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# Local knowledge of environmental management of karst area in Ketro Village, Pacitan District, East Java, Indonesia

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**Abstract.** *Ramadhani DD, Setyaputri AF, Almadani AR, Sholichah DM, Dianti, Hanum U, Setyawan AD. 2025. Local knowledge of environmental management of karst area in Ketro Village, Pacitan District, East Java, Indonesia. Intl J Trop Drylands 9: 10-19.* Karst areas are unique and complex landscapes formed by the natural dissolution of limestone, creating unique environmental conditions, and are home to the karst area in Ketro Village, Pacitan District, East Java, Indonesia. This area, with its high ecological and aesthetic values, including biodiversity and ecotourism potential. However, behind the beauty is a close relationship between the local community and the karst environment that has developed over many years. This study aims to determine the knowledge of the karst area community of Ketro Village, Kebonagung Sub-district, Pacitan District, East Java Province, Indonesia, on environmental management in accordance with the traditions prevailing in the community for generations. This research was conducted using survey and interview methods in Ketro Village community related to karst area management in Ketro Village using purposive sampling techniques in determining respondents. Based on the results of the data analysis obtained, this research shows that the management of karst areas in Ketro Village still uses hereditary habits, and the community has the principle that every house has empty land for planting crops.

**Keywords:** Community, environment, karst, local knowledge, tradition

## INTRODUCTION

Indonesia is a nation that is rich in natural resources, islands, population, customs, languages, tribes, cultures, and traditions (Hidayah 2020). The national motto of *Bhinneka Tunggal Ika*, which translates to Unity in Diversity, has been the driving force behind Indonesia's ongoing expansion of diversity for centuries. The archipelago in which the people of Indonesia currently reside was primarily inherited by their forebears (Sulistiyono and Amaruli 2023). The legacy can take the form of rules and management that are passed down through generations, often accompanied by religious beliefs and belief systems. For instance, land can be cleared by cutting or burning without causing harm to the surrounding environment (Murhaini and Achmadi 2021). Diversity also influences the numerous natural products that God has bestowed upon humanity. Therefore, it is a human responsibility to safeguard and prevent their destruction, as this is a form of preservation that ensures the persistence of nature in human civilization (Noviana et al. 2023). It is our collective responsibility to preserve this diversity, ensuring its continuation for future generations.

The vast territory of Indonesia supports a large population of communities, which can provide an adequate supply of natural resources to sustain life. The continuity of indigenous knowledge with extant knowledge systems can further contribute to environmental management practices (Jarvis et al. 2021). Communities' significance in the preservation of sustainable natural resources has been acknowledged globally (Garnett et al. 2018). Natural resources that are currently in existence are gifts from God that should be preserved and maintained to ensure that their benefits can be experienced sustainably (Alfiani 2022). One such resource is in the karst area. The karst area is a geologically formed rock area that is the result of the dissolution of limestone or carbonate minerals by rainwater or groundwater (Zerga 2024). Karst regions offer numerous advantages, such as the capacity to retain pure water in their holes (Kaiser et al. 2023), the potential for mining due to the presence of minerals that can be extracted to produce gypsum, lime, and marble, and the presence of a high level of biodiversity (Fatinaware et al. 2019). The community's pressing requirements frequently supplant efforts to preserve karst areas, resulting in the exploitation of these areas without regard for the conservation and protection functions they contain (Siegel et al. 2023).

In this era of accelerated globalization, numerous challenges arise, particularly in the management of the environment (Jie et al. 2023). These changes are precipitated by population growth, accelerated development, and heightened community requirements (Khan et al. 2021). The changes that occur should be utilized to enhance the prosperity and accessibility of the community; however, a significant number of individuals intentionally exploit and cause environmental damage. Mining is a common form of exploitation in karst areas, where the limestone content is extracted in large quantities

as a basic material for cement production. The disintegration of karst boulders is a consequence of the vibrations that mining produces (Wei et al. 2023). The rate of degradation of natural resources will be influenced by the decline in environmental quality, which will disrupt the equilibrium that has been established by society to coexist with nature. The water system within karst areas can be impacted by the exploitation of these areas, such as a decrease in water quantity and groundwater pollution (Fang and Fu 2011). Local knowledge is, of course, based on a long history ranging from land tenure to natural resource management (Yanou et al. 2023). Local knowledge in each region is different, including in preserving the environment, this is because each region has a different topography. Ketro Village is one of the villages in Pacitan that has a karst area, and this village also has its own natural resources that integrated management is needed to protect it. This research was conducted to find out the local knowledge of the Ketro Village community in preserving the environment. This research aims to find out how the community manages the environment in accordance with local traditions or knowledge.

## MATERIALS AND METHODS

### Study area

Research on community knowledge in managing the karst area environment according to prevailing customs was conducted at the end of 2023 in Ketro Village, Kebonagung Sub-district, Pacitan District, East Java, Indonesia, with coordinates 8°10′3.432″S, 111°11′54.42″E which is pictured in Figure 1. Ketro Village is limestone mountains stretching to the north and is directly adjacent to clay hilly land with a landslide character because it has a fairly steep slope. Ketro Village has an abiotic environment consisting of fertile soil and sufficient water sources, supporting agriculture and daily life. The biotic environment includes diverse local flora and fauna, including agricultural crops such as rice and corn, as well as livestock such as cows and goats. The culture of the people in this village is very thick with Javanese traditions and customs, with social and religious activities routinely carried out, reflecting the values of beneficial cooperation and togetherness. This village consists of 7 hamlets, namely Krajan, Wonojoyo, Njeruk, Nongko, Gawang, Klepu and Brengosan Hamlets. Ketro Village is a rural area that has an area that includes a plateau, around 800 meters above sea level. The administrative boundaries to the north are Kalikuning Village, the south Sanggrahan Village, the east Jatigunung Village, and the west Ketepung Village.

### Data collection

The data collection methods used were observation, interview, and documentation. The three methods are used because they can produce data that can be explained in detail, clearly, and comprehensively related to a phenomenon (Hazzan and Nutov 2014), in this case, community knowledge in managing the karst area environment in accordance with the prevailing traditions in Ketro Village, Kebonagung, Pacitan.

*Field observation*

Observation is carried out directly in the field by the author, an experienced researcher in the field of environmental studies, so that the author can directly observe the conditions and activities of the research area, which can help the author in comparing the data found with other methods. The conditions observed were related to the state of the biotic environment, and abiotic and community habits. This community habit will be deepened in the observation to find out how the Ketro Village community manages the environment. Documentation is needed in this observation activity because it can provide actual evidence in accordance with the conditions that occur in the field from the observations that have been made (Irawati et al. 2022).

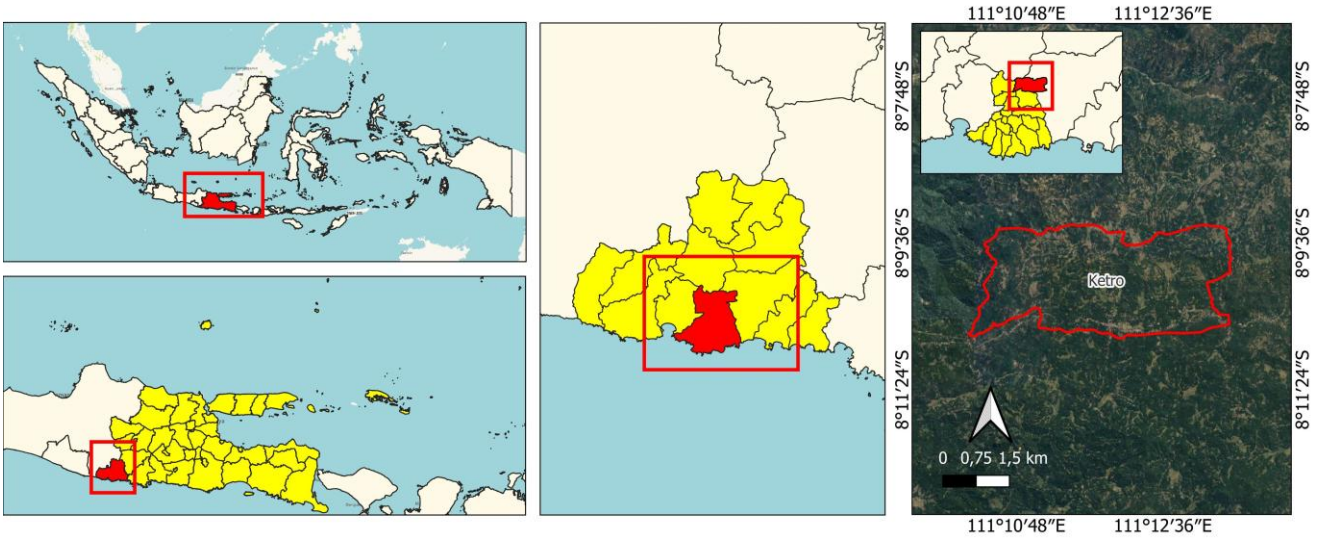


**Figure 1.** Location of Ketro Village, Kebonagung Sub-district, Pacitan District, East Java, Indonesia

*Interview*

Interview and questionnaire data collection methods are carried out personally to several respondents who are randomly selected (purposive sampling) according to certain considerations (Hossan et al. 2023). This interview was aimed at the Ketro Village community to find out the community's knowledge related to karst environmental management. The category of respondents is based on the age group where they have participated in the process of managing the karst environment. Some of the questions that will be asked during interviews and questionnaires include agricultural cultivation and irrigation, construction and maintenance of water systems, nature conservation actions, views on nature and the universe, transmission of local customs, responsibility for environmental protection, collective moral obligations, community self-organization, and leadership roles.

**Data analysis**

This research is descriptive qualitative research, which is research whose process will be studied in detail and presented descriptively based on primary data that has been collected previously. Primary data in this study are data obtained from observations, interviews, questionnaires, and documentation. According to Sugiyono (2016), the credibility test that primary data can verify is the triangulation method, where information testing is carried out continuously until the data is saturated. The data that has been collected is processed and presented in a table which includes respondent data and respondents' assessment of their knowledge of the environmental tradition of karst areas in Ketro Village, Kebonagung, Pacitan.

Respondent data in Table 1 shows that the assessment data from respondents were processed using valid and reliable instruments to obtain reliable research results. Valid in the sense that the instrument can be used to measure what should be measured and reliable in the sense that if the instrument is used several times to measure the same object, it will produce the same data (Yusup 2018). Validity and reliability tests are instruments for processing assessment data using the help of the SPSS computer program. The list of questions asked for the interview has been tested through SPSS. The answers to each question are accumulated to determine the average answer means "Good category," "Excellent category," or "Moderate category."

## RESULTS AND DISCUSSION

Based on observations, karst environmental management in Ketro Village, Kebonagung, Pacitan, is still strongly influenced by local customs that emphasize nature conservation and ecosystem balance. The people of this village practice various traditions aimed at preserving natural resources, such as river clean-up events that honor springs and karst caves. In addition, they also implement environmentally friendly and sustainable farming systems, and protect forests and karst lands from overexploitation. This approach not only preserves the environment but also maintains cultural values and local wisdom that have been passed down for generations. The following Table 1 shows the results of respondents' interview answers in Ketro village.

**Agricultural cultivation and irrigation**

The majority of responses show that 40 residents chose the good category regarding special rules or procedures for cultivating agricultural commodities. This is because the current agricultural cultivation has been able to adapt to current conditions. Starting from the planting process, irrigation, maintenance, to harvesting. This is because the sediment in this area is different from other areas. The soil in this area is not fertile for certain agricultural commodities due to its karst soil structure, so it requires special treatment (Khusna et al. 2020). The crops they grow are not subject to specific rules, as indicated by the interview results. However, they demonstrate a keen understanding of local conditions by modifying the types of crops planted based on the season, with different crops for the rainy and dry seasons. The crops observed during the observations are depicted in Figure 3, particularly rice, as data collection was conducted during the rainy season. Meanwhile, the producers planted maize and beans during the dry season. Observations also showed that not all of their usual crops were grown during this period, as observations were made during the rainy season.

**Table 1.** Frequency of gender, age, education level and work

| Parameters | Specifications | Frequency |
|---|---|---|
| Gender | Male | 22 |
| | Female | 38 |
| Age | 16-25 | 1 |
| | 26-35 | 9 |
| | 36-45 | 18 |
| | 56-65 | 26 |
| | >66 | 6 |
| Education level | Not attending school | 9 |
| | Elementary School | 34 |
| | Junior High School | 10 |
| | Senior High School | 7 |
| Work | Farmer | 33 |
| | Housewife | 19 |
| | Trader | 8 |

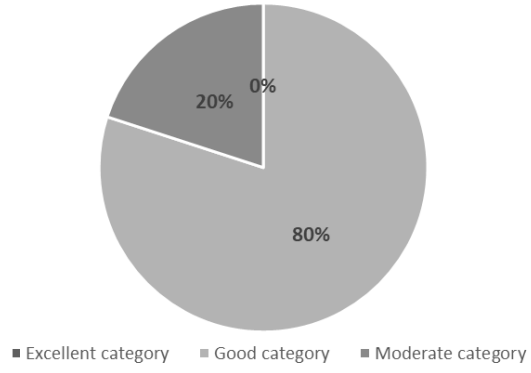


**Figure 2.** Category of irrigation system condition

**Figure 3.** Agricultural cultivation

**Figure 4.** Irrigation system

Based on the results of the questionnaire distribution regarding the irrigation system that irrigates farms in Ketro Village as shown in Figure 2, the good category has the highest number of 48 responses. Existing agricultural cultivation in Ketro Village is represented in Figure 3. The irrigation system used in the research location is illustrated in Figure 4. The community stated that the irrigation system that irrigates their rice fields has never experienced problems. In addition, the village has never experienced drought. The equitable water distribution system means that there are no disputes between residents over irrigation water. This finding was obtained from interviews conducted with the community. The water used to irrigate crops is sourced from a very deep spring, and residents report that the depth of the water is even unlimited. This information is based on observation. Water is delivered through additional pipes.

According to the results of the community dominance questionnaire, 30 residents considered the decrease in crop yields to be adequate compared to the previous year. The community did not experience a decrease in yields, as they believed that their yields remained consistent. This is because the land area used has not increased or decreased, resulting in the same yield. Interview results support this statement. Observations showed that none of the crops in the farming areas or fields were affected by disease, drought, or rot as a result of excessive water. As a result, there was no indication of potential causes of crop failure that could result in lower yields. This underscores the crucial role of stable water, normal rainfall, and appropriate soil content in maintaining healthy crop yields. In agriculture, these factors are of paramount importance (Harbowo and Muliawati 2023).

**Construction and maintenance of dams and canal systems**

As shown in Figure 5, 49 residents answered good category to the questionnaire regarding the existence of dams, waterways, and maintenance systems. Based on interviews conducted, Ketro Village has an irrigation system that comes from springs but not in the form of a dam. Water from these springs is distributed through a maintenance and distribution system to ensure farmland and fields have access to water. The socio-economic life of the community is heavily influenced by the extant dam (Milanovic 2021). Residents reported that the irrigation process from the dam to the community is not hampered by any problems, as indicated by the interviews. The community guards the spring area with an iron fence to ensure its safety, and the area around the water source is vegetated. There are no buildings or sources of pollution. This is evident from the observations. It should be noted that dams must follow specific standards for maintenance as karst areas have different geological structures, groundwater, intensity, and depth compared to non-karst areas (Milanovic 2021).

As shown in Figure 6, 38 residents answered good category on the questionnaire regarding the relationship between dams or water canals and the preservation of existing karst ecosystems, which was the dominant answer. The people of Ketro Village believe that the current water system provides benefits to the community and does not interfere too much with nature, as shown by the interview results. According to observations, the Karst environment that dominates the land of Ketro Village is also partly utilized as agricultural land or fields. Therefore, the sustainability of the karst ecosystem is indirectly influenced by the presence of dams or waterways that serve as a source of water for these crops. The availability of water sources in Ketro Village can be seen in Figures 7 and 8.

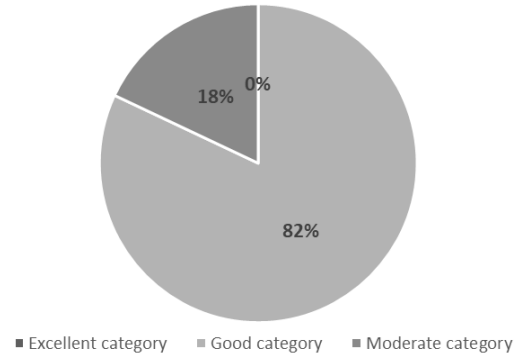


**Figure 5.** Category of dam, waterways, and maintenance system conditions

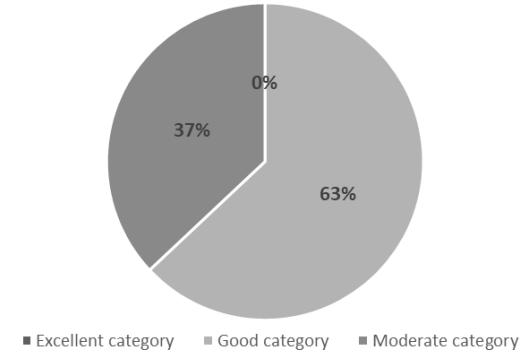


**Figure 6.** Category of relationship between dam's preservation of existing karst ecosystems

**Figure 7.** Spring water flow in Ketro Village, Kebonagung, Pacitan, East Java, Indonesia

**Figure 8.** Spring water source Ketro Village, Kebonagung, Pacitan, East Java, Indonesia

**Local knowledge of karst environment and conservation actions as responsibility for environmental protection, collective moral obligation**

The dominance of responses from Ketro villagers regarding nature conservation actions is evident from the interviews conducted, the results of the questionnaire regarding nature conservation actions and views on nature and the universe, and the fact that 53 people strongly agreed with the need for nature conservation activities (Figure 9.A). The study revealed that 56 people strongly agreed with the question of interdependence between humans and nature. In comparison, 50 people responded positively to the concept of spirituality or local beliefs, indicating that people's views on the elderly are interconnected (Figure 9.B). The moderate category relates to community activities that disturb the karst ecosystem, and 28 individuals have dominated the responsibility to protect the environment, as shown by the questionnaire results (Figure 9.C). In addition, 52 residents chose the excellent category for questions regarding environmental protection efforts that are the collective responsibility of residents (Figure 9.D).

Based on the results of the collective moral obligation questionnaire, 46 residents (Figure 9.D) dominated the good category for the question regarding the collective role of ensuring that individuals who utilize shared natural resources, such as karst or forest products, operate responsibly, especially in terms of environmental sustainability. The good category in relation to questions about collective activities undertaken by communities or organizations that can prevent environmental damage caused by human activities dominated the answers of 50 residents (Figure 9.D). We combined these three principles because of the significant link between community answers and observations. Communities often conduct village clean-up activities to maintain sanitation in order to protect the environment, as shown by the interview results. In addition, the government and community conduct

reforestation initiatives to maintain the existing environment. The resources and services of an ecosystem are not separate entities but are intricately interconnected (Goldscheider 2019). The community believes that nature has fulfilled the needs of the community, so the community is obliged to maintain its sustainability. The actions of the Ketro Village community are structured and not tied to a specific period. In particular, they were established at the request of the local neighborhood chairman. Although some minerals in this area are extracted and utilized as building materials by individuals from outside the area, the sustainability of the extant karst ecosystem is not greatly affected by these activities, as they do not occur on an ongoing basis.

Based on the results of interviews and field observations, Ketro Village has no pattern of natural resource utilization that can lead to exploitation or utilization activities that can damage the environment. Therefore, until now there has been no collective community activity in the form of preventing environmental damage caused by human activities that utilize natural resources such as karst and forest products. The Ketro Village community only utilizes natural resources as necessary to meet their needs and does not overexploit them. As a result of this pattern of behavior, the karst area and its natural resources are preserved, and no efforts are made to prevent environmental damage caused by human activities (Taheri and Groves 2023). This pattern of behavior has been inherited since ancient times, and Ketro Village community continues to instill the principle of utilizing nature only to the extent necessary to support their daily needs. The environment of Ketro Village is still well maintained, as evidenced by our observations. The streets are free of garbage, and the surrounding area is dotted with verdant green vegetation. This research was conducted when community service activities were not taking place, but the results of these activities can be seen in the clean and trash-free appearance of Ketro Village (Figures 10 and 11).

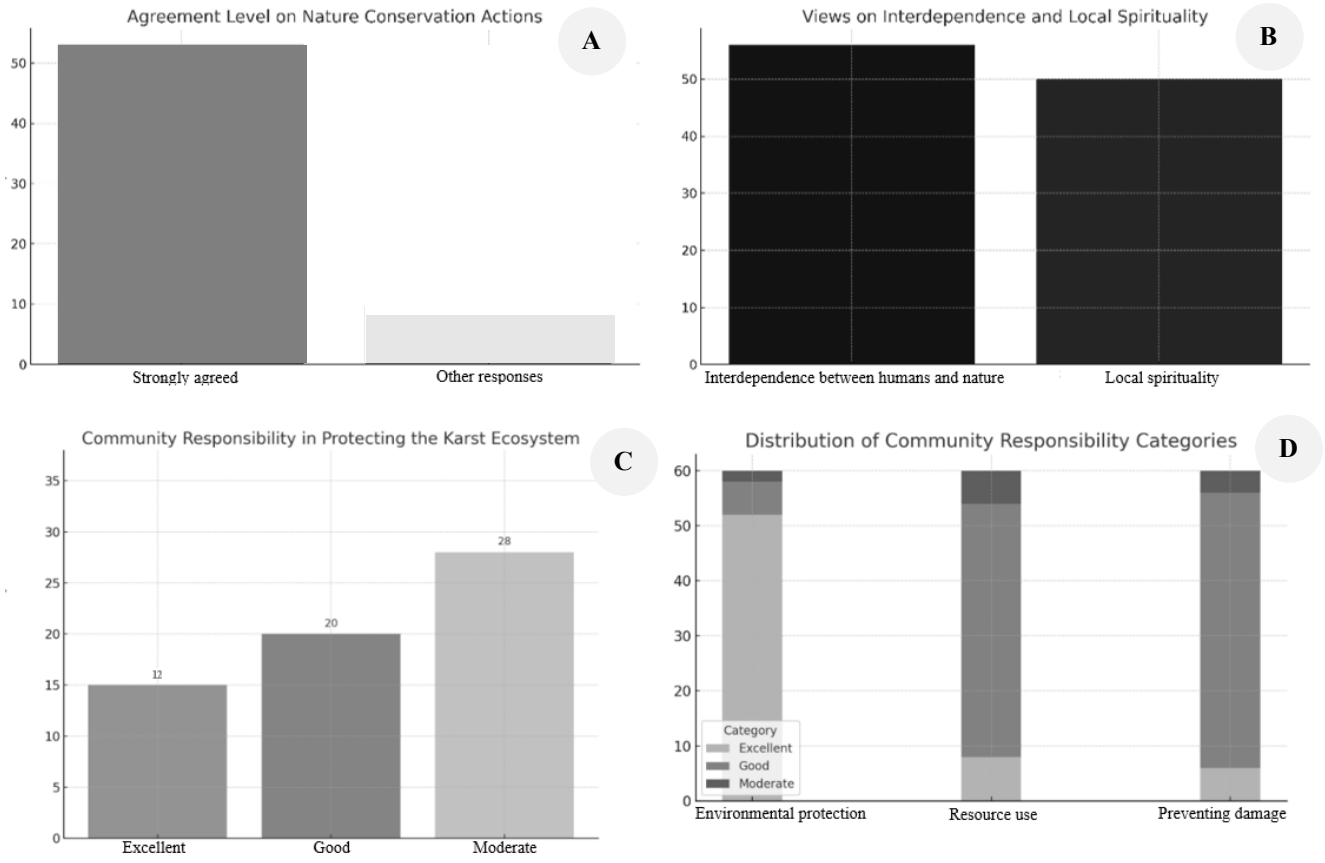


**Figure 9.** Local knowledge of karst environment and conservation actions as responsibility for environmental protection, collective moral obligation. A. Nature conservation activities; B. Interdependence between humans and nature and spirituality or local beliefs; C. Responsibility to protect the karst ecosystem; D. Community responsibility in environmental protection, resource use, preventing damage

**Figure 10.** Karst land is converted into rice field

**Figure 11.** The conversion of karst area into agricultural land

**Transmission of local customs**

The results of the questionnaire as shown in Figure 12, that 48 residents strongly support the preservation of local customs, 43 residents support the integration of other customs, and 34 residents support the existence of customs that have an impact on karst or forest ecosystems. Most individuals are unaware of the importance of local customs, as evidenced by interviews. However, several individuals stated that they had consistently utilized nature to meet their needs for a long time, ensuring that nature was not damaged or manipulated arbitrarily. These actions are sufficient to show that hereditary customs were established by previous societies, especially moderation and avoidance of excessive use of natural products. The community continues to carry out various social activities that have been considered mandatory, including "*arisan*" in Indonesian, which means activities carried out together in groups to raise funds and socialize with neighbors, village cleaning, and other activities designed to commemorate certain days, such as Independence Day. According to the community, the customs in Ketro Village are not affected by the customs that were introduced, thus ensuring that the existing customs continue to function effectively. Because the prevailing customs provide benefits to the community and the current ecosystem, these customs continue to run well (Riyanto et al. 2020). The condition of the area in Ketro Village can be seen from the results of the interview; not a single area was monitored to be exploited. As a result, it is clear that the community is moderate in utilizing it.

**Community self-organization**

The existence of youth organizations and similar entities in Ketro Village was answered favorably by 51 residents, as indicated by the questionnaires that were disseminate as shown in Figure 13. The organizations that are present in the Ketro Village community are largely comparable to those that are present in other areas of Indonesia. The village is home to successful organizations, including *Karang Taruna* and *Rukun Warga*. *Karang Taruna* is a self-organization formed to build community harmony managed by young people, while *Rukun Warga* was formed to mobilize self-help and community participation in the area. Self-organization is a critical factor in encouraging villagers to protect the environment for the benefit of all (Li and Han 2022). As shown in Figure 14 the questionnaire results about conditions of effectiveness of the existence of self-organization indicated that 49 residents were awarded the youth association's work program in the field of environmental management, including community service and high marks. The organization's current labor program is also functioning effectively. *Karang Taruna* participates in village clean-up initiatives, serves as a committee member for Independence Day celebrations, and participates in other activities in Ketro Village. The community is more socially active and independent in daily life as a result of the presence of a youth organization. This is directly correlated with the observations that were made, which indicate that the current youth organization is still functioning effectively.

**Leadership role**

As shown in Figure 15 the questionnaire results regarding the labor program supplied by the hamlet head consistently demonstrated that 42 residents deemed it satisfactory. The role of leadership influences the extant communal activities. The existing community will also implement various existing provisions as appropriate if the leadership is executed correctly. Then, 36 residents indicated that the lack of communication between residents and hamlet heads regarding community activities was sufficiently addressed as shown in Figure 16. This indicates that the community and the existing leadership are effectively communicating. The work program that has been developed is also classified as good, which indicates that the current leadership in the community is good and acceptable to the community (Li and Han 2022). The findings of the observations indicate that the leadership in Ketro Village is functioning effectively. This is evidenced by the successful completion of various activities, such as the clean-up of the villages, a testament to the community's collective efforts and effective leadership, which is evident in the absence of litter near the village.

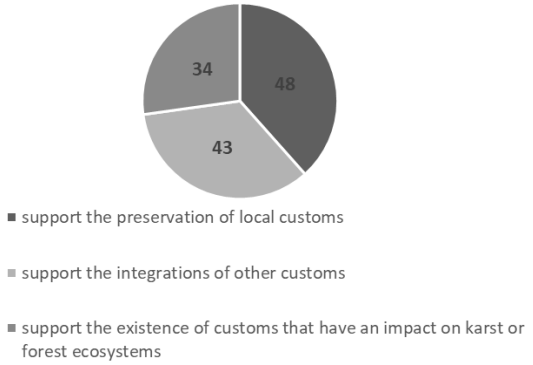


**Figure 12.** Graph of transmission of local customs

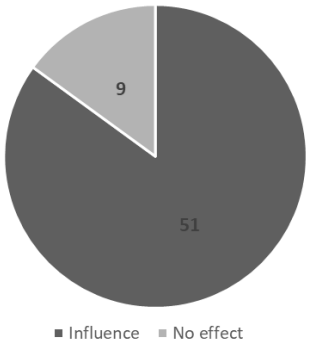


**Figure 13.** Residents perspectives on the existence of self-organization

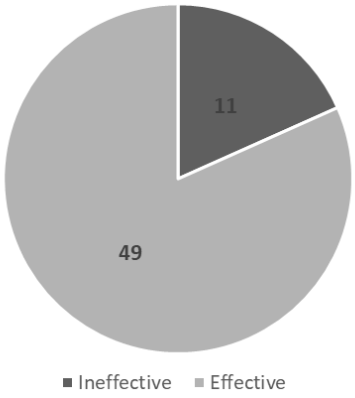


**Figure 14.** The conditions of effectiveness of the existence of self-organization

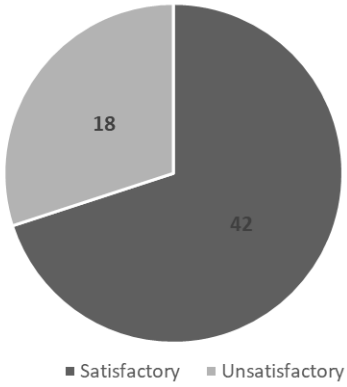


**Figure 15.** Assessment of work programs by residents

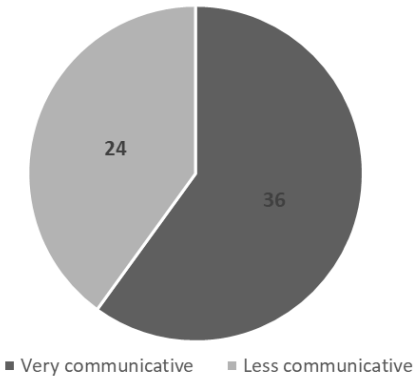


**Figure 16.** Residents views on communication in self-organization

## Discussion

The karst area is characterized by limestone, which is readily soluble and has both surface and underground components. Consequently, numerous underground caverns are formed as a result of cracks and fissures. The soil in karst areas is less fertile as a result of the dissolution of minerals, as per Sudarmadji et al. (2013). Karst is characterized by land that is less fertile for agriculture, susceptible to erosion and landslides, and susceptible and has limited aeration pores, which are small openings in the soil that allow air to penetrate and reach plant roots. Limestone mining is one of the ways in which karst land can be utilized, as limestone is a basic material for cement (Indriyani et al. 2023). Karst land use that unintentionally alters the karst environment can diminish the quality of the environment, which will impact the rate of damage to natural resources. This disruption will disrupt the harmony of the environment that the previous community has established in order to coexist with nature (Wibowo et al. 2022). The natural conditions in Ketro Village, which is primarily a karst area, have resulted in the majority of the population becoming cultivators. They plant crops based on the season, ensuring that the varieties of plants planted during the rainy and dry seasons are distinct. *Cocos nucifera* is typically planted during the dry season; however, it is crucial to appropriately fertilize and irrigate karst soils due to their low nutrient content and reduced fertility (Djaenudin et al. 2002). As a result of the fact that a portion of the population in Ketro Village is employed as

farmers, they are exceedingly reliant on the irrigation system. This is due to the fact that the karst area is notoriously challenging to access, necessitating the irrigation of plants from extremely deep springs. According to residents, the water's depth is not even that deep (Pramudita et al. 2023). In order to irrigate agricultural land and fields, the water is circulated through additional pipelines.

The residents of Ketro maintain an environmental tradition that includes refraining from the heedless cutting of trees, the burning of agricultural land, and the regular execution of village cleansing activities. The manner in which land users cleanse land is a factor in the level of soil fertility, as per Panda et al. (2018). The reforestation activities of the government and the residents of Ketro Village are also contributing to environmental conservation efforts. Using shrubs as nurse plants is one method of greening agricultural land (Castro et al. 2004). They are of the opinion that the essentials of existence are provided by nature, and as such, society is obligated to ensure its preservation. The local citizen leadership directed the organization of these actions, which were not associated with a specific period. While some of the stones in this area are extracted and utilized as building materials both within and outside the region, the impact on the karst ecosystem is not particularly substantial due to the fact that the extraction is not conducted sustainably. Currently, communities are working together to prevent environmental harm that is a result of the excessive use of natural resources, including karst and forest products. This is due to the fact that Ketro Village has not encountered a pattern of exploitation or utilization of natural resources that could potentially harm the environment. Individuals utilize natural resources exclusively in accordance with their requirements, avoiding exploitation or excess. This stance has ensured the preservation of natural resources and karst areas, necessitating no preventive measures to mitigate environmental damage caused by human activities. This practice has been handed down through generations as a means of utilizing nature for the necessities of daily life, and the inhabitants of Ketro Village continue to adhere to these principles. Martini and Tisngati (2017) also researched the conservation of local culture in Pacitan District. The community's confidence in its cultural values and their consistent application to ensure its safety and prosperity is a source of security about the sustainability of Ketro's practices.

The inhabitants of Ketro Village continue to observe numerous customs and traditions, including the implementation of policies that prioritize the prudent use of natural resources, the preservation of equilibrium, and the prevention of arbitrary treatment of the environment. These actions are indicative of a hereditary cultural heritage, in which the values promote the efficient utilization of natural resources without generating pollution. These events are often held to commemorate important events, such as Independence Day. Even though there are external customs that have infiltrated Ketro Village, they do not alter the existing customs of the community. Consequently, traditional customs persist without being influenced by external customs.

In conclusion, the people of Ketro Village who work as farmers have a straight view regarding the use of karst land for agricultural land where land conversion does not have a negative impact on the karst environment. Environmental management based on customs passed down from generation to generation is still maintained, such as river cleaning activities or cleaning water sources in the form of springs with the help of the management of the Regional Drinking Water Company, or known as PDAM, for distribution to residents around Ketro Village. In addition, in Ketro Village, development has not been massive. The community has the principle of leaving empty land to be planted with agricultural crops, such as secondary crops, in each house. This activity has become a tradition passed down from generation to generation for the people of Ketro Kebonagung Village, Pacitan, so it can be interpreted that the people have knowledge regarding environmental management in karst areas in accordance with applicable customs.

## ACKNOWLEDGEMENTS

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