RAPID IMPACT ASSESSMENT OF STRUCTURAL FLOOD MITIGATION MEASURES IN METRO MANILA, PHILIPPINES

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Abstract
In Metro Manila, structural flood mitigation measures are receiving considerable attention both from the local and national governments due to its potential impacts on the environmental, social and economic conditions. The assessment of these impacts is often summarized in the form of an environmental impact assessment (EIA) study. The common practice of EIA in the Philippines is generally qualitative and lacks clear methodology in evaluating multi-criteria systems. Thus, this study proposes the use of the rapid impact assessment matrix (RIAM) technique to provide a method that would systematically and quantitatively evaluate the social and environmental impacts of planned structural flood mitigation measures (SFMM) in Metro Manila. The RIAM technique was slightly modified to fit the requirements of this study. The scale of impact was determined for each perceived impact, and based on the results, the planned SFMM for Metro Manila will likely bring significant benefits; however, significant negative impacts may also likely occur. The proposed modifications were found to be highly compatible with RIAM, and the results of the RIAM analysis provided a clear view of the impacts associated with the implementation of SFMM projects. This may prove to be valuable in the practice of EIA in the Philippines.

Introduction
Structural flood mitigation measures (SFMM) are regarded as major infrastructures that can play significant roles in the sustainability of urban development (Kundzewicz 1999). In Southeast Asia, most of the key cities, including Jakarta (Indonesia), Bangkok (Thailand) and Metro Manila (Philippines), to name a few, are highly vulnerable to floods due to climate change. The drastic changes in the weather conditions will further aggravate the situation in this region, making SFMM more valuable, and perhaps preferable in alleviating flood risks in highly urbanized areas (The World Bank 2010). Even though SFMM are designed to prevent disasters and optimize developmental benefits in flood-prone areas, SFMM still generate negative impacts that affect natural hydrological and ecological processes (World Meteorological Organization 2007), which makes it more important to include EIA during the early planning stages. Likewise, the use of appropriate EIA techniques can aid the decision-makers to formulate necessary actions based on informed decisions in light of project urgency and limited resources, which are common constraints in infrastructure projects in developing countries as discussed by Shah et al. (2010).

In the Philippines, the EIA methods used were generally descriptive and qualitative in nature (e.g. City Office of Navotas 2009). These methods are similar to the traditional methods (ad hoc and simple checklist methods) described by Lohani et al. (1997), which heavily relies on the "experience, training and intuition" of the assessing expert. These basic assessment methods are non-replicable, which makes the EIA conclusions difficult to review or even criticize.

With clear assessment guidelines, a quantitative scaling of subjective judgments can help address the limitations of the 2 traditional EIA methods (Ijas et al. 2010) mentioned

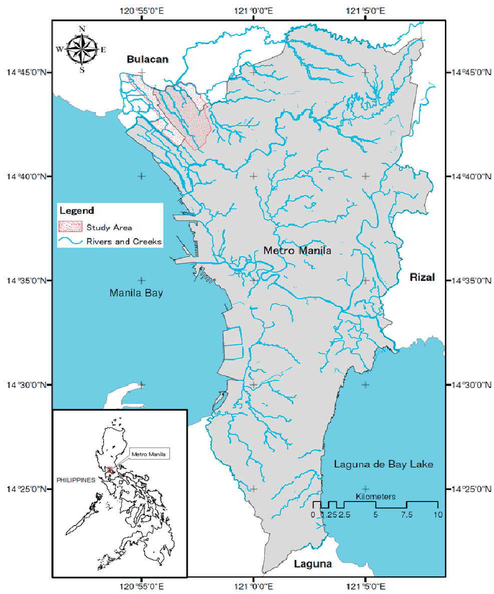

Fig. 1 Map of Metro Manila and the location of the study area

above. Such concepts are fundamental in the rapid impact assessment matrix (RIAM) technique. The RIAM technique is a semi-quantitative EIA approach that utilizes standardized assessment criteria and rating scales in the evaluation and measurement of a project's potential impacts (Pastakia and Jensen 1998).

This paper primarily explores the benefits of using the RIAM technique in the evaluation process of SFMM by examining the results of the EIA of selected planned SFMM in Metro Manila. Furthermore, a slight modification (consisting of adding a new impact description and integrating 3 project phases in the general assessment process) of the RIAM method is proposed not only to enhance the transparency and sensitivity of the evaluation process, but also to cope with the requirements of the EIA system in the Philippines. In view of this paper's intentions, the following section (Environmental setting of the study area) introduces the basic profile and environmental conditions of the study area. The subsequent section elaborates on the RIAM method (with the proposed modification), followed by a demonstration of its application. The fifth section presents the RIAM results and discusses the analyses of impacts of the selected SFMM with some suggestions for the environmental management program. The final section offers some recommendations and conclusions with the aim of providing valuable insights to decision makers, planners and policy makers for the improvement of the practice of EIA of SFMM in the Philippines.

Study Area
The study area (approximately 20 km^2), as shown in Fig. 1, is located in the north-northwest part of Metro Manila, which is

home to approximately 160,000 residents. Its topography is generally characterized by flat and low-lying coastal plains with ground elevation ranging from 0 to 1.5 m above mean sea level. It has a mixed land-use comprised of commercial, industrial and residential districts with fishponds. The river system in the study area has limited aquatic biota due to the poor water quality conditions. Migratory birds that feed on insects, fishes and invertebrates were observed wandering and nesting close to the river systems, while few patches of mangroves exist at the lower section of the main river. Most mangrove areas have been converted to fishponds and settlement areas. Water hyacinths were also observed in the river system of the area. High volume of settlers is found on the left bank of the upper section of the main river and along narrow natural waterways. Due to the very poor discharge capacity of the study area, floods easily manifest during the rainy seasons, contributing to the slow economic growth of the affected municipalities. To improve the drainage conditions, 2 dike structures and 2 open channels were proposed as SFMM under the Metro Manila flagship program on flood mitigation. The river improvement works consist of masonry walls (Dk1), riprapping dikes (Dk2), diversion canal (Ch1), and a small open channel (Ch2) within the study area.

Methodology

The EIA of SFMM was carried-out using a rapid impact assessment approach taken after the RIAM technique developed by Pastakia and Jensen (1998).

Results and discussion

To compare the impacts of the 4 SFMM in terms of the environmental categories identified by Pastakia and Jensen (1998), i.e. Physical/Chemical (PC), Biological/Ecological (BE), Social/Cultural (SC) and Economic/Operational (EO), a histogram was created to represent the impact profiles of the SFMM using the impact range bands of RIAM defined by Pastakia and Jensen (1998) as shown in Fig. 2. By inspection, [-A] is the most numerous range band in all the 4 SFMM (dominated by the SC category), while [-E] and [+E] are not present in any of the proposed projects. Negative impacts are much more numerous than the positive impacts, however, most of the negative impacts are in range band [-A]. The positive impacts on the other hand are fairly distributed in the scale of positive range bands. Generally, the impact profiles of Dk1 and Dk2 are similar. Likewise, the impact profiles of Ch1 and Ch2 are also very similar, which implies that similar types of SFMM projects will likely generate the same impacts provided that the environmental conditions are also similar (such as in the case of co-located projects).
However, to further examine the positive and negative impacts of the 4 SFMM, the sum of *ES* values were calculated for PC, BE, SC and EO categories of the environment as shown in Table 1. In this table, there exists a clear gap in the positive impacts between the dike structures (Dk1 and Dk2) and the open channel structures (Ch1 and Ch2). The dike structures are generally more desirable compared to open channel structures in terms of the PC, BE and SC categories, while the EO category generates the same cumulative scores. On the other hand, the cumulative scores of negative impacts do not show any clear conclusion as to which structure will generate more severe impacts. The results in the SC category indicate that open channel structures are less socially desirable compared to the dike structures.

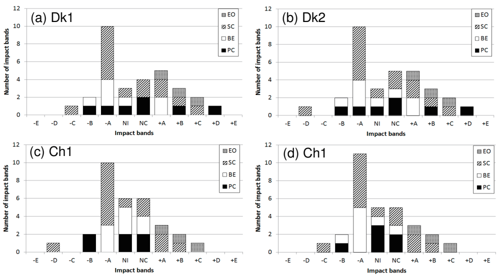

Fig. 2 Histogram of the RIAM analysis showing the profiles of the 4 SFMM in terms of the environmental categories: PC, BE, SC and EO

Table 1 Summary of the summed environmental scores of the SFMM

SFMM	Cumulative Positive Environmental Scores				Cumulative Negative Environmental Scores			
	PC	BE	SC	EO	PC	BE	SC	EO
Dk1	48	12	72	50	-19	-40	-53	0
Dk2	48	12	72	50	-19	-30	-67	0
Ch1	18	0	27	50	-24	-19	-81	0
Ch2	18	0	27	50	-10	-42	-79	0

In general, this study has shown that the environmental assessment using RIAM has gone much further than the past EIA techniques practiced in the Philippines. The RIAM technique has shown the capability to be impartial in the use of subjective judgments to attain more meaningful results There is however a limitation when examining the cumulative effects of co-located projects (within the same study area). Solution for the examination of cumulative effects has not yet been created in RIAM. Thus, the combined effects of 4 SFMMs were not investigated in this study.

Conclusion

The case of the EIA of SFMM in Metro Manila has demonstrated the applicability of the RIAM technique as an alternative EIA method in the Philippines. Essentially, the RIAM technique complies with the basic EIA requirements in the Philippines, making it highly viable for application in other sectors and project types besides SFMM. One limitation of the RIAM technique however is the lack of means to evaluate the cumulative effects of co-located projects. A flood control project in Metro Manila normally consists of several structural components, as shown in this study. In general, the EIA of SFMM by RIAM provides a simple but very effective means to identify the significance of potential impacts in a very transparent manner, leading to clearer and more meaningful EIA conclusions.

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