



# Water Sustainability Concept of Hindu Javanese Community Settlements Toward Global Climate Change Resilience in the Indonesia Mountainous Area

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## ABSTRACT

Traditional settlements in the mountains are most vulnerable to climate change impacts. The threat of water sustainability to support the life of a traditional residential area is one of the climate change challenges that must be faced. This research aims to explore the local wisdom of the Hindu Javanese community in regulating the landscape of its settlements to maintain water sustainability now. This research methodology used a qualitative approach. This study took place in a traditional settlement of the Hindu Javanese community in the Cetho Temple area. The Cetho Temple area is one of the traces of the remnants of the Majapahit kingdom civilization on Mount Lawu, which was built in the 15th century. Data collection techniques are conducted by direct observation and interviews of several purposively selected informants in the study area. Data analysis is done by analyzing data into physical data and socio-cultural data spatial analysis. The two groups of data were analyzed to obtain a complete picture of the strategy of the Javanese Hindu community to regulate water sustainability in residential areas. The research result shows that The Hindu Javanese community built its settlements concerning local topographic and hydrological conditions in maintaining water sustainability. The Mountain – Springs – Settlement - Farm field relationship forms an environmental ecosystem that is always balanced. In addition to maintaining physical water continuity, the Javanese Hindu community has a spiritual tradition to maintain the spirit of its people to maintain water continuity. The Hindu Javanese community in the Cetho Temple area can align settlements and nature through this local wisdom. This research in the future is expected to be useful as a reference for water management in traditional settlements in the mountains and planning for structuring settlement areas in the mountains.

## INTRODUCTION

In recent decades, climate change has impacted the environment and human life. Threats from the impacts of climate change-related to food security, water availability for living needs, and socioeconomic dynamics in a settlement landscape (Aktürk & Dastgerdi 2021, Dastgerdi et al. 2020). Although two-thirds of the planet is covered in water, some parts of the Earth experience water scarcity. The World Economic Forum's Global Risk Report 2019 ranked the water crisis as one of the top global risks. The threat of this water crisis is caused by the disruption of natural ecosystem balance, minimal water infrastructure investment, and uneven water distribution (Reig Paul 2020). Water has led to conflicts in various regions of the world, such as conflicts in Iran and Iraq over the Euphrates and Tigris reservoirs, water conflicts in Africa (Yemen, Mali), water crises in Guatemala, Honduras, and El Salvador (Gleick et al. 2020).

Water is essential for the sustainability of human life and the environment. Human needs for water are not only biological needs but also social, economic, and religious aspects. In the tradition of various human cultural backgrounds, water is a sacred object. Major religious traditions such as Muslims, Christians, Hindus, Buddhists, and various other local beliefs view water as one of the elements of purification in carrying out religious rituals (Bryan 2017).

The water sustainability concept is defined as managing water resources while considering water availability for future generations. Water sustainability management can be achieved through a multidisciplinary approach to various fields, namely environmental, economic, sociocultural, and engineering (Mendes et al. 2021). Traditional settlements are known to have the ability to adapt to various natural challenges. They organize their environment according to the values of local wisdom derived from the experience of

interaction with the natural environment (Wei et al. 2021). These local wisdom values respond to adapting to natural conditions and available resources (Velázquez-Rosas et al. 2018). Water resources and geographical conditions affect the design of a settlement (Omer 2016).

Ancient civilizations have shown that traditional settlements have had local wisdom in managing water. For example, People in the mountainous region of Kathmandu-Nepal have a water management method called Hiti (Selvaraj et al. 2021). The Dai Village-Yunnan settlement has an ecological concept that combines four settlement components, namely water-forest-field-village (Wang & Chiou 2019). Floating settlement system in Vietnam (Nguyen 2022). Water conservation culture in Egypt and Greece (Ahmed et al. 2020). Drainage system integrated with trenches in settlements in Chengkan village China (Bi et al. 2021). Water tank utilization system for agriculture and settlement in Sri Lanka (Kamani Sylva & Aruna Sylva 2021). Method of capturing rainwater and filling the aquifer layer with pond management in Bengal-India (Roy 2010). Terracing land management methods to prevent erosion and store water to maintain the land's fertility rate sustainably and using the rain harvesting method in managing water in settlements (Gravagnuolo & Varotto 2021, Taji et al. 2021, Zhou et al. 2018).

However, today mountain ecosystems with high slope characteristics tend to experience more complex impacts of climate change. One of the impacts is changes in the hydrological cycle caused by changes in precipitation patterns in the Earth's atmosphere. Changes in the hydrological cycle cause changes in the balance of regional ecosystems, including agricultural productivity and the livelihoods of the region's population (Bhagawati et al. 2017). The topographic conditions of mountains with high and steep slopes have challenges in managing heavy environmental ecosystems (Tarolli & Straffelini 2020). The topographic conditions of a residential area also affect groundwater conditions (Nagamani et al. 2021).

Land-use changes in the mountains have disrupted the balance of water catchment, runoff, and decreased groundwater supply. Expanding the residential and agricultural areas causes forest areas as catchment areas to decrease (Baruah 2020, Ketjulan et al. 2019). The expansion of residential and agricultural areas poses the risk of drought in the dry season and flooding in the rainy season (Muis 2019). Land-use changes in the mountains can also disrupt groundwater flow (Fan & Xiao 2020). Research on water sustainability in traditional settlements in the mountains has a strategic role. When viewed from the distribution of the world's population, one-tenth of the world's population lives in mountainous regions (Liu et al. 2019). Learning traditional

water sustainability knowledge is beneficial for dealing with water crises in other residential areas (Dayaratne 2018, Kamani Sylva & Aruna Sylva 2021, Roy 2010).

This settlement relies on springs for the needs of life and agricultural cultivation. The settlement of the Hindu Javanese community in the Cetho Temple area is one of the traditional settlements that still survive on the western slopes of Mount Lawu, Indonesia. In 2007, Cetho Temple was designated as one of the cultural landscape heritage by the Indonesian government.

However, since it was developed into a tourist area, there has been an increase in tourist activity. Tourist activity affects the increasing water consumption in the region. Based on studies of various existing tourist areas, the impact of tourism on an area will impact increasing water consumption. Globally, there is expected to be a 92% increase in water consumption between 2010 and 2050 (Shen 2020).

That's why it's important to do this research on the water sustainability concept in Hindu Javanese community settlements which aims to uncover the community's best practices in maintaining water sustainability until now. The study is focused on the characteristics of residential space that have a relationship with the position of agricultural land and socio-cultural activities.

## MATERIALS AND METHODS

### Research Design

This research methodology uses a qualitative approach. The research was conducted on the settlement of the Hindu Javanese community. The location of this settlement is fused with the Cetho Temple complex. The settlement of the Hindu Javanese community in the Cetho Temple area is one of the traditional settlements that still survive on the western slopes of Mount Lawu. This area is included in the administrative area of Cetho Village, Karanganyar, Indonesia.

### Description of Area Study

The Hindu Javanese settlement location is at an altitude of 1413 m above sea level and is located on the western slope of Mount Lawu. The region has the characteristics of a humid tropical climate with an average rainfall of 1,817mm per year. The highest rainfall occurs in January, while the lowest rainfall is June-October. The air temperature ranges from 24 -34 C. The type of soil in Cetho Village is brown Andosol which comes from a young volcano. The soil conditions are relatively fertile. The contour condition of the soil varies with a slope of about 10-40 percent. Pine and fir trees dominate the vegetation in the forest area of Mount Lawu. Agricultural land around residential areas is cultivated for horticultural

crops such as carrots, onions, and corn. The research was conducted for one year. The duration of study for one year aims to see the phenomena that occur in the rainy and dry seasons. Fig. 1. Shows the study area map of Cetho village, Karanganyar, Indonesia.

### The Instruments

Data collection techniques are conducted by direct observation and interviews of several purposively selected informants in the study area. The observation area is a residential area located in the Cetho Temple area. The object was a landscape of settlements formed in the Cetho Temple area. Landscape settlements in the form of residential areas and agricultural cultivation areas. Interviews with several key informants obtained socio-cultural data. The selection of informants was conducted purposively, a member of the Hindu Javanese community who has the knowledge to explain phenomena related to water conservation in the village of Cetho.

### Data Analysis Techniques

Data analysis is organized into physical spatial data and socio-cultural data. The two data groups were then dialogized and interpreted to obtain a complete picture of regulating water sustainability in the settlements of Hindu Javanese communities.

## RESULTS

**History of Hindu Javanese Community Settlements in Cetho Temple Area:** According to historical records, the settlement of the Hindu Javanese community on the western slope of Mount Lawu was initiated by the construction of

a *Mandala* (education center) and hermits who deliberately resigned from the crowd to get closer to *Hyang Widhi* (God). This phenomenon is indicated by considering the selection of locations located on remote mountain slopes. During the Majapahit kingdom, many Mandalas were built on mountain slopes that were considered sacred. In 1451 AD, around the *Mandala* was built a temple by followers of the last Majapahit King (Brawijaya). This temple came to be known as the Cetho Temple. Based on information obtained from various sources, Hindu Javanese community settlements in the Cetho Temple area began to appear in 1885. Over time, the population grew to form a Hindu community known until now. Fig. 2. shows a typical village of a Hindu Javanese settlement.

**The Spatial Arrangement of Settlements to Maintain Water Sustainability:** This settlement is divided into three zones based on the type of activity: Cetho Temple zone for worship, settlement zone, and moorland zone / agricultural field. The Temple Zone position is at a higher place than the settlement zone. Following the Hindu teachings embraced by the people in Cetho village, the place of worship is sacred and must be placed in the highest position on the east. This illustration can be seen in Fig. 3.

In the beginning, *Pundisari* springs are the oldest springs source of water needs in the Cetho Temple area. *Pundisari* spring is just east of Cetho Temple. The existence of *Pundisari* springs cannot be separated from the existence of the Cetho Temple. The water component is part of the needs of religious rituals in the Temple. After the settlements around Cetho Temple appeared, *Pundisari* springs began to be used for various needs. Water is used to meet the needs of settlements and agricultural areas.



Source: Google Earth edited by author.

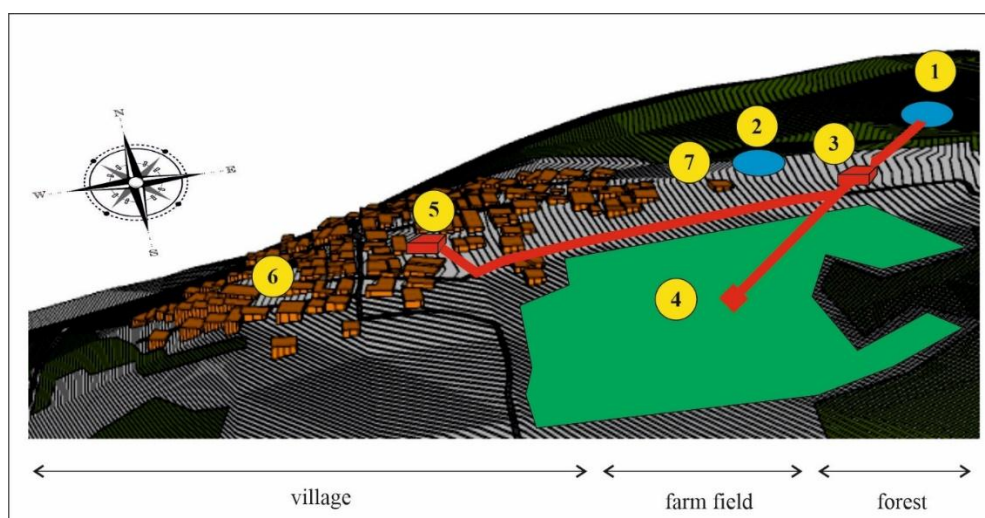
Fig. 1: Study area map of Cetho Village, Karanganyar, Indonesia.





Source: Author.

Fig. 2: Typical village of Hindu Javanese settlement



Source: Author

Fig. 3: The spatial layout of Cetho Village, 1 is *Sendang Macan* springs, 2 is *Pundisari* springs, 3 is water distribution station, 4 is farm field, 5 is *Kalibaku*, 6 is houses, and 7 is Cetho Temple.

In ancient times, air from *Pundisari* springs was distributed to settlements using water pipes made of bamboo stems connected one by one. Water is distributed to several water reservoirs located within the settlement. This shelter is called *Kalibaku*. To drain water from *Pundisari* springs to *Kalibaku* using the principle of gravity. The water will continue to flow downwards as long as the end of the drain is not closed. Once known as PVC water pipes (a type of water pipe that uses Polyvinyl chloride material), the community in Cetho village replaced bamboo water pipes with water pipes. The concept of water distribution using the principle of *Kalibaku* is a traditional way of Hindu Javanese communities in Cetho Temple areas to regulate water use in residential areas.

The houses of the first-generation residents in Cetho Village generally do not have bathroom facilities. *Kalibaku* becomes the center of activities to take clean water and bath-washing activities. *Kalibaku* is also used for traditional ceremonial facilities related to the life cycle (rite of passage). Such as the ceremony of bathing a baby and the ceremony of bathing the citizens who died. Along with the development of culture, bathing, cooking, and washing activities have shifted to their respective homes. However, the existence of *Kalibaku* as a water reservoir is still maintained. *Kalibaku* water is still used to take water for traditional ceremonies.

The larger population and increasing tourism activities in the temple area lead to increased water needs. The discharge

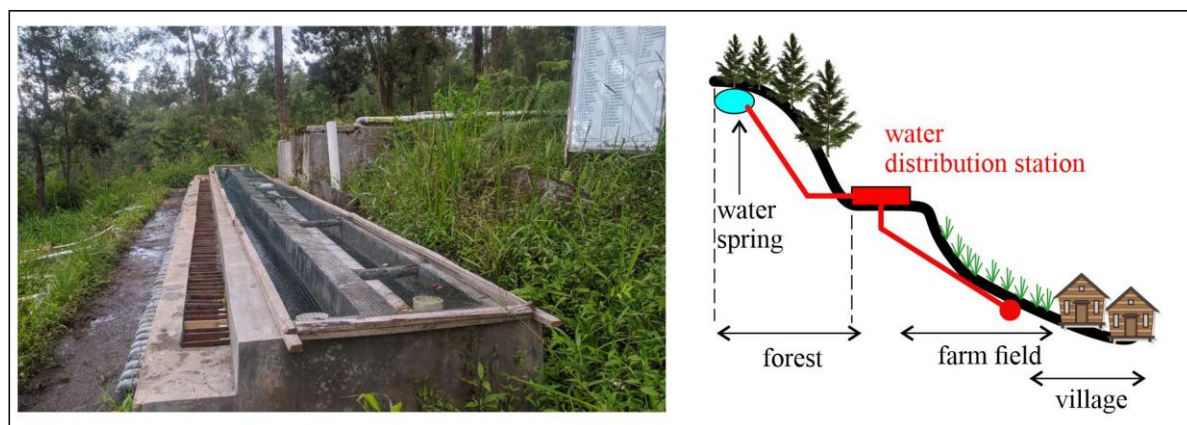
of *Pundisari* springs is not enough. Residents take a new spring from *Sendang Macan*. The location of the *Sendang Macan* springs is further away from the settlement but has a more extensive discharge. Water flows from the *Sendang Macan* springs with one main water pipe to the water distribution station. The water distribution station will divide the water into each resident's home, and farm fields use 0.5-inch PVC water pipes. Each resident has a private pipeline to the water distribution station. The number of pipes owned is arranged through a mutual consensus to distribute water evenly. The water distribution system utilizes the force of gravity, so no mechanical machine is needed to push water from the water distribution station to the residential area. This illustration of the water distribution station can be seen in Fig. 4.

**Water Retention Pond to Control Flooding and Irrigate Farm field:** The majority of Javanese Hindu community settlements are on the mountain's slopes with a slope of

10-40%. During the rainy season, surface water will flow from the top of the mountain to the residential area. Locals regulate the pattern of rainwater flow by making water ponds around the house. This water pond has many functions, first, slowing the flow of rainwater from the top of the mountain to the settlement; second, maximizing the rainwater catchment area to support the stability of groundwater production; third can be used to irrigate agricultural land. Fig. 5. shows a water retention pond.

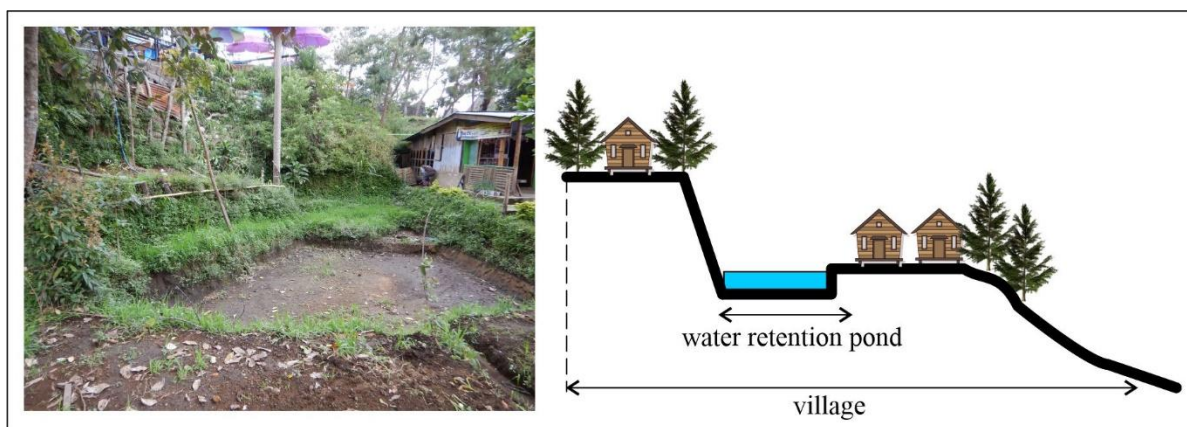
**Water Catcher to Support Water Supply on Farm Field:**

Residents in the Cetho Temple area are very efficient in utilizing water. Rainwater and residual water use from the bathroom are used to irrigate farmland. Rainwater and residual water use from the bathroom are accommodated in a water collection place equipped with PVC water pipes. This water pipe flows to their farm field area located under the residential area. Water is flowed by utilizing the force of



Source: Author

Fig. 4: Water distribution station.



Source: Author

Fig. 5: Water retention pond.

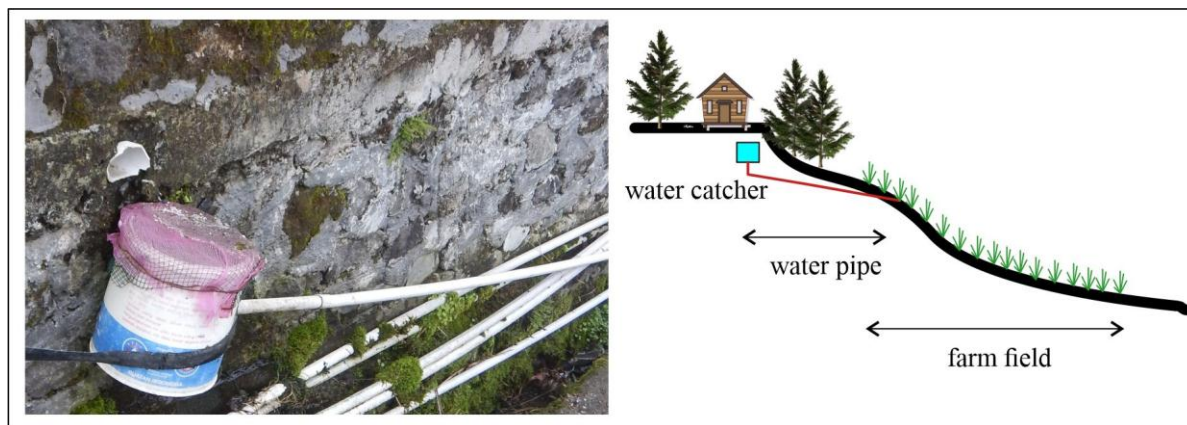


gravity. Illustrations of the water catcher can be seen in Fig. 6.

**Mountain Belt to Control Water Movement and Soil Erosion:** The agricultural area around the Cetho Temple has a slope of land between 10-40 percent and relatively high rainfall. Farmers make a *sabuk gunung* (mountain belt) to control water movement when high intensity. A Mountain belt is a land engineering pattern on sloping areas by following the contours of cutting mountain slopes. This pattern visually looks like the shape of a belt or belt that circles the body of a mountain. The benefits of mountain belt systems are to slow water movement down and reduce erosion of agricultural soil surfaces. The mountain belt system will increase the water's suction power into the soil so that the water does not go down directly. This illustration of the mountain belt at the farm field can be seen in Fig. 7.

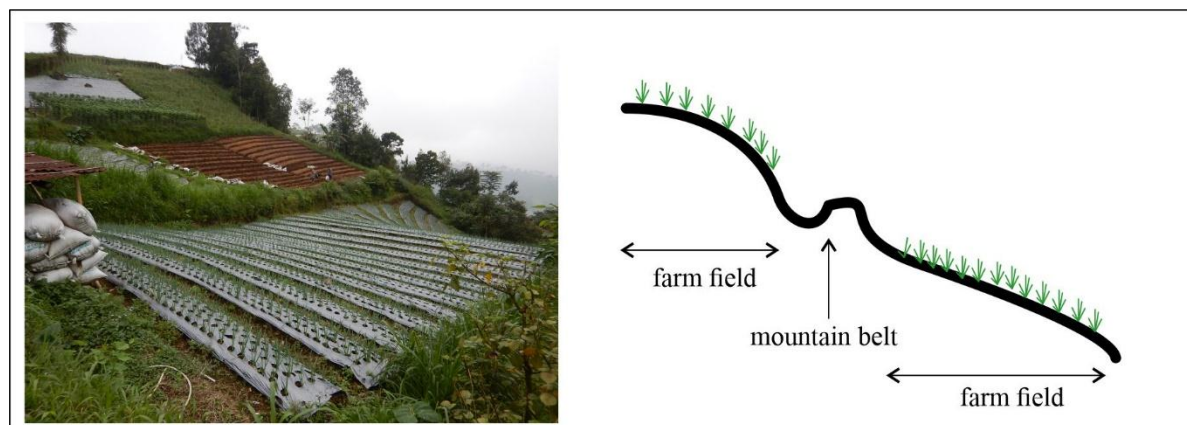
**Dawuhan Ritual Tradition as a Spirit to Maintain Water Sustainability:** The water source for the Hindu Javanese

community in the Cetho Temple area is a sacred place. In addition to being used for living needs, the water serves as a complement to worship rituals. The *Dawuhan* ritual is a form of traditional Hindu Javanese community ceremony to honor the source of the springs. The *Dawuhan* ritual is carried out for generations by the Javanese Hindu community around Cetho Temple. This ceremony is carried out regularly every Saturday *kliwon* month of *Sura* (Javanese calendar). This ceremony was attended by all residents in the Cetho Temple area. The meaning of this ceremony is an expression of gratitude to God for having been given springs that can be used for living needs such as drinking, cooking, and agricultural cultivation. Through *Dawuhan* rituals, the Hindu community in the Cetho Temple area wants to *meruwat* (rearrange the cosmological aura) of existing springs. The springs that have been performed at the ceremony will have an excellent cosmological aura, thus providing adequate



Source: Author

Fig. 6: Water catcher



Source: Author

Fig. 7: Mountain belt at farm field

water needs for all citizens. By carrying out this ceremony, it is expected that the lives of citizens will always get blessings and tranquility. Fig. 8. shows the *Dawuhan* ceremony in the Cetho Temple area.

The location of the ceremony is centered in front of the *Pundisari* spring building. Before carrying out *Dawuhan* rituals, people in Cetho village will carry out activities to clean the springs and check the distribution channels of water flowing throughout the settlement area. By the time *Dawuhan* day arrives, the series of *Dawuhan* ceremonies begin with the leadership of local stakeholders (*Mangku*). The ceremony began in the afternoon. Residents come to the location together using traditional clothes. The *Dawuhan* ceremony begins by placing offerings on the *Meru* building in the complex of *Pundisari* springs. A set of offerings in the form of *tumpeng* grilled packages (rice, roasted chicken, fruit, flowers). Then a prayer procession led by stakeholders followed by people sitting on mats with parallel configurations facing east. The ritual process lasts approximately 2.5 hours, ending with a blessing (giving holy water to all ceremony participants). Holy water is believed to be the essence of life for the well-being and salvation of humanity. The last stage of this ceremony is the *kembul bujono* (eating offerings that have been prayed together). This activity is a traditional way for the Hindu Javanese community to maintain nature passed down through generations. Rituals can remind all community members to manage water resources wisely every year.

## DISCUSSION

The Javanese Hindu community in the Cetho Temple area still maintains local wisdom in maintaining water sustainability in

their residential areas. They build their settlements regarding topographic and hydrological conditions to form a unique settlement pattern. The characteristics of mountain settlement space are closely related to agricultural land and sociocultural activities (Cillis et al. 2020, Zheng et al. 2021). There are three known mountain settlement structures; agglomeration, belt, and dispersion (Xu et al. 2021). The settlement of the Hindu Javanese community in the Cetho Temple area is a type of agglomeration settlement.

If traced further, the spatial layout of the village of Cetho is formed by the interaction of four main elements, namely the Mountain – Springs – Settlement - Farm field. This settlement is on the western slope of Mount Lawu. The top is the protected forest area. In this protected forest area, there is a *Sendang Macan* spring that becomes a source of water for the living needs and agricultural activities of the Hindu Javanese community in the village of Cetho. The Mountain-Spring-Settlement-Farm field is an inseparable ecosystem. Settlements and farm fields cannot live if there are no springs. Meanwhile, the springs will be lost if the surrounding residents cannot care for the forest. To care for this ecosystem, the Javanese Hindu community in the Cetho temple area strives to maintain the balance of nature both physically and spiritually. Arranging settlement landscaping, making water retention ponds, water use efficiency, and mountain belts are the embodiment of physically caring for the ecosystem. At the same time, the *Dawuhan* ritual ceremony is an embodiment to care for the ecosystem spiritually. This action cannot be separated from the background of Hindu teachings embraced by the community in the Cetho Temple area. Hindu teachings have always taught man always to maintain a balance of relations with God, relationships with fellow human beings, and relationships with nature.



Source: Solotruster documentation (Solotruster 2022)

Fig. 8: Illustration of the *Dawuhan* ceremony in the Cetho Temple area.

## CONCLUSION

In maintaining water sustainability, the Javanese Hindu community built a local mechanism that regulates the cycle for the needs of life and the process of agricultural land production. The relationship between the Mountains-Springs-Settlements-Farm field relationship forms an organic environmental ecosystem that is always balanced. In addition to maintaining physical water continuity, the Javanese Hindu community has a spiritual tradition of *Dawuhan* to maintain the spirit of its people in maintaining water sustainability. This understanding is in line with the Hindu teachings embraced by this community. In carrying out life must always maintain the relationship between Man-God, Man-Man, and Man-Nature to create a harmonious life. This research shows that traditional settlement arrangements built with local values can maintain water sustainability. This knowledge can be an additional reference in building a sustainable development theory in traditional settlements in mountainous areas.

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