Model of ecological approaches to build community response to flood disasters

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Abstract. In seeing the threat of a disaster, the community must have the capability to respond. Disaster risk increases for those who do not prepare themselves for the possibility of a disaster. The purpose of this study is to model the harmony of human interaction with the environment in which they live. Behavioural awareness of people living in disaster-prone areas can increase community resilience to disasters. The ecological approach is used to see the interaction of the community with its physical environment. The data of this study were obtained through in-depth observation and interviews of residents living on the banks of the Cimanuk river in Garut City District. Respondents were randomly selected from the community on the banks of the Cimanuk river affected by the Banjir Bandang in 2016. The results of the interviews were analyzed qualitatively.

Physical environmental factors that form the adaptation of community behaviour are land characteristics, rainfall, river border conditions. Community behaviour in dealing with disaster risk is determined by the perception of self-determination that shapes attitudes and awareness of the safety of life and property. There are also social norms that strengthen people's attitudes in disaster response efforts. River embankments, water monitoring posts, evacuation routes, funding sources, and institutions are supporting infrastructure for community interaction in responding to potential flood disasters and being a necessity in building disaster response communities.

1. Introduction

Hydrometeorological disasters have recently shown an increasing trend. Flood disasters become seasonal disasters caused by the destruction of ecosystems in watersheds (DAS) [1,2]. This is exacerbated by rainfall conditions which tend to increase due to climate change globally. The risk of floods is increasing for people living along the riverbanks [3].

In urban areas, the limited land area causes people to stay on the banks of the river. The limited economic capacity of some residents to access strategic lands in the city center causes low-income residents to be forced to occupy marginal lands even with the risk of threats / security to high disasters. Referring to the 2015 Minister of Public Works Regulation concerning the establishment of river border lines, stating that the river border is retention areas or floodplains that function for flood control so that they are not supposed to be used as residential settlements. However, it is not easy to relocate people living on the banks of the river [4]. Perceptions of relocation plans relate to the factors that influence them: physical and environmental aspects, economic aspects, internal characteristics of society, social
and cultural aspects, information dissemination, communication between stakeholders, and community involvement in the decision making the process [5,6]. Institutional roles are also needed for disaster management such as spatial management, river normalization, control of riverbank utilization, land acquisition and construction of flood control infrastructure facilities such as weirs, tombs etc. [7].

People who live in disaster-prone areas must be provided with knowledge about the condition of the region and its potential to be able to anticipate disasters [3]. Resilience in facing this disaster is manifested in development planning that contains prevention, preparedness, disaster risk reduction, and capacity building efforts for post-emergency recovery by utilizing local resources.

The Cimanuk and Cikamiri flash floods in September 2016 in the Garut region hit six sub-districts. Not only houses and property belonging to residents, but the disaster also claimed many lives and damage to various public facilities such as educational facilities, health facilities, and religious facilities [8]. Given the magnitude of the potential material and non-material losses due to flooding, it is necessary to make a community-based disaster response model that lives around the river banks to minimize the risk of flood disasters.

2. Method
An Ecological approach is a method of analysis that emphasizes the relationship between humans and activities in their environment so that humans and various activities are always the focus of analysis about abiotic, biotic, and social, economic and cultural environments [9,10].

The focus of this research study is human interaction with the environment. This research produces a model of community interaction with the environment in which it is focused on how people behave in response to their physical environment, prominent interactions between living things and their environment and changes in biotic and abiotic components.

Research data is collected by a survey. The community objects studied were 135 families affected by flash floods in the Cimanuk River, which are residents of the Pakuwon sub-district, Garut Kota. Also, in-depth interviews and observations were carried out. The informant determination technique starts with observing and communicating to find out the parties that meet the criteria of being informants.

The researcher made steps to validate the data using triangulation. Triangulation technique is an information checking technique that utilizes the use of various sources, namely observation, interviews, and documents. Data validation techniques are taken through the confirmation of the statements of the informants and the documents studied.

3. Result and discussion
Resilient society is a society that can anticipate and minimize destructive forces through adaptation [11]. This concept also emphasizes that the community can manage and maintain certain basic structures and functions in the event of a disaster. If affected by the disaster, they will quickly be able to build their lives to be normal again or at least be able to quickly recover themselves independently.

In building disaster response communities all stakeholders, both the community and the Village / Kelurahan government must actively participate and involve infrastructure, economic, political and socio-cultural support (multi-disciplinary and multi-sectoral in nature) [12]. Disaster response communities have Community-Based Early Warning Systems, and Contingency Plans and evacuation routes based on their knowledge and capabilities of the environment, as well as the pattern of economic resilience as a supporting element in sustaining life when disasters occur at any time.

Natural disasters as events or series of events caused by nature, humans, or by both cause disruption to the life order and livelihood of the community [13]. In disaster mitigation efforts, urban communities living in disaster-prone areas need local wisdom of the community. Local wisdom arises in the form of structuring city space configurations with building elements, density, and open space [14].

Cimanuk River in Garut Regency flows through the city of Garut. As the river banks in Indonesia, the banks of the Cimanuk River are used as residential land due to the high price of land for settlements in urban areas. The land of the Cimanuk river in the Pakuwon village area is very strategic because it is located in the center of the city, close to the centers of economic activities such as markets, shopping
centers and has very good accessibility. Almost all public transportation lines cross the Pakuwon area. This causes vacant land in the Pakuwon Village area to be of strategic value as well as marginal lands on the banks of the Cimanuk River.

3.1. Bio-Physical Environmental Factors: Analysis Relating to Disaster Risk Assessment

Bio physical environmental factors related to the potential of Banjir Bandang disasters include land characteristics, rainfall, river border conditions. Flash floods are a flood due to the overflowing of river water due to the enlarged water flow beyond the capacity of the river. The characteristics of Banjir Bandang are the increase of river water discharge with a very fast vulnerable time, usually less than 6 hours, the flood flows are very strong with a rise in water height of about 3-6 meters, and usually, carry debris which is very dangerous for the area it passes [15].

Climatology conditions in general in the Garut regency are included in the wet tropic climate category or Af to Am type in the Koppen climate classification. Type Af means that in the worst months the average rainfall is > 60 mm while in the type of am rainfall in the wet month can compensate for rainfall in the dry months. The average rainfall around Garut ranges from 2,589 mm with nine wet months and three dry months. In mountainous areas, Rainfall reaches 3,500-4,000 mm [16].

The mountainous area in Garut Regency is upstream for several large rivers that cross the city of Garut. One of them is the Upper Cimanuk river, which is on Mount Papandayan, which is included in the Cikajang and Pasirwangi sub-districts. The condition of the upstream watershed of the Cimanuk River which has been damaged causes the risk of Banjir Bandang always appearing when high-intensity rainfall occurs, especially for residential settlements close to the Cimanuk river [16].

River boundary land is land along the right and left of the river, which plays an important role in the sustainability of river functions. The use of river border land should be directed at protecting rivers from activities that disrupt and damage the quality of river water and the physical conditions of rivers and riverbeds. Currently, the border condition of the Cimanuk river begins to be disrupted by the intervention of building residential settlements. Residents built houses and even reached the river embankment.

In the rainy season settlements in the river border area are at high risk of being hit by a river overflowing. To avoid the risk of loss, it is necessary to raise public awareness and structuring settlements along the banks of the Cimanuk River. The introduction and understanding of the community towards the physical environment conditions in the area where they live will make it easier for them to adapt and support the success of disaster mitigation.

3.2. Behavior Factors: Social Norms and Behavior Adaptation

In addition to natural factors, hydrometeorological disasters that occur in urban areas are usually caused by several factors, namely drainage conditions, the distance between buildings and rivers, inundation locations and decreasing soil infiltration [17]. At present river, dikes have been built and land clearing is located 10 meters from the river that to reduce the risk of disasters if there is a flash flood Cimanuk River.

Taking into account the causes of disasters, building disaster response communities is more directed at the intellectual capacity of the community, starting from conducting regional risk assessments consisting of components, assessment or assessment of threats, vulnerabilities, and planning capacity/capability to disaster management [9,11].

Disaster risk assessment is a process of identifying and drafting a plan based on the conditions that are expected to occur. The intellectual capacity of the community will influence the adaptation of society as reflected in their behavior in the face of disaster risk [18]. The government, the community, and some parties need to be always ready with an early warning system. Disaster early warning systems do not have to be sophisticated and expensive but can be with human sensors. Early warning of relying on human sensors is a form of community awareness and preparation for disaster.

Community behavior in dealing with disaster risk is determined by the perception of self-determination (self-determinations) that shape attitude or attitude is an awareness of the safety of life and property. The awareness response of the community on the riverbank to disaster risk can be observed
from the existence of community river monitoring groups formed by the community as a place to maintain mutual safety. The group is tasked with monitoring river water levels regularly when there are rain or rain signals in the upstream area. Indicators of river water rise are divided into four levels of vigilance based on the river water level on the river embankment.

**Table 1. Flood disaster early warning based on the river water level.**

| The high river water level | Status   | Response                                                                 |
|---------------------------|----------|---------------------------------------------------------------------------|
| More than 6 m             | Safe     |                                                                           |
| 6 – 4 m                   | Standby  | Check the safety of embankments and the readiness of the population closest to the embankment via chain SMS |
| 4 – 2 m                   | Alert    | Announcement of flood alert from the nearest mosque or mosque. Ready to evacuate at any time |
| Less than 2 m             | Danger   | Sirens and appeals from the mosque so that residents immediately evacuate to a safer place |

Source: interview

Also, there are also social norms that will strengthen community attitudes in disaster response efforts, namely religious norms and basic knowledge about the environment. Social norms are habits that become boundaries of community behavior with certain regional boundaries. Social norms that develop in people living on the banks of the river basically arise because of their experience and agreement on the risks of flood disasters. Social norms that develop as a response to human adaptation to their living environment can be seen from the strength of the invitation not to throw garbage into the river, plant / green along the river banks and use vacant land on the banks of the river only as a green open space and a place for socializing the community.

3.3. Supporting infrastructure

Supporting infrastructure for the success of the disaster response community consists of physical and non-physical infrastructure [19]. Physical infrastructure is all physical buildings needed to support community activities in response to disaster risks in the form of river embankments, river water observation posts, evacuation routes, and safe gathering points. Non-physical infrastructure in the form of funds and institutions specifically formed and involves local and private local governments to help make it easier for the community to adapt to the environment in which they live.

The relationship between the biophysical environment, behavior adaptation, and supporting infrastructure can be explained in the following Figure 1.

![Figure 1. Relationship biophysical environment, behavior adaptation, and supporting infrastructure.](image-url)
4. Conclusion
Increasing public awareness of disasters can be realized by using an ecological approach, especially for people living in areas that are at high risk of disasters. If relocation of the population is often unsuccessful for various reasons, this model is expected to encourage people living in disaster-prone areas to have knowledge and awareness about their bio physical environment so that they can adapt through behavior change and create and use various supporting infrastructure so that they are better prepared for disasters.

Anticipation for the medium and long term can be done through a review of spatial planning or land use, especially in upstream areas and along riverbanks. Also, it should also be noted the alternative socio-economic life of the community in the context of land use.

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