International Journal of Architecture and Urbanism

Flood Preparedness Assessment among Flood-Prone Communities in Medan

Robi Arianta Sembiring *[1], Gina Cynthia Raphita Hasibuan [1], Dicky Andrea Sembiring[2]

[1]Department of Civil Engineering, Faculty of Engineering, Universitas Sumatera Utara, Medan, 20155, Indonesia
[2]Department of Architecture, Faculty of Engineering, Universitas Sumatera Utara, Medan, 20155, Indonesia

*Corresponding Author: robisembiring@usu.ac.id

ARTICLE INFO	ABSTRACT
  	Flooding remains a pressing challenge for the city of Medan, posing a risk of considerable damage and loss of life. Understanding how well communities are prepared to face such disasters is crucial in developing effective mitigation strategies. This study focuses on assessing the readiness of communities living in flood-prone areas across Medan, comparing preparedness levels across different urban districts. This has a long-term goal to reduce the negative impact of flooding in the city of Medan with a bottom-up approah. The research will use a quantitative approach, namely a questionnaire to 200 respondents consisting of households that are in flood-prone locations at several points in the city of Medan. The primary data obtained from the questionnaire will be analyzed and tested for face validity. The final result of the research is expected to be able to project the level of community preparedness in the city of Medan in dealing with floods. Preliminary findings indicate that Aur Urban Village demonstrates the highest level of flood preparedness compared to nine other urban villages. Interestingly, the high level of informality in Aur Urban Village appears to have a strong correlation with the community's preparedness, suggesting that informal settlements may develop resilience strategies due to necessity. The findings obtained are important to be used to plan strategies that are more responsive, data-based, and relevant to community needs, leading to more targeted policies in flood mitigation. **Keywords:** community, disaster, flooding, mitigation, preparedness

1. Introduction

Flooding remains a major challenge for the city of Medan, and finding effective solutions is crucial for the well-being of its residents. During a 2016 Focus Group Discussion at Universitas Sumatera Utara (USU), the Medan City Government identified two types of flooding in the area: micro and macro floods. Micro floods occur due to inadequate drainage systems unable to channel rainwater into rivers effectively, while macro floods result from river overflows [1]. There are 13 districts and 25 urban villages that are prone to flooding in the city of Medan, namely, some of them are Medan Johor District (Kwala Belaka and Gedung Johor Urban Village), Medan Baru District (Padang Bulan Urban Village), Medan Polonia District (Sari Rejo and Polonia Urban Village), Medan Maimun District (Hamdan, Suka Raja, Kampung Baru, Sei Mati Urban Village), these urban villages are traversed by 8 rivers, some of them are namely the Babura River, Deli River, Sei Sikambing River [2]. It is also known that flood disasters has been associated with the health, economic problems, and can also cause fatalities. The main key to safety in dealing with disaster emergencies is the community's preparedness and skills by understanding the characteristics of disasters [3].

The risk of flooding is usually caused by extreme aspects of meteorology and hydrology which are predominantly influenced by human factors, thus, understanding the various factors contributing to flood risk is therefore crucial. Risk is defined by Raaijamakers et al in [4] as 3 related components (anxiety, awareness and preparedness), and further Raaijamakers et al in [4] stated that an increase in one of these factors would have implications for an increase in preparedness for flood disasters as a result of a decrease in anxiety and worry. Flooding undeniably has a significant impact on low-income communities; thus, it is only natural to strengthen the role of these communities in addressing flood risks through a bottom-up approach. [5].

The centralized policy or the top-down approach is believed to be out of date and not in accordance with the development of democratic principles that focus on community involvement, especially in flood management [6]. An important element that discusses community involvement is found in research conducted in Malaysia [7,8,9]. This study is also in accordance with the results found by which revealed that integrated flood risk management should consist of structural and non-structural elements to be able to reduce the negative impact of the flood hazard [5]. Structural elements usually consist of technical readiness, namely the installation of flood protection dams as demonstrated by the work of Ejeta (2018) [10]. This research with a qualitative approach recommends that the community be involved comprehensively, especially in socialization and training of non-structural emergencies to be better prepared in dealing with flood disasters. However, in the report made by Bappenas, it is also stated that the legal aspects in enlisting the concept to deal with flood disasters have not been able to facilitate community involvement [6].

Marlyono and Nandi (2018) in their research also found that using a descriptive survey method, their study found differences in the level of community preparedness in dealing with disasters in West Java Province, where in the Pangandaran district was very ready in dealing with tsunami, in Tasikmalaya district it was in the ready category while the community in Garut was in a lower position [11]. lowest level of readiness for landslides. Research conducted by Noor Diyana et al. (2020) determined the level of community readiness in 22 districts in Johor; The findings highlighted the need to improve community preparedness, particularly in Segamat, and to encourage proactive community involvement which emphasize the crucial role of local authorities [8]. Meanwhile, Onmuwele (2018) focuses on study which uses a quantitative approach with questionnaires distributed to see the level of community preparedness for flooding in Nigeria (200 questionnaires) [4]. The results show that a high level of preparedness is obtained from people who have previous experience with flooding compared to people who have never experienced flooding at all. This study also recommends the formation of public awareness that is at a flood-prone point in the city of Lagos to jointly fight to minimize the possibility of flooding in the megacity. In line with this , prior research by using a Likert scale and GIS, and questionnaires to 100 communities in Segamat, Johor recommends that community involvement is crucial and must be considered in flood disaster management, especially on community experience and awareness regarding understanding of flood risk [9]. The research of Atreya et al. (2017) also states the importance of a more comprehensive understanding of what drives the implementation of preparedness measures for low- income communities in dealing with floods, due to gaps in the literature related to this context, especially in developing countries [5]. This indicates that a framework concept is needed as in the research of Kellens et al. (2013) which examines the lack of standardization in measuring the community's perspective in the 57 scientific articles they study, in which this framework can be used by the community, especially low-income communities in Indonesia in order to prepare for flooding while emphasizing community involvement as a form of bottom-up approach [12].

In relation to the main problem mentioned earlier, frequent flooding occuring in the city of Medan cause many problems and can even cause fatalities. The large number of fatalities from the flood disaster can be caused by the lack of public understanding in understanding the flood disaster and the lack of community involvement in implementing flood management strategies. Based on the problem statement, the following research questions can be formulated, namely : 1. What is the level of community preparedness in flood-prone areas of Medan City? and 2. How does flood preparedness vary across different urban villages in Medan City?

To assess the level of community preparedness in handling flood disasters, this study focuses on residents living in flood-prone areas of Medan City. By examining and comparing preparedness levels across different

urban villages, this research aims to identify variations in flood preparedness. The findings of this study will offer valuable insights for government decision-making in flood disaster management, helping to develop more effective strategies for improving community resilience.

2. Method

The data collected will be categorized into primary and secondary data. Secondary data, including an administrative map of Medan and information on flood-prone locations, will be gathered simultaneously through a review of relevant literature studies.

The primary data in this study are the results obtained from 100 respondents (households) who are in flood-prone locations in the city of Medan; Primary data was collected using a questionnaire using a Likert scale to measure the level of readiness of each respondent in dealing with floods disaster in the city of Medan. The research time is carried out according to the research program implementation schedule, namely for activities for 8 months (April 2021– October 2021). The location of the activity is at several flood-prone points in the city of Medan, namely Gedung Johor, Padang Bulan, Polonia, Aur, Silalas, Kwala Bekala, Beringin, Kampung Baru, Hamdan, and Glugur Kota. Figure 1 shows the map of these ten urban villages.
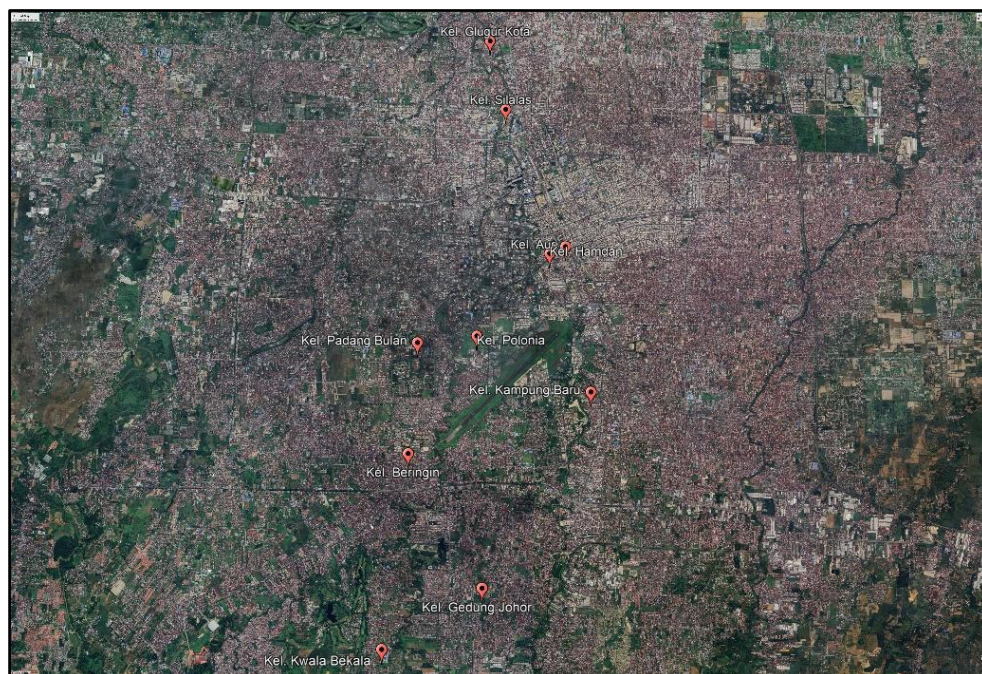

Figure 1 Location of 10 case study urban village
(source : Google Earth, 2021)

The first stage of the research is to conduct a pilot survey to ensure the suitability of the contents of the questionnaire that will be sent to prospective respondents. The pilot survey is aimed at experts who will validate the contents of the questionnaire are appropriate or not in terms of language and content presented, whether it is in accordance with the ability of the respondents. After getting approval from the validity test, a questionnaire will be sent to the respondents. Then, the results and discussion will be attained and finally conclusions will be drawn from the research that has been carried out.

3. Results and Discussion

This research is carried out by first taking secondary data showing flood-prone urban villages in the city of Medan from the mass media, and as a result of purposive sampling, 10 urban village are chosen to be the case study in which 20 questionnaires are distributed to households, RT/RW heads and local government. In Table 1, it can be seen the items being measured during the questionnaires.

Table 1 The items being measured during the questionnaires.

No	Items being measured	Scale
1	Knowledge and Attitude (K&A)	A Likert scale, from 1 (lowest) to 5 (highest). Indicating how far the respondents understand the definition of flood and its implications.
2	Emergency Plan (EP)	A Likert scale, from 1 (lowest) to 5 (highest). Indicating wether the household has already had emergency plan/evacuating route
3	Disaster Early Warning System (EWS)	A Likert scale, from 1 (lowest) to 5 (highest). Indicating the early warning system availability
4	Assistance and Recovery Mechanism (A&R)	A Likert scale, from 1 (lowest) to 5 (highest). Indicating the length of recovery mechanism and whether the residents is provided with any asisstance.

There are four items being measured to indicate the level of preparedness of 5 Ward that are prone to flood disaster in Medan, namely Knowledge and Attitude (Indicating how far the respondents understand the definition of flood and its implications) , Emergency Plan (Indicating whether the household has already had emergency plan/ evacuating route), early warning system about disaster (Indicating the early warning system availability) and Assistance and Recovery mechanism (Indicating the length of recovery mechanism and whether the residents is provided with any assistance). The questionnaire for each of this item will use Likert Scale from one to five, where one is indicating the lowest and five indicating the highest value which then implies the high level of preparedness of the respondents. 1 indicates the not very prepared level 2 indicates not prepared, 3 indicates neutral position, 4 indicates prepared, and 5 indicates very prepared position from the resident perspective.

Additionally, besides obtaining the level of preparedness of the residents who live in flood prone areas in Medan, the study also obtains the type of evacuation plan which has been implemented by the residents, evacuating supply and tools, and the place where the residents usually go if the flood occurred in their neighbourhood. The process of surveying the residents can be seen on Figure 2, in Padang Bulan of Medan Baru District, which was taken in October 8th 2021 by the Surveyors.

Figure 2 Interviewing the flood prone residents of Medan - Padang Bulan

From Figure 3, it can be observed that there is visible damage to wall surfaces caused by flooding in Padang Bulan Urban Village. Furthermore, one of the flood mitigation efforts in the area includes the installation of

sand-filled sacks to counteract land subsidence.

Figure 3 Padang Bulan (left) and Aur (right) characteristic

The preparedness level of different administrative villages in Medan City varies significantly, as shown in figure 4. Aur Urban Village has the highest preparedness score of 3.39, suggesting that its residents demonstrate a relatively high level of readiness in facing flood events. This could indicate better awareness, community engagement, or prior experience in handling floods.

Kampung Baru has a preparedness score of 3.31, and Hamdan at 3.07, both of which indicate a moderate to high preparedness level. Similarly, Silalas (3.03) and Padang Bulan (3.08) expose moderate levels of preparedness, suggesting that while the residents have some level of readiness, there may still be gaps in their flood response strategies.
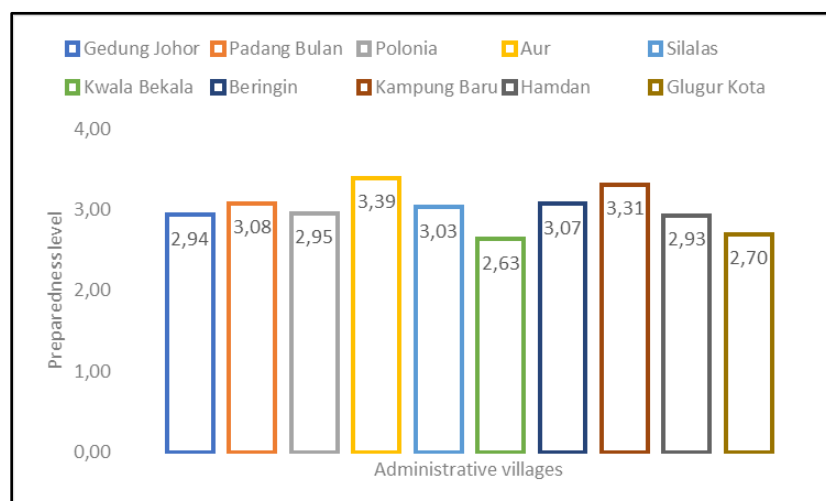

Figure 4 Comparison of level preparedness of 10 urban villages towards Flood in Medan

On the other hand, Kwala Bekala has the lowest preparedness score at 2.63, indicating a low level of preparedness, which could be due to a lack of awareness, possibly insufficient flood mitigation measures, or limited access to early warning systems. Glugur Kota (2.70) and Gedung Johor (2.94) also show lower levels of preparedness, highlighting the need for improved disaster response strategies and community engagement.

It can be inferred from Figure 4 that Aur Urban Village has the highest value in terms of level of preparedness (score 3,39) in comparison to the other 9 urban villages, namely Gedung Johor, Padang Bulan, Polonia, Silalas, Kwala Bekala, Beringin, Kampung Baru, Hamdan, and Glugur Kota. The informality of Aur Urban Village is believed to have a significant correlation with the high level of preparedness among its residents. These findings highlight the disparities in flood preparedness across urban villages, emphasizing the importance of targeted interventions to enhance resilience in communities with lower preparedness scores. Addressing these differences through education, infrastructure improvements, and better disaster management strategies can help mitigate the impact of future flood events.

The Early Warning System (EWS) and Recovery/Assistance(A&R) parameters in figure 5 show notable variations across different urban villages in Medan, indicating disparities in preparedness and response mechanisms. Among all urban villages, Aur shows evidence of a relatively higher A&R value (4.25) compared to others, suggesting that post-flood recovery efforts and assistance are likely more established in this area. This aligns with Aur's higher preparedness score, which can be linked to the fact that Aur Urban Village experiences flooding more frequently than the other nine urban villages. Because of this, the government has given more attention to early warning efforts and post-flood assistance, making these measures stronger in Aur compared to the other areas. Polonia (3.75), Padang Bulan (3.65) and Silalas (3.63) also show relatively strong recovery/assistance systems, likely due to better local government or community-driven support structures.
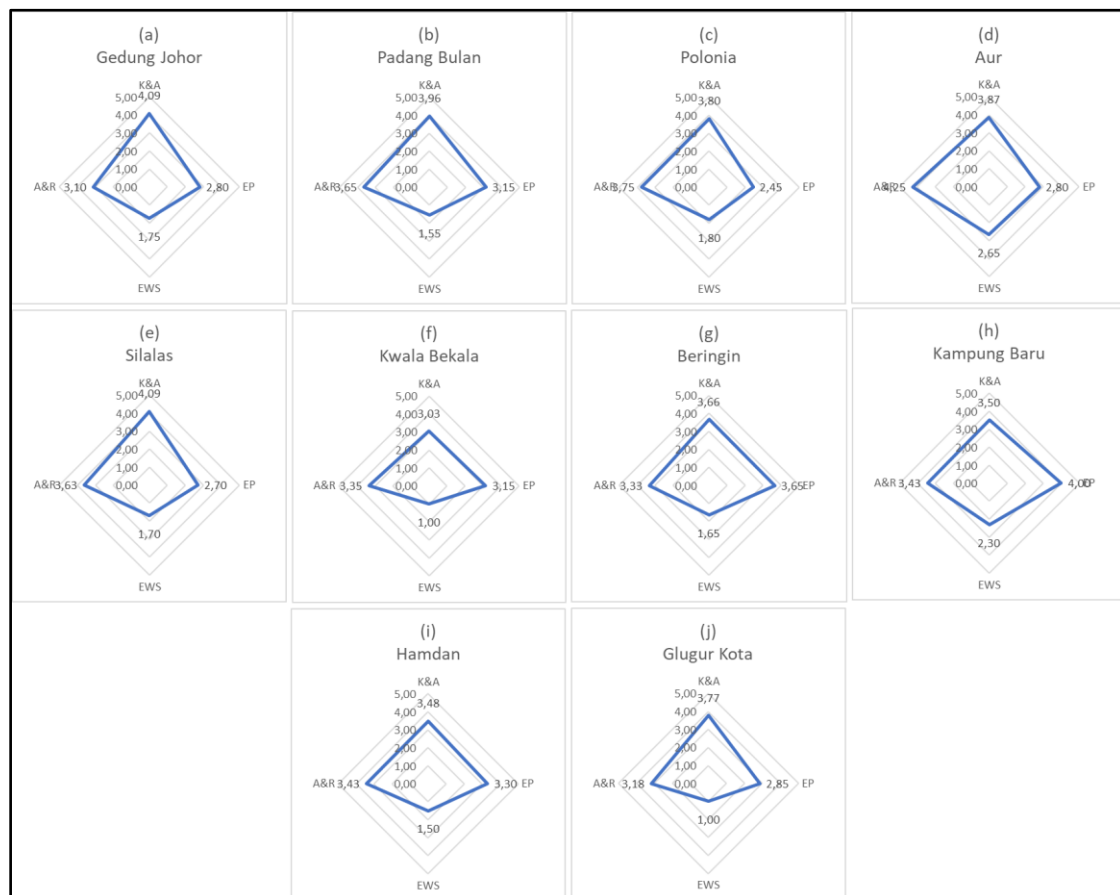

Figure 5 Level of preparedness of (a) Gedung Johor, (b) Padang Bulan, (c) Polonia, (d) Aur, (e) Silalas, (f) Kwala Bekala, (g) Beringin, (h) Kampung Baru, (i) Hamdan, (j) Glugur Kota

In contrast, Kwala Bekala (3.35), Beringin (3.33) and Glugur Kota (3.18) exhibit lower A&R scores, which may signify limited access to recovery aid or ineffective post-flood relief measures. The lowest A&R value is in Gedung Johor (3.10), suggesting that recovery efforts in this area might be insufficient. Regarding the Early Warning System (EWS), all urban villages have scores below 3.0, highlighting an overall lack of effective early warning mechanisms. Aur (2.65) and Kampung Baru (2.3) have relatively higher EWS scores, indicating that these areas might have better communication or early warning dissemination strategies. However, Kwala

Bekala (1.00) and Glugur Kota (1.00) score the lowest, indicating that these communities may lack proper early warning infrastructure or awareness campaigns. The findings in figure 5 highlight significant gaps in early warning and post-flood recovery systems, emphasizing the need for targeted interventions in urban villages with lower EWS and A&R scores.

The results obtained are crucial for the formulation of effective policies in flood disaster mitigation. Thus, the Government and related institutions can plan strategies that are more responsive, data-based, and relevant to the needs of the community to produce more targeted policies. As highlighted in a previous study by McEwen et al., (2018), this approach not only strengthens community resilience to flooding but also fosters a culture of preparedness and proactive risk management among stakeholders [13]. Encouraging collaboration between government agencies, local organizations, and community members is essential in developing a comprehensive framework that effectively addresses the complexities of flood risk management [14]. This framework should incorporate regular training sessions and simulation exercises to ensure that all stakeholders are adequately prepared for potential flood events, thereby reducing the overall impact on affected communities [15]. Additionally, such initiatives can enhance the sharing of resources and knowledge, allowing communities to leverage local expertise while establishing stronger networks to improve disaster response capabilities [16].

4. Conclusion

It can be concluded that Aur Urban Village has the highest level of preparedness compared to the other nine urban villages: Gedung Johor, Padang Bulan, Polonia, Silalas, Kwala Bekala, Beringin, Kampung Baru, Hamdan, and Glugur Kota. The high level of preparedness in Aur is believed to be strongly linked to its informal nature, which may contribute to greater community resilience. This is further illustrated by the significant differences in values for the Early Warning System and Recovery/Assistance parameters. Further analysis and research will be conducted to explore how preparedness levels vary based on gender, occupation, and the average score of each preparedness parameter.

5. Acknowledgements

6. Conflict of Interest

Funding for this study came from Lembaga Penelitian Universitas Sumatera Utara. The methodology, analysis, findings, and conclusions of this study were all independent of the sponsoring agency. The authors affirm that there are no institutional or personal conflicts of interest associated with this study.

References

[1] USU, "Penanggulangan Banjir Kota Medan Dibahas Di USU," *Arsip USU*, Dec. 21, 2016. [Online]. Available: https://www.usu.ac.id/id/arsip-berita/84-accordion-1/1300-penanggulangan-banjir-kota-medan-dibahas-di-usu.html.

[2] "Ini 13 Kecamatan di Medan yang Rawan Banjir, BPBD Sosialisasikan Pengurangan Resiko Bencana," *Tribun Medan*, Sep. 18, 2018. [Online]. Available: https://medan.tribunnews.com/2018/09/18/ini-13-kecamatan-di-medan-yang-rawan-banjir-bpbd-sosialisasikan-pengurangan-resiko-bencana.

[3] BNPB, *Buku panduan kesiapsiagaan BNPB*. [Online]. Available: https://siaga.bnpb.go.id/hkb/po-content/uploads/documents/Buku_Pedoman_Kesiapsiagaan_Keluarga_FA_A5.pdf.

[4] A. Onwuemele, "Public perception of flood risks and disaster preparedness in Lagos megacity, Nigeria," *Academic Journal of Interdisciplinary Studies*, vol. 7, no. 3, pp. 179–185, 2018. [Online]. Available: https://doi.org/10.2478/ajis-2018-0068.

[5] A. Atreya, J. Czajkowski, W. Botzen, G. Bustamante, K. Campbell, B. Collier, F. Ianni, H. Kunreuther, E. Michel-Kerjan, and M. Montgomery, "Adoption of flood preparedness actions: A household level study

in rural communities in Tabasco, Mexico," *International Journal of Disaster Risk Reduction*, vol. 24, pp. 428–438, 2017. [Online]. Available: https://doi.org/10.1016/j.ijdrr.2017.05.025.

[6] BAPPENAS, *Kebijakan Penanggulangan Banjir di Indonesia*. [Online]. Available: (n.d.).

[7] N. N. M. Shariff and Z. S. Hamidi, "Community-based approach for a flood preparedness plan in Malaysia," *Jamba: Journal of Disaster Risk Studies*, vol. 11, no. 1, 2019. [Online]. Available: https://doi.org/10.4102/jamba.v11i1.598.

[8] F. A. Noor Diyana, A. Fakhru'L-Razi, M. S. Aini, R. Ahmad Azan, and M. R. W. Mohd Muhaimin, "Community preparedness to flood disaster in Johor, Malaysia," *IOP Conference Series: Earth and Environmental Science*, vol. 479, no. 1, 2020. [Online]. Available: https://doi.org/10.1088/1755-1315/479/1/012015.

[9] Asmara, T. A. T., & Ludin, A. N. M., "Mapping perception of community preparedness towards flood in Muar River, Johor Malaysia," *IOP Conference Series: Earth and Environmental Science*, vol. 18, no. 1, 2014. [Online]. Available: https://doi.org/10.1088/1755-1315/18/1/012126.

[10] L. T. Ejeta, "Community's Emergency Preparedness for Flood Hazards in Dire-dawa Town, Ethiopia: A Qualitative Study," *PLoS Currents*, vol. 10, 2018. [Online]. Available: https://doi.org/10.1371/currents.dis.3843ad9fc823c8c853970148b350750c.

[11] S. G. Marlyono and N. Nandi, "The Preparedness Level of Community in Facing Disaster in West Java Province," *IOP Conference Series: Earth and Environmental Science*, vol. 145, no. 1, 2018. [Online]. Available: https://doi.org/10.1088/1755-1315/145/1/012103.

[12] W. Kellens, T. Terpstra, and P. De Maeyer, "Perception and Communication of Flood Risks: A Systematic Review of Empirical Research," *Risk Analysis*, vol. 33, no. 1, pp. 24–49, 2013. [Online]. Available: https://doi.org/10.1111/j.1539-6924.2012.01844.x.

[13] L. McEwen, A. Holmes, N. Quinn, and P. Cobbing, "'Learning for resilience': Developing community capital through flood action groups in urban flood risk settings with lower social capital," *Int. J. Disaster Risk Reduct.*, vol. 27, pp. 329-342, 2018. [Online]. Available: https://doi.org/10.1016/j.ijdrr.2017.10.018.

[14] M. Ishiwatari, "Flood risk governance: Establishing collaborative mechanism for integrated approach," *Prog. Disaster Sci.*, vol. 2, p. 100014, 2019. [Online]. Available: https://doi.org/10.1016/j.pdisas.2019.100014.

[15] R. Beerens, P. Abraham, P. Glerum, and B. Kolen, "Flood preparedness training and exercises," in *Encyclopedia of Natural Hazards*, P. T. Bobrowsky, Ed. Dordrecht: Springer, 2014, pp. 154. [Online]. Available: https://doi.org/10.1007/978-3-642-04253-9_154.

[16] Y. Sermet and I. Demir, "Flood Action VR: A virtual reality framework for disaster awareness and emergency response training," in *Proceedings of the ACM SIGGRAPH Conference on Virtual Reality Continuum and Its Applications in Industry (VRCAI)*, 2018. [Online]. Available: https://doi.org/10.1145/3306214.3338550.