]. Another cause of G3 is lingering nepotism influences funding in some government organizations in the Philippines [8]. Hence, funding for flood control-related projects depends on the “unpredictable political landscape” in the country.

G4 describes the lack of flood control measures in Metro Manila. Due to low funding allocation and low priority on solving flood problems, the existing flood control infrastructures in Metro Manila is insufficient [6]. Drainage systems are lacking both numbers and capacity [9]. As for the non-structural measures, these are mainly

focused on response and recovery, rather than prevention and mitigation [6,10]. Currently, there are no preventive measures at the national and local levels [11]. There is also little attention given to flood insurance provision and availability, and upland watershed protection [5].

Social aspect barriers

S1 is one of the outcomes of massive urbanization compounded by exponential land appraisal increase, which is a very distinct phenomenon in many developing countries. The urban poor population, known as the informal settler families (ISFs) in the Philippines, encroach at marginal, flood-prone land along canals, riverfronts, and coastal areas, where they can live cheaply on the interim [12,13]. The existence of ISFs has become a culture in Metro Manila but they ISFs suffer losses regularly from flooding brought by typhoons. They have no access to the security of tenure, capital, social networks, or any environmental and legal security, which makes them more vulnerable to flood risks [5–7,11,12,14]. However, eviction and demolition of such communities have severe political ramifications because they constitute a significant portion of votes during the election period [3], and relocation plans for them require massive fund allocations [14].

Meanwhile, the excessive encroachment has also exacerbated existing problems with S2 in Metro Manila because ISFs do not have any access to any essential utilities, including sewer systems [3]. They directly dispose of their wastes to their surroundings, including river systems thereby worsening river conditions. The indiscriminate disposal of wastes is a norm not only among ISFs but also from majority of the households and ordinary citizens in Metro Manila [1,5,11,14,15]. As a result, most drainage and river systems are clogged with trash and debris that expedites pluvial and fluvial flooding during heavy rainfall. Despite numerous declogging and clean-up efforts by various government and private agencies, this was not a sustainable solution for solid waste management.

Problems underlying S1 and S2 are emanated from S3. The services provided by the government of the Philippines (GOP) are inadequate to address issues on both S1 and S2 that are likely to worsen because of continuous population growth and migration of people from rural areas to Metro Manila. The lack of social planning roots from the unprecedented privatization of planning in Metro Manila [8,15,16] since the GOP has been lacking visions for urban development while being economically aggressive. Weak enforcement of urban regulations and planning systems resulted in unregulated commercial and residential developments at flood vulnerable areas [1,4,11]. Moreover, the settlements in which ISFs reside have been forgotten [12]. S3 at the local level is also problematic as there are no existing community-wide hazard networks. Communities rely on their capabilities to withstand the magnitudes and frequency of floods [7,14,17]. There is also a social exclusion of ISFs, and urban poor population [5,18] as the availability of support networks during calamities have been low [11,13,14].

Technological resources aspect barriers

For T1, there are no real-time forecasts and updates on the water level and rainfall depths in Metro

Manila. The flood forecasting system by the Philippine Atmospheric Geophysical And Astronomical Services Administration (PAGASA) does not include flood estimations in Metro Manila since they solely rely on storm intensity and dam release as a flood warning [5,19,20]. Moreover, most government offices in the Philippines are still used to the manual way, manual tabulation and processing of data, production of paper maps instead of acquiring Geographic Information System (GIS) data to create GIS maps, and manual comparison of data instead of using the temporal and spatial analyses of GIS [21].

In the case of T2, the hydro-meteorological information available in Metro Manila is thinly distributed, not automated, and is measured on a daily time interval [19–22]. Access to this information is also often restricted, especially to the private sector. In some instances, data are open for purchase, which is very costly. Meanwhile, there are no reliable data on the drainage system in Metro Manila. There is no integration of the drainage facilities installed and maintained by DPWH and those installed by LGUs [9]. Without reliable data, it is challenging, if not impossible, to analyze the causes of and evaluate measures against recurrent flooding.

For T3, experts from government agencies, academics, and LGUs are lacking. Government agencies have heavily relied on third-party consultants or international aid for flood modeling and design where continuity on flood risk research is often sacrificed [22]. There should be continuous evaluation and assessment of flood risks at least every five years to help mitigate the threats on uncertainty [23]. Academically, flooding received little attention and is limited only at flood-prone area identification and proposals for installing flood control infrastructure [5]. Meanwhile, LGUs need resources and capacity building to increase their capacity to adapt [6,20].

T4, on the other hand, is closely related to T3. Because of the lack of experts, hydro-meteorological information like water levels and rainfall depths are recorded and stored only by government agencies. This information is not utilized for any real-time flood forecasting or research due to scarce research, development funding, and T3 [19].

For T5, this describes the various problems in existing flood control structures due to poor operation and maintenance [19,21,22]. The overuse of infrastructure is compounded by the government's continuous neglect in maintaining and improving them [5]. Funding for maintenance works on the cleaning and rehabilitation of existing flood control measures is also very costly [3].

Supplementary Material References

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