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In IWRM, Should Scientific Modeller Perspectives Receive Priority over the Benefit Recipients? †

Rathnayake Mudiyanselage Manjula Pradeep [1,*] and Nallaperuma Thanthirige Sohan Wijesekera [2]

[1] Transdisciplinary Research Lab, Faculty of Computing, General Sir John Kotelawala Defence University, Kandawala Road, Ratmalana 10390, Sri Lanka
[2] Construction Industry Development Authority, Colombo 00700, Sri Lanka; sohanw2@gmail.com
* Correspondence: pradeep@kdu.ac.lk
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Abstract: Throughout history, discussions on IWRM have established the idea that the recipient stakeholders' poor participation is obstructing sustainable decision making in urban flood management. However, we found that no in-depth study has been carried out to explore the status of stakeholder integrations in such modelling. The present work explored the stakeholder integrations in the modelling through critical literature analysis and expert discussions. We found there are five main components in the modelling, and the recipient stakeholder requirements are satisfactorily integrated with the modelling approach. Nevertheless, we found that integrations of scientific modelling perspectives remain unsatisfactory. This paper urges water resource decision makers to prioritise scientific modellers' perspectives when developing flood management models.

Keywords: IWRM; flood stakeholders; urban flood management; hydrological modelling; GIS modelling; Hydro-GIS modelling

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1. Introduction

The ultimate aim of the United Nations Sustainable Development Goals (SDG) is the sustainable development of humans in harmony with the environment [1]. Therefore, one of the key undertakings in water resource management is to maintain a satisfactory relationship between natural water cycle needs and social/economical needs. Scientists and water governors have already been working independently to achieve these goals for decades. Nevertheless, with different influences on research, such as the need to incorporate the general public's opinion in decision making [2], as well as stakeholder theory [3], researchers are used to integrating the two agendas. In the meantime, the 1997 UN water conference and 1992 "Dublin Principles" established an international norm for water governance, namely Integrated Water Resource Management (IWRM) [4].

Since IWRM is based on water governance for achieving sustainable goals, it is always better to maintain a close relationship between decision makers and key stakeholders while developing management tools to optimise the requirements [5]. In parallel, various other initiatives, such as Green Infrastructure (GI), Low Impact Development (LID), and the water framework of Economic Co-operation and Development (OECD) [6,7], are also in practice; however, an analysis of the available data found that the effects of flood damage on national economies is increasing [8].

The common excuses for this situation are the recipient stakeholders' poor participation, that governance discourses are limited to stakeholders, and that decisions are mainly theoretical [9,10]. Apart from those, there are dozens of negative reasons for the practical incorporation of recipients' perspectives in administrative decision-making modelling or processes. Furthermore, we found that no study had been carried out to inductively explore the integrations of the requirements of the total stakeholder profile of the process in the current setting. Therefore, our initial work was carried out to evaluate the integration of stakeholder requirements for a specific area of urban flood management [11]. As such, the aim of the present work is to analyse and discuss the results for practical stakeholder integrations in IWRM.

2. Methods

2.1. Evaluation of Levels of Stakeholder Requirements Integration

As there is no established method to carry out this type of transdisciplinary research, which needs to evaluate different components in integrated water management decision making, we required an acceptable research methodology. As such, an in-depth study, including a literature review and expert discussion, was carried out to develop a research methodology for gap identification [12–14].

Then, accordingly, we carried out abductive research using a sequential multi-phase approach of the mixed method. We employed modified constructivist grounded theory, documentary research, and survey strategies to find and verify the main components and their integration depths in the scientific and management model of urban flood management. For the component identification, we studied the GIS2MUSCLE urban flood management tool, 4 hydro-GIS integration models, and 247 works of research; furthermore, for calibration, we utilised 21 experts. The average integration depths among the components were calculated using 32 studies employing Multi-Attribute Utility Theory (MAUT) and Weighted Average Programming (WAP). Finally, we evaluated the results with 70 experts and analysed the result by employing thematic analysis and Multi-Criteria Group Decision Making (MCGDM) methods.

2.2. Data

Through the above steps, we identified five components (main stakeholder categories) as shown in Figure 1. However, in practice, the hydro specialists and GIS specialists were also integrated into the HydroGIS model.

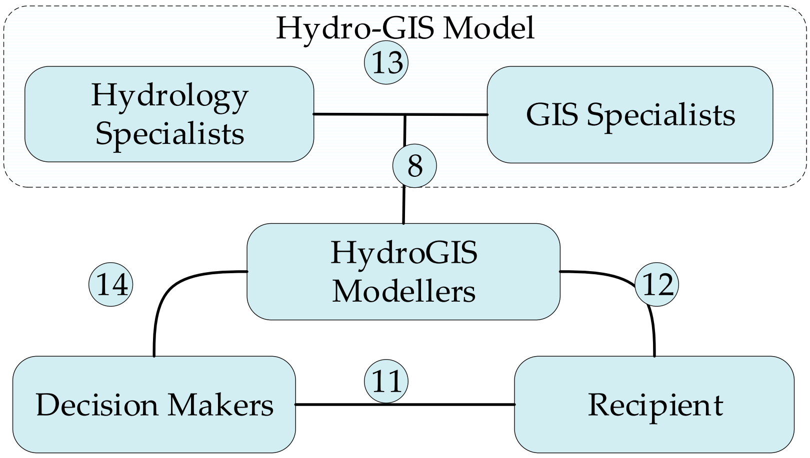

Figure 1. Main components (stakeholder categories) of flood management model. (The lines between components indicating existing integrations. The numbers in the circles indicate how many research works have considered such integration. Source: Author.

Then, rationale was developed to weigh the depth of scientific investigation carried out by the researchers on each integration shown in Figure 1. Furthermore, we analysed the depth of investigation level (scale of Very low to Very high) on each integration carried out by each study by utilising the modified MAUT. However, we observed that studies analysed the integrations in either Very high, High, Medium, or Low depths only (Figure 2).

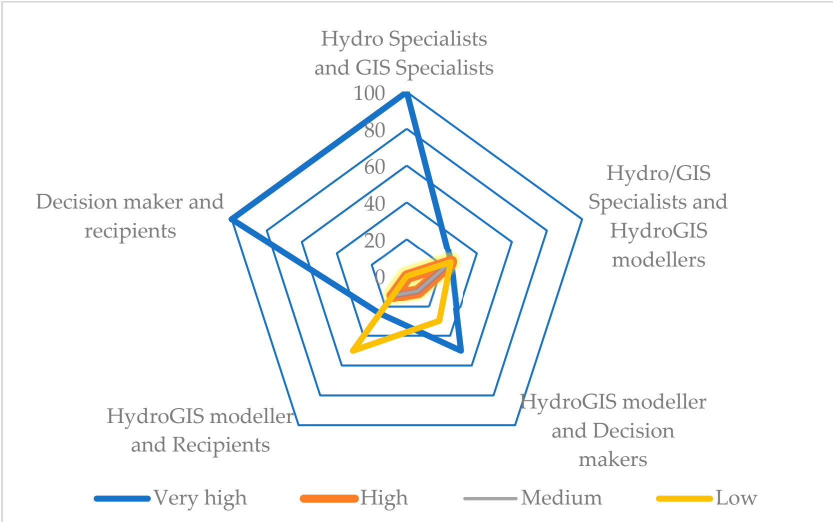

Figure 2. Distribution of investigation depth classes among the integration types. Source: Author.

By generalizing the individual study's investigation depths to develop a final decision, we developed a rationale for weighting the scientific value of the publication [15]. Thereafter, the depth of investigation for each integration was calculated using WAP, and the values are on a 1–5 scale, where 5 is Very high and 1 is Very low. The comparative level of the investigation depths among the integrations was also calculated. Another understanding made during the step is that there are two groups in which the components can be accumulated considering the main undertaking of the flood management model. The present work called them "scientific components" and "management components" (Figure 3).

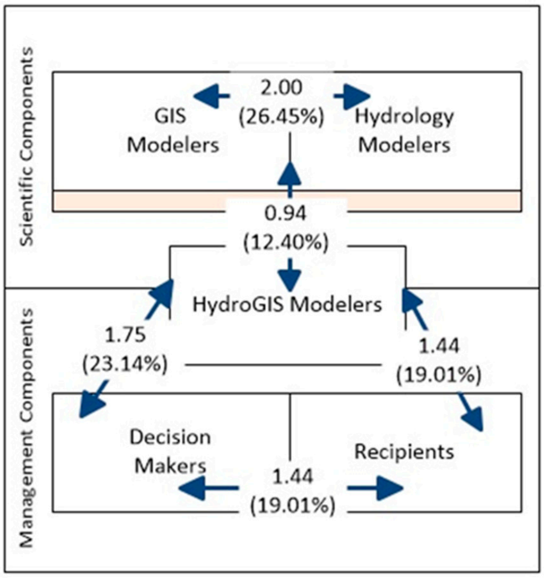

Figure 3. The present investigation depth status of the integration of main components in flood management modelling. The average depth of investigation in each integration is shown as a fraction. The comparative level of the investigation depths is shown as percentages (computed%) (Adapted from Ref. [11]).

Then, we reclassified the investigation depths according to a 1–5 scale and computed the deviation from the mean comparative value of 20% (if equal attention is being paid to all 5 integrations, the 20% is the mean value) using Equation (1). The positive values exhibited exaggerations of attention, while negatives showed an understatement of attention (Table 1).

$$\text{Deviation from mean comparative value} = ((\text{computed\%} \div 20) - 1) \times 100 \quad (1)$$

Table 1. Computation results.

Integration	Identified Depth of Investigation through the Study			Deviation from the Mean Comparative Value (Equation (1) Result)
	Computed	Classified	Computed%	
Hydro Specialists and GIS Specialists	2.00	Low	26.45%	32% (+ve)
Hydro and GIS Specialists and HydroGIS Modellers	0.94	Very low	12.40%	38%(−ve)
HydroGIS Modellers and Decision Makers	1.75	Low	23.14%	16% (+ve)
HydroGIS Modellers and Recipients	1.44	Very low	19.01%	5%(−ve)
Decision Makers and Recipients	1.44	Very low	19.01%	5%(−ve)

3. Results and Discussion

The resulting flood model development framework, which demonstrates all the roles involved in the flood management modelling with the levels of present attention on integrations, is shown in Figure 4. This work found two definitions for the present level of researchers' interest distributions: (1) The individual interest: the investigation depth of each integration, which is independent of other integrations; (2) the comparative interest: the comparative level of investigation, which demonstrates how the total attention of the researchers is distributed over all possible integrations.

As per the scale of investigation depth defined in the present work, all assessment values that were received were less than 2. This means the present interest in all the integrations is below the "Low" level. Furthermore, we observed that the researchers' attention levels regarding incorporating the perspectives of scientific component modellers with management modellers (hydro/GIS specialists and HydroGIS modellers), HydroGIS modellers with recipients, and recipients with decision makers are in the "Very low" level. Therefore, our findings prove the importance of one of the concepts behind IWRM, namely integrating the recipients into water decision making.

According to the analysis, we found that the researchers understate 37% of the optimum when integrating the scientific modellers' (hydro and GIS modellers) concerns into the management model via the HydroGIS modellers. However, we found that the most challenging requirements being discussed in public at the present include integrating the general public's (recipient) perspective into flood management, which must be satisfactorily attended to, as it received a 5% understatement value. In the meantime, the results show that there is a level of 32% exaggerated attention paid to integrating the hydro modellers' and GIS modellers' perspectives.

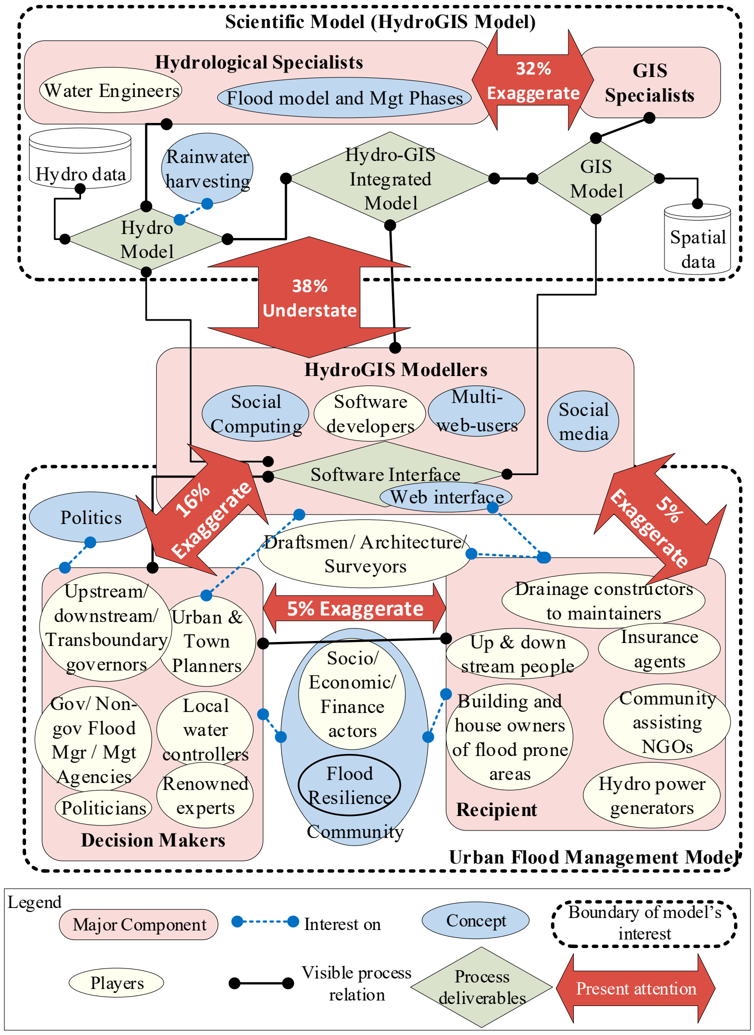

Figure 4. Descriptive view of flood management model development framework. Source: Author.

4. Conclusions

IWRM governs flood management and it requires an understanding to identify all the major components (stakeholder categories) for sustainable flood management modelling.

This study found that there are five main stakeholder categories which need explicit integrations or sustainable flood management modelling. They are hydro modellers, GIS modellers, HydroGIS modellers, decision makers, and recipients.

These five stakeholder categories were grouped into two components: (1) scientific components and (2) management components. The integration of these groups is being carried out by the HydroGIS modeller who develops the flood management model.

The present study shows that perspectives of the components in the scientific model are well integrated with model development, while components within the management model are also satisfactorily integrated. The most discussed recipient stakeholders are also in the management group; hence, we can argue that, at present, recipients' perspectives are satisfactorily incorporated into the flood management initiatives.

Nevertheless, the poorest attention (38% less than optimum) is being paid to integrating the scientific model perspectives into the management model. Therefore, this work concludes by stating that, at the present, there is a need for better attention to all five interactions and therefore, IWRM initiatives should focus more attention to integrating scientific modellers' perspectives thereby fully satisfying the recipient stakeholders' requirements.

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