

Empowerment of Karang Taruna Jelakcatur Kalitengah Village, Lamongan Regency, Through an Integrated IoT Early Warning System in an Effort to Increase Independence in Flood Disaster Emergency Response

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ABSTRACT

Jelakcatur Village is a village located in Kalitengah District, where the district has a basin contour or what is called Bonorowo and is included in the River Basin Area (DAS), which is prone to flooding, so that every year it is always affected by flood disasters. Based on the results of discussions with partners, the problems faced related to flooding are: Low knowledge of youth in Karang Taruna regarding flood mitigation has implications for low community preparedness for flood disasters; The unavailability of physical infrastructure for handling floods, namely EWS, which is able to provide up-to-date information about flood disasters; The unavailability of flood disaster hazard maps, safe zones, and evacuation routes. The purpose of this activity is to provide solutions in the form of: increasing the knowledge of youth in Karang Taruna regarding preparedness in facing flood disasters through counseling and education about floods to Karang Taruna in order to increase understanding, concern, and the role of youth in their environment; Making an IoT-integrated EWS so that it can provide early warning information for flood disasters to the Jelakcatur Village community in real time; Making disaster hazard maps in a participatory manner, namely safe zone maps and evacuation routes, to provide the community with an understanding of environmental conditions related to flood disasters. This participatory flood disaster evacuation route map-making training activity is a supplement to increase the capacity of Karang Taruna cadres in non-structural disaster mitigation carried out at the pre-disaster stage, as well as to improve the soft skills of Karang Taruna cadres so that they can increase their role in the local village.

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INTRODUCTION

One of the areas in East Java Province that often experiences flooding is Lamongan Regency. As an area included in the Bengawan Solo River Basin Area (DAS), Lamongan Regency is an area prone to flooding during the rainy season (Aprillya & Chasanah, 2021, 2022). This is because the land surface elevation of Lamongan Regency is lower than the surrounding areas and also lower than the height of the Bengawan Solo River (Arifin & Rizaldy, 2023). Based on geographical location, Lamongan Regency is divided into two parts, namely the area along the DAS and Bengawan Jero. The Bengawan Jero area, also called Bonorowo consists of 6 sub-districts, one of which is Kalitengah Sub-district, which has a lower land surface elevation than the surrounding areas, including lower than the height of the Bengawan Solo River, so it is often hit by floods when the rainy season arrives (Syaifur, 2018).

The partner in this community service program is the non-productive youth group of Jelakcatur Village. Referring to Permensos No. 25 of 2019 concerning Youth, the age limit for its members adheres to a passive system, namely the young generation aged 13 (thirteen) to 45 (forty-five) years. Currently, the Youth Organization of Jelakcatur Village, Kalitengah, Lamongan has no less than 35 active members, both those who are still domiciled and/or those who are traveling due to further studies and work outside the city. When rainfall increases, the water discharge of the Bengawan Solo increases, causing flooding in densely populated areas and agricultural land (Figures 1a and 1b). Jelakcatur Village consists of four hamlets, namely Plarisan Hamlet, Gangin Hamlet, Jelak Hamlet, and Glumo Hamlet. Administratively, the area of Jelakcatur Village is 5524 km² with a population of 2,950 people per 2023 with a density of 2 people/km² (Nailatussa'ada, 2023).

Some residents of Jelakcatur Village live in semi-permanent and non-permanent houses, and the condition of the building floor is directly on the ground. With these conditions, when a flood occurs, houses in Jelakcatur Village will be submerged in water (Figure 2.1). The impact of the Bengawan Solo River flood was experienced by Jelakcatur Village, Kalitengah District, Lamongan Regency, recorded data from the Lamongan Regency BPBD in 2019, as many as 405 residents' houses were submerged and 2,950 residents were evacuated (Wulansari et al., 2019). In addition, the flood also had an impact on the agriculture and fisheries sector, namely 1,132.23 ha of ponds were flooded from a total pond area of 3,565.60 ha with a loss of 3,902,800 rupiah (Syaifur, 2018). This resulted in crop failure, caused significant losses for farmers, and had an impact on the level of household income of farmers.



FIGURE 1. a) The road access to Jelakcatur Kalitengah Village was cut off, b) The houses of residents of Jelakcatur Kalitengah Village, Lamongan Regency, were submerged, Source: Author's, 2024

Efforts taken by the community to overcome flood disasters can only be implemented minimally, because the natural conditions and location of this village cannot be changed (Febriawati & Yanuarti, 2022;

Listyaningrum et al., 2023). However, they hope that there is participation from the community and government and other stakeholders who will help, especially ideas, which can be done to reduce the danger of flood disasters through the role of village youth or Karang Taruna. In line with Law Number 24 of 2007 concerning disaster management, which discusses the responsibilities and obligations of the government and community to work together in disaster preparedness (Putri et al., 2021). This emphasizes that community participation and disaster planning are important for communities that have areas with a high level of flood disaster vulnerability. So that activities are needed that can increase community understanding of flood disasters, their relationship with the environment, and the mitigation model that will be applied.

The mitigation model that will be implemented must be supported by strengthening the physical infrastructure for flood management, such as the Early Warning System (EWS) integrated with the Internet of Things (IoT), and an understanding of disaster management by the youth of the Karang Taruna in Jelakatur Village as an effort to increase independence in responding to flood disasters. So that it is hoped that the community, especially the Karang Taruna group of Jelakatur Village, will be able to become the vanguard among young people who care about the environment and have knowledge of flood disaster mitigation.

METHOD

The implementation method of the Community Partnership Empowerment (PKM) activity is carried out using a participatory approach method where target partners will be involved comprehensively in each activity (Chasanah & Widodo, 2023). In this activity, partners play an active role in each stage of observation, counseling, discussion, training, and mentoring (Wayan Merta et al., 2022; Legowo et al., 2022). The following are the stages of the PKM implementation activities with Jelakatur Village partners offered by the proposing team in the Community Partnership Empowerment (PKM) activity as follows:

1. Focus Group Discussion

Before the implementation of PKM, a focus group discussion was conducted between the service team and partners, namely the youth of Jelakatur Village. The FGD will also involve the youth of the village and the village government. The purpose of this FGD activity is a means for service providers to convey the PKM program plan that will be carried out with the hope that there will be input so that this PKM can run well (Gamela Saldy et al., 2020). Furthermore, building a joint commitment and working together so that this PKM runs well according to its objectives

2. Socialization

Socialization and counseling activities are sequential program solutions held in this PKM program and attended by Partners with the following activity details:

- Counseling and education about flooding to youth of Karang Taruna to increase understanding, concern and the role of youth towards their environment.
- Formation of disaster-resilient cadres from elements of Karang Taruna youth of Jelakatur Village

3. Training

Training activities held in this PKM program and attended by Partners with the following activity details:

- Training on the use and maintenance of an integrated IoT Early Warning System (EWS) as an effort to increase independence in responding to flood disasters (Alam et al., 2022)
- Training in making hazard maps, safe zones and disaster evacuation routes carried out in a participatory manner

4. Application of Technology

The application of technology in this PKM activity is a follow-up to the training held previously in this PKM program and attended by Partners. The details of the technology applied in this program are as

follows:

- Installation of an integrated IoT Early Warning System (EWS) as one of the flood disaster mitigation infrastructures (Adyatma et al., 2022)
- Installation of maps of hazards, safe zones and evacuation routes for flood disasters

5. Evaluation of Program Sustainability

Evaluation is carried out at each stage of program implementation. With this evaluation, it is expected that the implementation of the next program can be better prepared, and if there are still things that have not been resolved in the previous stage of the program, improvements can be made as soon as possible. In the final evaluation of the PKM program, partner representatives participated in providing program results in the form of an integrated IoT Early Warning System (EWS), disaster-prone maps, safe zones, and evacuation routes, the organizational structure of disaster-resilient cadres as a complement to the flood disaster mitigation infrastructure of Jelakcatur Village (Adipradana et al., 2021; Adyatma et al., 2022; Novita Sari et al., 2023).



FIGURE 2. Flowchart of implementing community service

RESULT AND DISCUSSION

The results of the five stages of community partnership empowerment activities with the title Empowerment of Karang Taruna Jelakcatur Kalitengah Village, Lamongan Regency Through an Integrated IoT Early Warning System in Efforts to Increase Independence in Flood Disaster Emergency Response are as follows:

1. Focus Group Discussion Results

Before implementing the PKM program, the PKM team together with partners held an initial discussion and conveyed the PKM program plan that would be carried out (Figure 2). The following are the results of the initial discussion with partners, namely the Jelakcatur Village Youth Group:

- Members of the Jelakcatur Village Youth Group still have minimal understanding and knowledge about preparedness in facing flood disasters
- The Jelakcatur Village Youth Group has not shown its youth role in the village, especially in flood disaster mitigation efforts
- Jelakcatur Village does not yet have physical infrastructure for handling floods, namely EWS which is able to provide up-to-date information about flood disasters.
- Jelakcatur Village does not yet have a flood disaster hazard map, safe zones and evacuation routes.

Furthermore, in the meeting, the PKM team and partners built a joint commitment and worked together so that this PKM runs well according to its objectives.



FIGURE 3. Focus Group Discussion between the PKM team and members of the Jelakcatur Village Youth Organization

2. Socialization

At the socialization stage, community service activities were carried out in September 2024 in Jelakcatur Village, Kalitengah District, Lamongan Regency. This socialization activity received a good response from the management of the Jelakcatur Youth Organization and the Jelakcatur Village Government, along with the community. The number of participants who attended this activity was 46. The participants consisted of the management of the youth organization, members of the youth organization, and some village officials. The implementation of the activity took place at the Jelakcatur Village Hall. At this socialization and outreach event, the PKM team provided material related to flooding and its mitigation as well as the role of youth in flood disaster mitigation efforts (Figure 3).

The socialization and counseling activities in this program were carried out using lecture and question-and-answer discussion methods so that there would be no gap between participants and resource persons (Yayan Suryana et al., 2024). The goal was for participants to be able to receive the material well and not hesitate to ask if they did not understand. And at the beginning of the activity, a pretest was carried out to measure the extent of the participants' understanding of the socialization, and at the end of the activity, it ended with a posttest.

In this activity, the PKM team also conveyed what needs to be done to resolve the flood problem in Jelakcatur Village and explained the important role of youth in flood disaster mitigation efforts, namely by forming Disaster Resilience Cadres at the village/sub-district level with all their roles related to mitigation.



FIGURE 4. Socialization and Counseling Activities with Karang Taruna Jelakcatur Village

Counseling and education about flooding to youth of Karang Taruna to increase understanding, concern, and role of youth towards their environment. The following is the percentage of understanding of socialization participants before and after socialization and counseling:

TABLE 1. Level of Understanding of Socialization Participants Before and After Socialization, Source: Author's, 2024

No	Question	Percentage of Understanding (%)	
		Before Socialization	After Socialization
1	How often do you participate in outreach or training activities related to disaster management in your village?	46	76

No	Question	Percentage of Understanding (%)	
		Before Socialization	After Socialization
2	Which of the following signs do you think most clearly indicates that a flood is coming?	47	70
3	What is the first thing you do if you know there will be a flood in your area?	60	80
4	What emergency supplies do you think are most important to have ready before a flood occurs?	65	90
5	Do you know the emergency evacuation routes in your village well?	44	72
6	What role do you think is most important for Karang Taruna in flood disaster management?	75	86
7	How important is disaster management training for Karang Taruna's preparedness?	87	92
8	Which of the following skills do you think Karang Taruna members need to master the most in dealing with flood disasters?	45	78

Based on the data in Table 1, the level of understanding of the youth of Karang Taruna regarding floods is very good; this is tested with questions in Table 1 rows 1–5. While the questions in row 6 are questions about perceptions of the role of Karang Taruna. And the questions in row 7 are questions about the importance of training, and the questions in row 8 are questions about the skills needed to become a disaster-resilient cadre. There was an increase in the knowledge of the socialization participants from before and after the socialization; this shows that the delivery of the material given during the socialization was well received by the socialization and counseling participants. The community realizes that flooding is an annual cycle that is certain to occur, because in any case the land contour and land elevation in Jelakatur Village cannot be changed. What can be done is mitigation before and after the flood disaster arrives, one of which is forming disaster-resilient cadres and seeking other flood management infrastructure such as early flood detection tools and flood evacuation route maps.

In this socialization activity, a draft of the composition of disaster-resilient cadres from the youth elements of Jelakatur Village was also formed, consisting of: Chairperson, Secretary, Treasurer, Prevention and Preparedness Division, Emergency and Rehabilitation Division, Logistics and Public Relations Division with the attached organizational structure.

3. Training

After the socialization and counseling activities, the PKM team continued the program by holding training on the creation, use, and maintenance of an integrated IoT Early Warning System (EWS) as an effort to increase independence in responding to flood disasters and training on the creation of hazard maps, safe zones, and disaster evacuation routes, which were carried out in a participatory manner (Abdul Fikri Angga Reksa, 2021).

After that, the event continued with the practice of making disaster-prone maps such as safe zone maps, evacuation route maps, and temporary refugee distribution as the initial step in disaster mitigation (Figure 5). All team members, both lecturers and students, helped accompany the participants in this activity. It is hoped that this socialization and training event will continue until the output of this program is completed, public understanding of disaster mitigation increases, and disaster-prone maps are available.



FIGURE 5. Integrated IoT EWS Training Activities and Making Flood Evacuation Route Maps for Jelakcatur Village with Karang Taruna of Jelakcatur Village

Jelakcatur Village, located in Kalitengah District, is indeed close to the Bengawan Njero River, so it experiences flooding every year. Jelakcatur Village does not yet have an informative flood early warning system. So the presence of this IoT-integrated EWS is expected to work well and be able to provide information to the community regarding flooding quickly (Alam et al., 2022). This activity was continued with practice on the use of EWS and its maintenance as well as the creation of a flood evacuation route map. In this activity, the PKM team accompanied the Karang Taruna youth in its use (Figure 5).

4. Application of Technology

Installation of an IoT integrated Early Warning System (EWS) as one of the flood disaster mitigation infrastructures at four points, surrounding the village, namely the western, eastern, northern, and southern borders of Jelakcatur village with documentation as in Figure 7. Furthermore, the activity of making a flood disaster evacuation route map for Jelakcatur Village based on elevation data from the Indonesian Geospatial Agency, which is downloaded online and utilizing the Geographic Information System. From this data, it can be determined which areas are prone to flooding and areas that are safe from flooding, which will later be used as a reference for making flood disaster evacuation routes. Jelakcatur Village, which is a village where the majority of the population works as farmers, also really needs mapping (Abdul Fikri Angga Rekso, 2021). The aim is expected to provide information and awareness to the community in Jelakcatur Village against flooding in the agricultural sector because it can cause quite large losses. Installation of a map of hazards, safe zones, and disaster evacuation routes at the village hall because, based on previous training, it was determined that the village hall would be used as a gathering point for flood disaster evacuation based on the highest elevation point in the village (Figure 6).

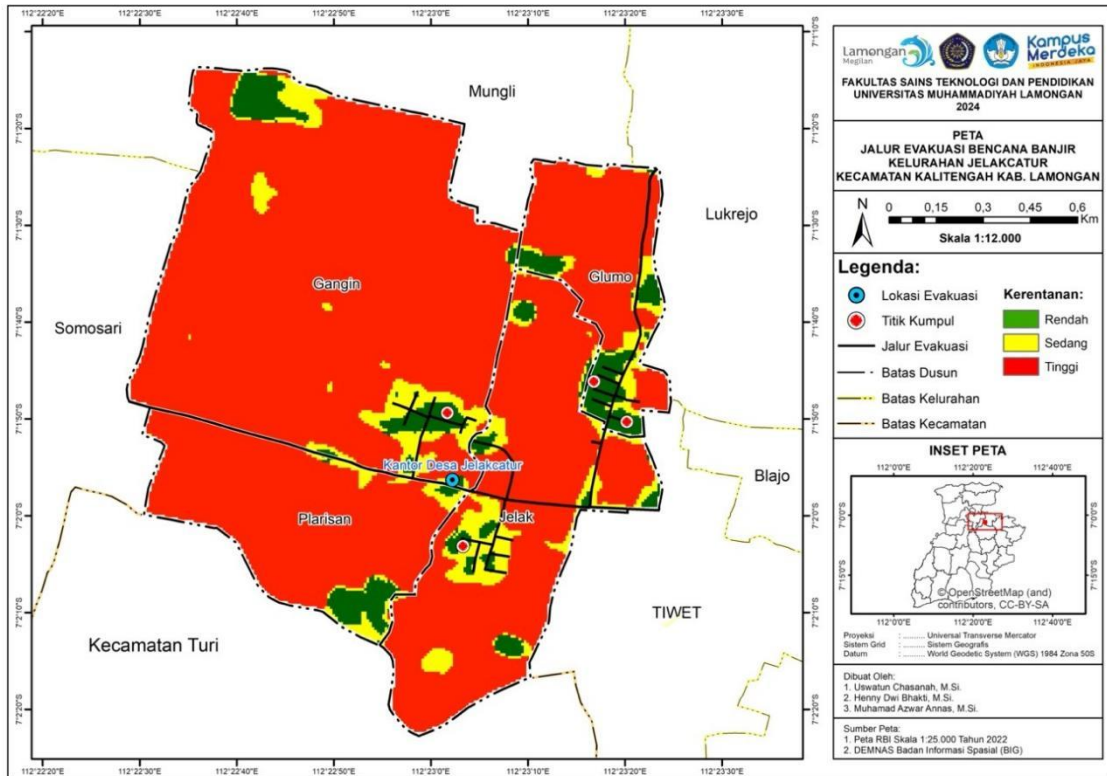


FIGURE 6. Peta Jalur Evakuasi Bencana Banjir Desa Jelakatur. (Source: Author's, 2024)



FIGURE 7. Installation of IoT integrated EWS at four points around the village on the West (a), East (b), North (c) and South (d) sides of Jelakatur Village

5. Evaluation of Program Sustainability

This PKM program is expected to be continued independently by partners, in this case the youth of Karang Taruna, because the facilities and infrastructure in the form of an early warning system in the form of an IoT integrated EWS, a flood evacuation route map, and disaster-resilient cadres as a complete flood disaster mitigation infrastructure in Jelakcatur Village have been formed together by the program implementation team and partners (Figure 8). In the follow-up plan for this PKM activity, the PKM team will conduct evaluations and monitoring in Jelakcatur Village. In carrying out periodic monitoring and evaluation, the PKM team has considered several aspects that need to be considered, namely:

- Sustainability of EWS Operations with indicators that the EWS is functioning properly, data is accurate, and notifications are timely
- Human Resource Capacity with indicators that there is a clear EWS management mechanism, involving various related parties and the community actively using EWS and participating in disaster mitigation efforts.
- Stakeholder Involvement with indicators that there are sustainable funding sources available for EWS operations and strategies to improve program sustainability.



FIGURE 8. (a) & (b) Handover of the IoT integrated EWS set and solar panels for Karang Taruna partners of Jelakcatur Village

CONCLUSION AND RECOMENDATION

The Empowerment Activity of Karang Taruna in Jelakcatur Village, Kalitengah, Lamongan Regency Through an Integrated IoT Early Warning System, an effort to increase independence in flood disaster emergency response, which has been carried out in several activities, has obtained results in accordance with the target. In addition, an integrated IoT flood detection early warning system, or Early Warning System (EWS), has been installed in Jelakcatur Village to provide fast information regarding signs of flooding in real time, and a flood disaster evacuation route map has been created to determine points prone to flooding and evacuation points if there is a flood. This participatory flood disaster evacuation route map training activity is a supplement to increase the capacity of Karang Taruna cadres in non-structural disaster mitigation carried out at the pre-disaster stage, as well as to improve the soft skills of Karang Taruna cadres so that they can increase their role in the local village.

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