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Community resilience index in the overflow flood area around Lake Tempe, Wajo District, South Sulawesi

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Abstract. In terms of survival, resilience serves as an example of choice when confronted with situations where opportunities to choose are lacking. Thus, in such conditions, it becomes necessary to adapt to the incompatible circumstances being encountered. The traditional settlement community of Bugis Wajo holds "ulayat rights", enabling them to thrive for generations in the vicinity of Tempe Lake. One of them, the traditional communities in Wette Hamlet in Lautang Village must grapple with annual flooding of 2-3 meters during the rainy season due to river water overflow from Tempe Lake. This flooding phenomenon stands as a testament to the unique ability of local traditional communities to adjust to normal conditions during dry seasons and adapt to the rainy seasons, allowing them to endure in their daily communal pursuits. This research employed quantitative descriptive methods and utilized eight variables, which were subsequently assigned scores to quantify resilience. Based on the results and the ensuing discussion of the analysis, it is evident that secure housing holds immense value in bolstering community resilience. There are high values in community resilience concerning community capacity, social capital, connectedness, and access to clean water. Meanwhile, there is a moderate level of community resilience when considering aspects such as disaster preparedness, livelihoods, and health. In conclusion, the analysis identifies a high degree of community resilience within the traditional community of Wette Hamlet in Lautang Village.

1. Introduction

Traditional settlements are rural areas that remain rooted in traditional values and culture. These settlements are distinguished by their agrarian and homogeneous communities, as well as their intimate connection with nature [1]. Traditional settlement communities share a direct rapport with nature [2]. The community's local wisdom holds the potential to significantly contribute to the sustainability of these settlements [3].

When it comes to survival, a prime example emerges when individuals lack the opportunity to choose; these circumstances necessitate adaptation to the challenges at hand. The susceptibility of a community to higher disaster hazards inversely impacts its resilience [4]. Stated differently, a community's capacity for survival directly correlates with its disaster preparedness and adaptive measures [5]. Resilience denotes the capacity to respond to obstacles or pressures in a constructive and effective manner [6]. It encompasses the ability of a system, community, or society exposed to hazards to endure, assimilate, accommodate, and recuperate from the impacts of those hazards promptly and efficiently. This includes the preservation and restoration of fundamental structures and functions [7].



Another facet of resilience is observable in the physical realm, where it can be gauged by changes in building integrity and the duration of a building's endurance [8]. Numerous aspects contribute to comprehending the concept of resilience, with community resilience being one of them. Community resilience hones in on the aptitude of communities to manage pressures and upheavals [9]. Indices employed to assess resilience encompass the community capacity index, social capital, inclusivity, connectedness, building security, preparedness, livelihoods, natural resources, health, and access to clean water and sanitation [10]. The evaluation of community resilience entails scrutinizing the physical, social, economic, and preparedness dimensions [5]. Factors tied to physical, social, economic, and institutional dimensions can gauge the resilience level of a community within a region, thereby motivating communities to enhance their capacity to cope with the challenges and disruptions that impact an area [9]. Assessing community resilience within a disaster-prone area bears significant importance, as the findings contribute to crafting appropriate mitigation strategies and policies for that locale [5]. Measuring resilience is complex, but by combining the characteristics of the region and the existing index variable process, there is a score that can correlate with the actual measure of resilience [10].

In accordance with Regulation [11] concerning river and lake boundary delineations, this regulation was instituted to ensure that the functions of rivers and lakes remain undisturbed by developmental activities in their vicinity. The aim is to facilitate resource utilization and value enhancement, while preserving the essential roles of rivers and lakes. Additionally, the regulation seeks to curtail the potential environmental impact posed by the force of river and lake water, limiting it to a range of 50 meters. There is also a data extracted from the Wajo Regency Regional Agency for Disaster Management (BPBD) within the Disaster Risk Assessment Document of Wajo Regency indicates that the recurrent annual floods carry a significant threat of flooding hazards.

Meanwhile, the Wajo Regency Government's assessment reveals that certain communities have adapted to existing disasters, yet they still struggle to coexist harmoniously with these challenges. The intensity of the yearly floods experienced by the residents of Wetee Hamlet in Lautang Village can escalate to heights of 2 meters or beyond (see red dot in figure 1 and figure 2). Tidal flooding poses a substantial threat to individuals living near water bodies, disrupting not only their residential surroundings but also exerting socio-economic repercussions. Communities situated around waterways generally exhibit a pronounced dependency on the water ecosystem for their livelihoods [12]. This represents a distinct feature of the community's capacity to adapt to both regular conditions during the dry season and the challenges posed by the rainy season, including the annual floods. Despite these circumstances, the community perseveres in their day-to-day activities. In light of the climate change phenomenon affecting both urban and rural areas, there is a pressing need for comprehensive adaptation endeavours aimed at mitigating and averting the greater impacts of climate change [13].

Hence, the objective of this research is to identify the resilience index value inherent to the community of Wetee Hamlet in Lautang Village, and to explore the research's significance in discerning which indexes hold resilience value for individuals residing in regions impacted by overflowing floods around Tempe Lake.



Figure 1. Lautang Village position in between two bodies of water (red dot).

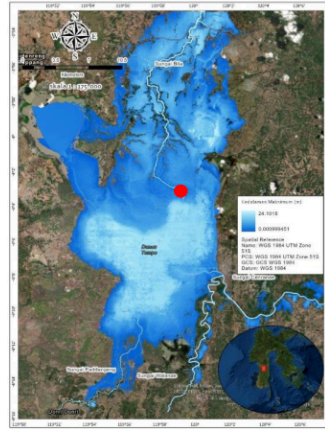


Figure 2. Lake Tempe' Flood Inundation Area Map (20 Year Return Period)
Source: [14]

2. Methods

This research used quantitative methods with a descriptive approach. This research was conducted in Wetee Hamlet Lautang Village, Belawa District, Wajo Regency, South Sulawesi (figure 3). Since the condition of the traditional settlement of the Bugis Wajo tribe in Wetee Hamlet, is a traditional settlement, homogeneous, and lives around Tempe Lake, which experiences flooding due to overflowing water from the lake, research in this hamlet can represent the entire village around the edge of Tempe Lake, Wajo Regency. Respondents in this study constituted the population of Wetee Hamlet. All family head (KK) from each household and the original community of Wetee Hamlet Lautang Village were surveyed by distributing questionnaires for data collection.



Figure 3. Study Site Delineation Map

The variables employed in this study are selected indices relevant to assessing resilience in Indonesia, as drawn from the indices utilized by [10]. Among the 10 indices, 8 resilience indices have been chosen: (1) community capacity, (2) social capital, (3) connectedness, (4) disaster preparedness, (5) safe shelter, (6) livelihoods, (7) health, and (8) clean water. The methodology adopted is quantitative research, utilizing a scoring system to translate qualitative data into numerical values. Each question within every indicator presented to respondents is converted using a scoring approach. This approach assigns a range of descriptors, with values ranging from 0.00 for the least favorable response to 1.00 for the most favorable response. Subsequently, the indicators of each variable are averaged to determine the resilience value for each specific variable (Table 1).

To calculate the resilience value for a particular hamlet area, an average value search is conducted using the values of all variables. Furthermore, to gauge the interpretation of the resilience value level, the acquired average number is evaluated using five tiers outlined in the Resilience Radar Index guideline established by Bolte et al [10].

Table 1. Resilience Radar Index

Index Score	Interpretation for resilience
0.81 – 1.00	Very high
0.61 – 0.80	High
0.41 – 0.60	Medium
0.00 – 0.21	Low
0.00 – 0.20	Very low

*[10]

3. Results and Discussions

3.1. Community Capacity Index

The value of leadership is highly esteemed within the community, underscoring the crucial role of a local community leader in addressing disaster vulnerability. A traditional leader's leadership is pivotal in establishing customary laws to ensure the sustainable development of the region. The value of disaster knowledge is also highly regarded. This knowledge, rooted in local wisdom, has been transmitted across generations. The recurrent annual flood disaster, experienced for months by the residents of Wettee Hamlet in Lautang Village, has shifted the perception of flooding from a menacing threat to a potentially advantageous occurrence. Consequently, the community has learned to capitalize on the conditions presented by the flood disaster (Table 2). The timing of flood tides is typically recognized by the people of Wettee Hamlet in Lautang Village by correlating it with the customary shifts between the dry and rainy seasons.

Table 2. Community Capacity Index

Indicator	Score	Interpretation for resilience
Leadership	0.7528	High
Disaster knowledge	0.6878	High
Total	0.7039	High

Considering the community capacity value in Wettee Hamlet of Lautang Village, it becomes evident that community leadership is motivated by the desire to safeguard their living area in alignment with traditional beliefs and societal norms. The elevated value of leadership suggests an active attempt to foster resilience, propelled by either a community governing entity (such as a neighborhood association or hamlet leader) or influential individuals like traditional or community leaders. This effort is aimed at nurturing an organized sense of community resilience.

Furthermore, the comprehension of disaster knowledge points towards the presence of local wisdom as a collective memory, emerging as a cornerstone of community knowledge that adapts to prevailing circumstances. This enables the community to make swift decisions aligned with the dynamics of flood conditions. The insights gleaned from years of grappling with disasters offer a valuable avenue for cultivating resilience-building practices. Knowledge exhibits a strong relationship with resilience, given its relevance to climate change adaptation, disaster risk reduction, and addressing psychological risks [13].

From the value of community capacity in Wetee Hamlet Lautang Village, it is known that community leadership has a motivation to protect the area where they live in traditional beliefs and society. The presence of a high leadership value indicates that there is a resilience value that is trying to be encouraged by a governing body (community institution; RW/hamlet head) or an individual who has great influence (traditional leaders or community leaders) in the environment to develop an organized community resilience value. Knowledge of disasters also indicates that local wisdom as collective memory becomes the value of community knowledge that can adapt to the situation so that they have the decision to move quickly with the dynamics of the flood conditions. The knowledge that communities have gained from years of experience with disasters is a good way to develop resilience-building practices. Knowledge has a good relationship to resilience because it is related to climate change adaptation, disaster risk reduction, and psychological risk hazards [13].

3.2. Social Capital Index

The concept of social capital is evident through its indicators of bonding, bridging, and linking [15]. Social capital holds significant value, which is manifested in the aspects of bonding, bridging, and linking. Bonding is strongly emphasized within the community's social activities, prominently due to the high value placed on kinship and social interactions (Table 3). This high kinship value fosters a sense of group trust, nurturing a communal spirit that encourages mutual care and support. Instances like lending money or goods between individuals contribute to a foundational level of trust, solidifying a commitment to safeguard each other when faced with disasters or events. The communal belief in seeking safety collectively is further reflected in the prevailing attitude that considers every member of the community as a part of one's own family or extended relatives. This mindset establishes a dependable network for assistance that can be relied upon without explicit requests.

Moreover, the residents of Wetee Hamlet and Lautang Village engage in various activities about flood disaster prevention, demonstrating their commitment to safeguarding their region as a collective. Bridging social capital is particularly notable due to active participation during evacuations, the presence of designated evacuation points, active engagement in rescue and search efforts from these points, and compliance with directives issued by the Community Association's head or norms rooted in customary law. The significance of linking social capital is underlined by the acquisition of information from neighbours. This practice contributes to the cultivation of robust interpersonal relationships within the community, fostering a sense of closeness and unity. These interactions extend to informal gatherings during leisure time, further nurturing the sense of camaraderie and shared identity.

Table 3. Social Capital Index

Indicator	Score	Interpretation for resilience
Bonding	0.7987	High
Bridging	0.7491	High
Linking	0.6596	High
Total	0.7358	High

The value of social capital in Wetee Hamlet of Lautang Village from bonding, bridging, and linking is high. The high value of bonding is shown by individuals who tend to rely on a sense of trust to support and encourage other individuals in their community. The value of bridging is an action or interaction

that has a positive influence and can build a community faster and better. The value of linking is shown in the attitude of exchanging information so as to create a feeling of mutual trust, but it is as personal as building a family or friendship relationship. The existence of aspects of bonding, bridging, and linking is the strength of social capital by the people of Wetee Hamlet Lautang Village to build the value of social resilience in the region.

3.3. Connectedness Index

The value of connectedness is high, evident through the active involvement of community leaders such as the Head of the Community Association in Wetee Hamlet of Lautang Village (Table 4). This leadership acts as a bridge, facilitating communication between the community and the local government, allowing residents to voice their opinions and concerns. The rapport between the government and the community concerning infrastructure facilities is strong due to the presence of bridges, road networks, and accessible internet signals. The interplay between the government, organizations, and the community concerning social assistance is profoundly apparent, underscored by the support provided by the local government of Lautang Village in Kab. Wajo. This support includes essential supplies, clean water, and rescue boats for the residents of Wetee Hamlet in Lautang Village, who have been affected by the flood disaster.

Furthermore, the "Hiper-mawa" Wajo Student Association actively participates in extending social assistance. They engage in soliciting donations, which will subsequently be distributed to Wetee Hamlet in Lautang Village, aiding their recovery from the flood disaster. The dynamic between the government, organizations, and the community concerning social assistance in the realm of education and social activities possesses a moderately discerned significance. This sentiment is underlined by the community's perception of a gap in education, particularly the lack of counselling activities geared towards coping with flood situations.

Table 4. Connectedness Index

Indicator	Score	Interpretation for resilience
Relations between community leaders and local government	0.7587	High
Government/organization relations with the community (related to providing social assistance)	0.6196	High
Government/organization relations with the community (related to the action of social activities)	0.5994	Medium
Total	0.7358	High

From the value of community connectedness in Wetee Hamlet Lautang Village, it is known that from the sub-variable of community relations with agencies, there has been a good relationship between the community and the local government and community organizations. This connectedness is built during disasters and when disasters do not occur. Regarding the condition of the community when dealing with disasters, the value of this relationship is important because the community will get support from communities outside the area to face the disaster and the aftermath.

3.4. Disaster Preparedness Index

The proficiency in emergency plans within the community of Wetee Hamlet is notably high (Table 5). This knowledge is instilled in the community's consciousness to mitigate the impact of disasters, serving as a means for individuals, particularly heads of families, to safeguard their family members. These emergency plans encompass aspects such as evacuation strategies, indicators of available evacuation tools, designated emergency storage locations, evacuation plans, and specific evacuation sites.

However, the disaster warning system remains relatively weak. When floods occur, the residents of Wetee Hamlet in Lautang Village lack a dedicated disaster warning mechanism in their vicinity. They instead rely on established rituals, situational observations, and the prevailing conditions to gauge the threat. This underscores a deficiency in preparedness within the community, aiming to minimize the extent of losses and the impact of disasters.

Table 5. Disaster Preparedness Index

Indicator	Score	Interpretation for resilience
Preparedness Knowledge	0.8388	Very high
Disaster Warning	0.2536	Low
Total	0.5462	Medium

Disaster preparedness is a matter of responding to disasters to minimize victims. Disaster warning is a preparedness action taken by the community to reduce losses and victims. The people of Wetee Hamlet Lautang Village, individually already know the risk of danger that will be faced; this knowledge forms a provision for each individual community to take preventive action to avoid the risk of danger. However, there is still a lack of disaster warning systems in the Wetee Hamlet area of Lautang Village, making preparedness of medium value.

3.5. Safe Shelter Index

The comprehension of constructing a safe shelter using appropriate materials is evidenced by the community's familiarity with the characteristics of an ideal wooden building. This includes aspects such as a cement-based foundation firmly anchored to the ground, the strategic placement of the structure on the land, and the layout of the house. Furthermore, an additional room is integrated above the ceiling of the house to serve as a space for storing essential items in the event of a flood disaster [16]. The recognition of practical house construction techniques employed by the community of Wetee Hamlet in Lautang Village also highlights the manifestation of an ideal safe shelter, particularly in the form of stilt house building. The significance of housing safety is highly emphasized, with an exceedingly strong interpretation (Table 6).

Table 6. Safe Shelter Index

Indicator	Score	Interpretation for resilience
Safe shelter awareness	0.8580	Very high
Safe shelter practice	0.9107	Very high
Total	0.8843	Very high

However, it's noteworthy that the indicator concerning community awareness of safe shelter awareness registers lower than the actual implementation of safe shelter practices in the field. This observation suggests that the local wisdom passed down through generations within the community of Wetee Hamlet in Lautang Village remains deeply ingrained. While not every individual may fully comprehend the rationale behind their building construction, the community consistently succeeds in constructing houses in accordance with their customs and traditions.

3.6. Livelihoods Index

The wider the range of livelihoods pursued by households, the greater the income generated, contributing to a more secure and resilient household economy. Furthermore, a broader spectrum of income sources within households leads to increased revenue, fortifying the stability and robustness of the household economy [17]. Consequently, within a single household where there is employment, the

reliance does not solely rest on a single individual, as several family members contribute to generating income or aiding the household head in their work. This dynamic ensures that when one individual is unable to work, other family members can step in to sustain the income flow.

The array of livelihood professions within the community of Wetee Hamlet in Lautang Village adeptly adjusts to the changing seasons. During the dry season, the community primarily engages in farming activities, while in the rainy season, their focus shifts to fishing. Despite possessing a broader spectrum of livelihood options in the dry season compared to the rainy season, the distribution of workers within households remains relatively even, although households with multiple workers still hold the majority. The versatility of livelihoods practiced by the residents of Wetee Hamlet in Lautang Village is evident in their adaptive approach to optimizing resources in accordance with the seasons. Although strained, this flexibility still proves advantageous, as the community consistently identifies opportunities to sustain their livelihoods through each seasonal shift. Embracing adaptability stands as the optimal strategy to mitigate the impact of seasonal fluctuations, particularly when confronted with flood disasters.

The level of income demonstrates a moderate value. The ratio between the total number of family members within a household and the count of working individuals in that household exhibits a consistently high proportion, typically ranging between 1.00 and 0.67.

Table 7. Livelihood Index

Indicator	Score	Interpretation for resilience
Livelihood diversity	0.5585	Medium
Income eariness	0.4796	Medium
Total	0.5190	Medium

3.7. Health Index

The value of community health in Dusun Wetee Desa Lautang can be seen from indicators of health knowledge, access to health facilities, and use of health facilities. Health knowledge of Dusun Wetee Desa Lautang already has disease knowledge (flood disaster related), which is dominated by being able to mention 1-2 symptoms of skin diseases, and mentioning 5 or more symptoms of dengue fever and its preventive measures. Accessibility to health facilities related to location and emergency contact is still lacking. The use of health facilities from the frequency of decisions shows only in times of emergency, prolonged or serious illness, and for childbirth.

Table 8. Health Index

Indicator	Score	Interpretation for resilience
Health knowledge	0.7159	High
Access to health service	0.3106	Low
Usage of service	0.5362	Medium
Total	0.5209	Medium

The health status of Wetee Hamlet in Lautang Village is moderately assessed. This is attributed to the fact that the community in Wetee Hamlet Lautang Village demonstrates a strong awareness of diseases and symptoms associated with flood disasters, such as dengue fever and skin ailments. The community is also well-informed about the availability and utilization of health facilities. Nonetheless, an existing challenge lies in the accessibility of Wetee Hamlet Lautang Village to the nearest health facility.

There exist obstacles perceived by the community, including considerable distances, costly expenses, and a preference for traditional medicine. Enhancing the affordability and accessibility of health facilities, along with ensuring the availability of medical personnel, could address these challenges,

ultimately bolstering community resilience. The condition underscores that improved accessibility from the settlement of Dusun Wetee in Desa Lautang to the health facility would positively influence the community's decision to seek treatment there, given their heightened disease knowledge.

3.8. Clean Water Index

The value of clean water shows high resilience. This can be seen from the people of Wetee Hamlet getting clean water from Municipal Waterworks (PDAM), drinking water sources from springs, processing for clean water by boiling water, and never lacking water throughout the year. In the handwashing indicator, the community also has an awareness of maintaining cleanliness through the habit of washing hands and the availability of handwashing facilities. Clean water shows that the community of Wetee Hamlet Lautang Village already has access to clean water and handwashing facilities.

Table 9. Clean Water Index

Indicator	Score	Interpretation for resilience
Clean water	0.7187	High
Hand washing practices	0.7890	High
Total	0.7539	High

3.9. Resilience Level of Traditional Community

Based on the analysis calculations to gauge the extent of community resilience in Wetee Hamlet Lautang Village, utilizing 8 variables, it becomes apparent that the resilience of the Wetee Hamlet community in Lautang Village is perceived as high, with an average value of 0.6662.

Table 10. Level of community resilience

Indicator	Score	Interpretation for resilience
Community capacity	0.6902	High
Social capital	0.7358	High
Connectedness	0.6790	High
Disaster preparedness	0.5462	Medium
Safe shelter	0.8843	Very high
Livelihood	0.5190	Medium
Health	0.5209	Medium
Clean water	0.7539	High
Total	0.6662	High

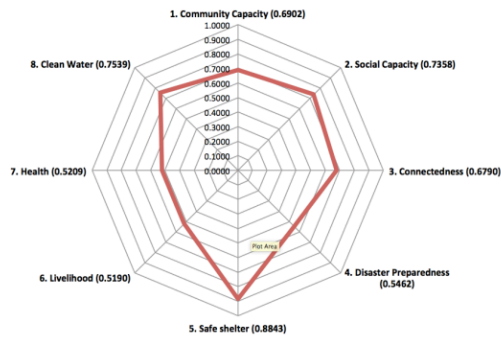


Figure 4. Resilience Radar Chart of Wettee Hamlet Community, Lautang Village

The community of Wettee Hamlet in Lautang Village demonstrates a profound understanding of constructing flood-resistant residential houses. This knowledge is derived from their local wisdom and ingrained within their traditional house-building practices, which they adopt without needing official information.

Regarding community capacity within Wettee Hamlet Lautang Village, it becomes apparent that community leadership is intrinsically motivated to safeguard their surroundings, rooted in their traditional beliefs and societal values. Additionally, disaster knowledge signifies that the community's collective memory, serving as local wisdom, allows them to adeptly adapt and respond promptly to the dynamic flood conditions they face. This contributes positively to increasing the value of community capacity, particularly in leadership and disaster knowledge. This value derives from the community's inherent ability to respond collectively and take initiative during challenging times.

The high social capital value encompassing bonding, bridging, and linking reveals that the individual members of the Wettee Hamlet Lautang Village community, as active resources, are deeply engaged and contribute to maintaining the region's resilience. When confronting disasters, connectedness is of paramount importance as external communities provide support to those within the residential area. The high value attributed to clean water pertains not solely to the water quality, but to the accessibility of clean water sources. This implies that while clean water is readily available, it often necessitates purchasing, particularly for drinking and hygiene purposes. This demonstrates the community's capacity to adapt and acquire clean water despite residing in an area susceptible to lake overflow.

The moderate value assigned to disaster preparedness within the community of Wettee Hamlet Lautang Village indicates their extensive knowledge about disasters. Consequently, the community is well-prepared to handle imminent threats through informed decision-making, not solely relying on disaster warning systems. In terms of health, the community recognizes the presence and utility of health facilities. Nevertheless, a challenge persists in terms of accessibility from the Wettee Hamlet settlement in Lautang Village to these health facilities.

The livelihood variable illustrates a moderate rating, reflecting the community's versatility in adjusting their employment choices according to the prevailing seasons during normal circumstances. Moreover, their adaptability extends to times of disasters, showcasing a moderate level of community income.

At the community level, rural resilience underscores a community-centric approach to fostering resilience in alignment with local culture, conditions, and challenges [18]. Ongoing and intensifying seasonal changes, leading to recurring disasters, necessitate a comprehensive approach from various

angles to bolster resilience. Rural communities express a strong desire to remain in flood-prone residential areas, yet this aspiration for survival must be balanced with the capacity to endure [4].

Research focusing on the resilience capacity of individuals residing in flood-affected settlements indicates a moderate interpretation. A common trait emerges from this research, indicating that communities within these settlements fundamentally possess a will to endure. They express a firm commitment to staying put despite the recurrent impact of floods and associated losses [5]. The outcomes of research conducted in Wetee Hamlet of Lautang Village portray a high resilience value. This underscores that Wetee Hamlet in Lautang Village embodies characteristics aligned with general resilience theory, operating within a medium to long-term framework. Additionally, they display resilience attributes rooted in proactive responses, demonstrating their readiness to take anticipatory measures without necessitating a triggering disturbance [13].

4. Conclusion

The resilience index value of the Wetee Hamlet community within the flood-prone area around Tempe Lake in Wajo Regency has been determined as a high resilience index value. The identified resilience values are categorized into three levels: very high, high, and medium. The very high resilience value is reflected in the building safety index. Meanwhile, the high resilience index value is evident in the community capacity index, social capital index, connectedness index, and clean water index. Lastly, the moderate resilience index value is observed in the disaster preparedness index, livelihood index, and health index. In their daily lives, the residents of Wetee Hamlet in Lautang Village confront the challenges posed by climate change to ensure their survival within their living area. It's crucial for each individual to enhance their understanding of disasters and raise awareness as part of an ongoing engagement effort, which needs continuous development to safeguard their community. This study scrutinized the resilience value of various variables within the Resilience Index, revealing that the community of Wetee Hamlet in Lautang Village already possesses a high resilience value. However, some index variables still display moderate values. This research indicates the necessity of further boosting the resilience value across several variables due to the persistent threat of annual flood disasters. Despite sustaining their livelihoods within the settlement, the residents of Wetee Hamlet in Lautang Village encounter challenges in fulfilling their basic life necessities. The adequacy of these basic needs is evaluated based on the accessibility of public facilities from their vicinity. This statement raises the question of whether this traditional settlement area should be classified as inhabitable or not, warranting further investigation.

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