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In IWRM, Scientific Modeller Perspectives Should or Should Not Receive Priority over the Benefit Recipients? †

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Abstract: History-long discussions on the IWRM are making the idea that the recipient stakeholders' poor participation is obstructing sustainable decision-making in urban flood management. However, it found that there is 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 instrumenting critical literature analysis and expert discussions. It found there are five main components in the modelling and the recipient stakeholder requirements are satisfactorily integrated with the modelling approach. Nevertheless, it found that there is an unsatisfactory 38% understate exists in integrating the scientific modelling perspectives. This paper urges water resource decision-makers to draw their priority to 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 achievement of the United Nations Sustainable Development Goals (SDG) is the sustainable development of humans and harmonies to the environment [1]. Then one of the key undertakes in water resource management is to be maintaining a satisfactory relationship between natural water cycle needs and social/economical needs. The scientists and water governors already had been independently working to achieve aforesaid goals for more than centuries. Nevertheless, with the different research influences exampling; incorporation of the general public's opinion to decision making [2] and stakeholder theory [3], researchers used to integrate the two agendas. Meantime the 1997 UN water conference and 1992 "Dublin Principles" made an international norm for water governance which is versioned as Integrated Water Resource Management (IWRM) [4].

Since the IWRM is based on water governance for sustainable goal achievement, always keen to maintain a better 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 water framework of Economic Co-operation and Development (OECD) [6,7] are also in practice but the available data analysis found that the flood damage to the nations' economies is increasing (Figure 1).

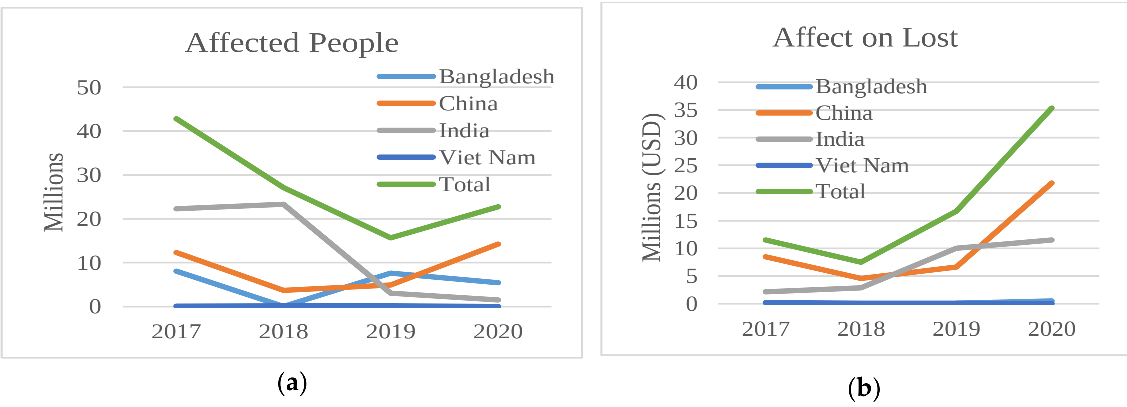

Figure 1. Effect of the flood on different nations (**a**) Flood effect on humans (**b**) Economic loss due to floods. (Created by the author, Data Source: EM-DAT, CRED/UC Louvain 2020).

The common excuses for this situation are the recipient stakeholders' poor participation, governance discourses are limited to stakeholders, and decisions are mainly theoretical [8,9]. Apart from those, there are dozens of negative reasons for the practical incorporation of recipients' perspectives in administrative decision-making modelling or process. Further, it found 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. Then the initial work of the authors was carried out to evaluate the integration of stakeholder requirements for a specific area of urban flood management [10]. Then 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 need to evaluate different components in integrated water management decision-making, it required an acceptable research methodology. Then, an in-depth study including a literature review and expert discussion was carried out to develop a research methodology for gap identification [11–13].

Then accordingly, it carried out abductive research using a sequential multi-phase approach of the mixed method. It 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, it studied the GIS2MUSCLE urban flood management tool, 4 hydro-GIS integration models, and 247 works of research and for calibration, it utilised 21 experts. The average integration depths among the components were calculated using 32 researches employing Multi-Attribute Utility Theory (MAUT) and Weighted Average Programming (WAP). Finally, it evaluated the results with 70 experts and analysed the result employing thematic analysis and Multi-Criteria Group Decision Making (MCGDM) methods.

2.2. Data

Through the above steps, it identified five components (main stakeholder categories) as shown in Figure 2. However, in practice, the Hydro specialists and GIS specialists are also integrated into the HydroGIS model.

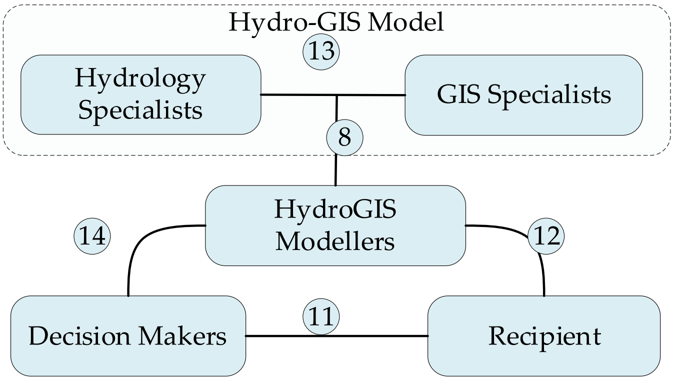

Figure 2. Main components (stakeholder categories) of flood management model. Lines between components show the existing integrations and numbers in the circles show how many research works considered such integration. Source: Author.

Then rationale was developed to weigh the depth of scientific investigation carried out by the researchers on each integration shown in Figure 2. Further, it analysed the depth of investigation level (scale of very low to very high) on each integration carried out by each research utilising the modified MAUT. However, it observed that researches have analysed the integrations in either very high or high or medium or low depths only (Figure 3).

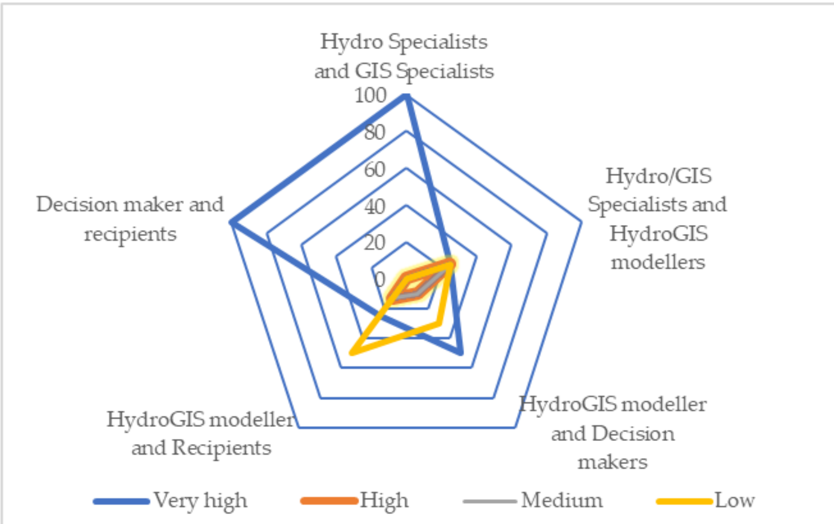

Figure 3. Distribution of investigation depth classes among the integration types.

To generalize the individual research's investigation depths to develop a final decision, it developed a rationale for weighting the scientific value of the publication [14]. 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, 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 4).

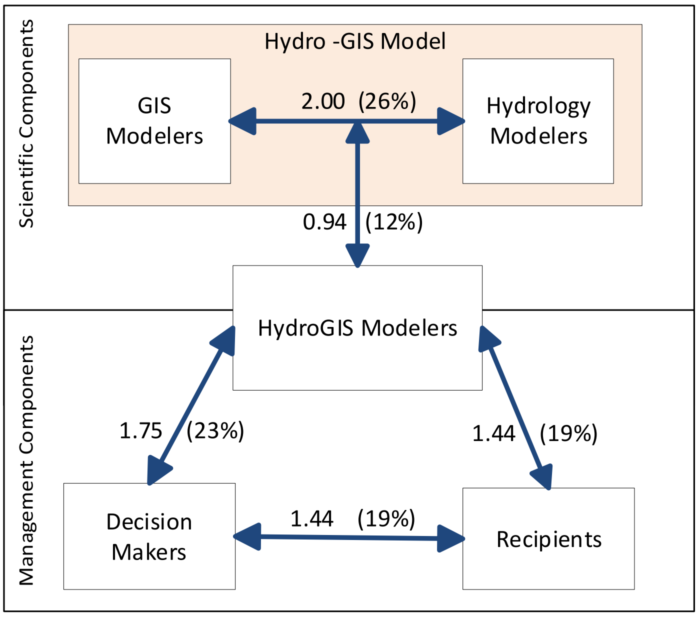

Figure 4. The present investigation depth status of the integration of main components in flood management modelling. The average depth of investigation in each integration is shown as a fraction. The comparative level of the investigation depths is shown as percentages (computed%).

Then it reclassified the investigation depths accruing to a 1–5 scale and compute the deviation from the mean comparative value of 20% (if equal attention is being paid to all five integrations, the 20% is the mean value) using equation 1. The positive values have exhibited exaggerations of attention while negatives are showing understate 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 5. This work found two definitions for the present level of researchers' interest distribution; (1) The individual interest: the investigation depth of each integration which is independent of other integration and, (2) The comparative interest: the comparative level of investigation which demonstrates how the total attention of the researchers are distributed over all possible integrations.

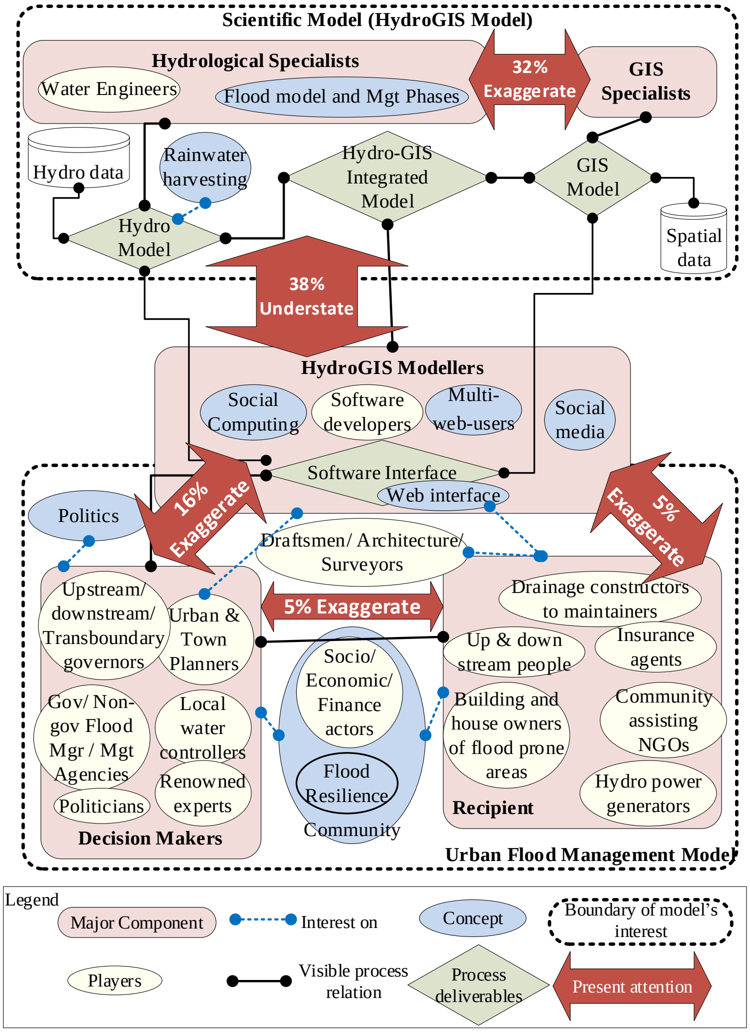

Figure 5. Descriptive view of flood management model development framework.

As per the investigation depth scale defined in the present work, all the values it received are less than 2. This means the present interest in all the integrations is below the "Low". Further, it can observe that the researchers' attention to incorporating the perspectives of Scientific component's modellers with management modellers (Hydro/GIS Specialists and HydroGIS modellers), HydroGIS modellers with recipients, and recipients with decision-makers are in "Very low" level. Then this finding is proving the importance of one of the concepts behind the IWRM, integrating the recipients into water decision-making.

According to the analysis, it found that the researchers understate 37% of the optimum when integrating the scientific modellers (hydro and GIS modellers) concerns to the management model via the HydroGIS modellers. However, it found that the most challenging requirement which is being discussed in public at the present; integrating the general public (recipient) perspective to flood management; satisfactorily attends as it received 5% understate value. Meantime, the results show that 32% exaggerated attention to integrating the hydro modellers' and GIS modellers' perspectives.

4. Conclusions

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

This study found that five main stakeholder categories need to be integrated for sustainable flood management modelling namely, Hydro modellers, GIS modellers, HydroGIS modellers, decision-makers, and recipients.

Those five stakeholder categories are grouped into two groups, (1) scientific components and, (2) management components. The integration of those 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 it 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, IWRM initiatives should pay more priority to integrate scientific modellers' perspectives while satisfying the recipients' requirements.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest: The authors declare no conflict of interest.

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