



Adapting to climate change: Exploring tourism vulnerability and agricultural development in Gedangan Village

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ABSTRACT

Background: Researchers agree on the necessity of a robust framework to adapt to and mitigate climate change, encompassing environmental education, financial support, green tourism, eco-tourism, and conservation projects. This paper investigates the vulnerability of tourism to climate change, tourism under various climate scenarios, and adaptation strategies within this sector. The tourism industry's reliance on energy sources such as water, electricity, and fossil fuels underscores the need for a thorough evaluation of systems and frameworks to ensure sustainability and resilience. Gedangan Village, located 14 km west of Boyolali's town center, is a major vegetable-producing area in Cepogo District, Central Java, Indonesia, characterized by its productive highland agriculture. **Method:** This study uses a descriptive-analytical method with a qualitative approach, focusing on a case study in Gedangan Village to understand its potential, issues, and transformations. The location was purposively selected due to its relevance, and data was collected through purposive sampling of key informants. The paper employs a literature review to support its findings, leveraging various databases and sources. **Conclusion:** The conclusion highlights the need for enhancing technological use and human resources to maximize Gedangan's agricultural potential and address the challenges posed by climate change.

KEYWORDS: adaptation; climate change; sustainable; tourism.

1. Introduction

One effective approach to enhancing a nation's economy is by developing its agricultural sector and rural areas. It is undeniable that agriculture and rural development can significantly boost national economic growth. Traditionally, the role of agriculture in economic development was seen as passive and merely supportive. Historical evidence from Western countries shows that economic development is closely associated with rapid structural transformation—from agriculture-based economies to modern industries and more complex public services. Thus, agriculture was primarily viewed as a source of labor and cheap food supplies, facilitating the growth of the dynamic industrial sector, which was considered the key driver in overall economic development strategies.

Future agricultural commodity development requires support from capital resources, advanced technology, and skilled human resources with agribusiness knowledge and a sustainable perspective. This new paradigm should be implemented within the context of

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regional development, local community-based approaches, and aligned with decentralization and regional autonomy. Such an approach is expected to ensure the continuity of development programs due to widespread community participation, synergy among agribusiness subsystems, across development sectors, and between rural and urban areas (agropolitan). This agribusiness development model aims to enhance competitiveness, value addition, exchange value, and farmer welfare.

Gedangan is a rural center in Cepogo District, Boyolali, Central Java, Indonesia. Located 14 km west of the Boyolali Regency center, the village is inhabited by 4,258 people, the majority of whom are engaged in agriculture. Situated at an altitude of 900-1500 meters above sea level, Gedangan is a major vegetable-producing area in Boyolali Regency, positioned between the slopes of Mount Merbabu and Merapi. Its productive land, primarily located in this highland region, is highly suitable for horticultural activities, particularly vegetable cultivation. Gedangan is bordered to the east by Sumbung Village, to the west by Wonodoyo Village, to the south by Jombong Village, and to the north by Sukabumi Village. The objectives of the research are to: understand the potential and issues of Gedangan Village; identify the structural transformations occurring in Gedangan; examine the institutional transformations in Gedangan; assess the technological transfers taking place in Gedangan; and determine the appropriate agricultural development model based on the analysis of agricultural development in Gedangan.

2. Methods

The research utilizes a descriptive-analytical method with a qualitative approach, conducted through a case study in Gedangan Village, Cepogo District, Boyolali Regency. Descriptive-analytical research focuses on current issues as they exist during the study, with findings processed and analyzed to draw conclusions. Qualitative research emphasizes description and analysis, highlighting processes and meanings, with theoretical foundations guiding the study to ensure alignment with field facts.

The location for this study was determined purposively, meaning the selection was intentional and based on specific criteria aligned with the research objectives. The choice of Gedangan Village was influenced by its relevance to the research case. Sampling was conducted using purposive sampling, where specific characteristics or criteria relevant to the research objectives are used to select participants. This approach ensures that the sample, including the Village Head of Gedangan, is accessible and pertinent to the study's focus.

Data sources are critical to research quality and determine the data collection methods. Data is categorized into primary and secondary sources. Primary data is collected directly from key informants, such as interviews with the Village Head. Secondary data is obtained indirectly through media or records compiled by others, including historical documents and statistical reports from sources like the internet, libraries, and the Central Statistics Agency. The paper was carried out using a literature review approach. The procedures involved in this paper include doing thorough research and selecting relevant literature on the topic. The fundamental idea is to utilize search engines to explore various information resources, including databases like Elviesier, Google Scholar, MDPI, Springer, Science Direct, ResearchGate, Connected Paper, Open Access Journal, etc.

3. Results and Discussion

3.1 Potentials and issues of Gedangan Village

The highest potential in Gedangan Village lies in its potential as a tourist village. A tourist village is a community comprised of residents in a limited area who can interact directly under a single management and have the concern and awareness to collectively participate by aligning their individual skills. The tourist village is established to empower

the community to act as direct participants in efforts to increase our readiness and concern in addressing the tourism potential or tourist attractions within each village.

The tourism offered in Gedangan Village includes historical tourism in the form of temples and socio-cultural tourism in the form of markets. The historical tourism of Gedangan Village includes temples from the Ancient Mataram Kingdom under the rule of Hindu kings from the Sanjaya Dynasty, namely Candi Sari and Candi Lawang. Candi Lawang is estimated to have been built around the 9th-10th centuries AD, based on the framing of the temple's base, which is a characteristic profile of Central Java. It consists of a flat ledge, a bell-shaped side (ojief), and half-round (halfround). Another basis supporting the estimated time of the temple's establishment is the inscription found on the left or southern doorway. The script used is Ancient Javanese characters, which were widely used and developed during that period. Candi Sari is a Hindu temple located on a small hill at an altitude of 991 meters above sea level. Currently, Candi Sari Cepogo only has the foundation and a few remaining relics. Candi Sari is highly valued for its excellent view for photography, especially in today's era, as it can be considered an "Instagrammable" spot due to its direct view of Mount Merapi and Mount Merbabu

The socio-cultural tourism in Gedangan Village is represented by Pasar Ngatpaingan. This market is unique because it only occurs once every 35 days on Sunday Pahing (according to the Javanese calendar). Pasar Ngatpaingan offers a variety of traditional snacks from the past, such as market snacks, Boyolali specialty foods, and drinks like dawet and durian ice. Another unique aspect of this market is the currency used for transactions, which is called Bengol. Bengol is made from plywood measuring 2x3 cm, complete with a stamp. One Bengol is valued at Rp 5,000 and is offered at the entrance before entering the market. The sellers at each stand also wear traditional Javanese clothing, including lurik and kebaya.

Another potential in Gedangan Village is in the agricultural sector. Almost the entire area of Gedangan Village is agricultural land, and nearly all residents work as farmers. The agricultural commodities in the village include vegetables, and during the dry season, the community plants tobacco. This is because Gedangan Village is located at an altitude of 900 meters above sea level at the foot of Mount Merapi, making it very suitable for vegetable farming. The vegetable harvest is usually sold at Cepogo Market, while tobacco is typically sold to PT Gudang Garam in Boyolali

Challenges and obstacles in utilizing the potential in the village certainly exist, and this also applies to Gedangan Village. Problems are obstacles to the development and progress of a region. These problems can originate from internal (internal factors) or external (external factors) sources of a particular area or region. The problems found in Gedangan Village include economic issues, which affect the development of infrastructure needed to enhance the existing tourism potential. The village head of Gedangan has expressed this concern to the government, but as of now, no assistance has been received, leaving the tourism sites in Gedangan Village in their current state, with insufficient parking areas at each site. Another issue in Gedangan Village is the presence of monkey pests that constantly disturb the villagers' vegetables and fruits. This is a serious problem for the residents of Gedangan Village because when the monkeys cause disturbances, and if the residents attempt to eradicate them, it is considered illegal hunting of the monkeys. Thus, the villagers have tried to address the monkey problem by enclosing their land with nets, but this solution is temporary as the monkeys eventually manage to break through the nets by jumping over them and creating holes to enter the land

3.2 Structural transformation in Gedangan Village

Based on the interview conducted with the Head of Gedangan Village, Mr. Waljuni, structural transformation in Gedangan Village has not undergone significant changes. The structural economic transformation in the village remains consistent with previous years, with the majority of the population being vegetable farmers. In addition to vegetable

farming, some hamlets also have residents who engage in livestock farming. The most significant transformation is in the methods of farming, as the people of Gedangan have begun to utilize technology. Agriculture remains the main source of income in Gedangan Village. Year by year, agriculture in Gedangan Village has advanced. The villagers are quick to adopt innovations in agricultural technology, which facilitates farming and improves the quality of agriculture in Gedangan Village.

The economy in Gedangan Village is supported by the agricultural sector. The agricultural sector in Gedangan Village is thriving, with some of its produce being exported abroad. Gedangan Village also receives support from several agencies and the agricultural department to continuously develop its agricultural potential. Currently, Gedangan Village is active only in the agricultural and livestock sectors; the industrial and service sectors are not operational in Gedangan Village.

3.3 Institutional transformation in Gedangan Village

Institutional transformation refers to fundamental restructuring efforts expected to impact system and structural changes. The system pertains to the relationships among elements that influence and connect to form a totality. The goal of Institutional Transformation is to improve organizational quality and align organizational structures, enhance business processes, modernize policies and human resource management, and improve governance and the quality of services provided. To achieve these goals, specific targets must be realized to achieve optimal outcomes for significant and fundamental changes (transformational change).

Institutional transformation in Gedangan Village has been minimal, primarily due to adherence to the regional regulations of the district. The youth organization structure in Gedangan Village has transformed, evolving from separate hamlet-based groups to a unified association named Paguyuban Cempakasetya. This association comprises youth members from various hamlets within Gedangan Village and holds regular monthly meetings. Paguyuban Cempakasetya frequently organizes youth activities in Gedangan Village, such as competitions, regular sports events, and serving as committees for competitions during major holidays.

Another institution that has transformed in Gedangan Village is the Posyandu (Integrated Health Service Post). Initially, Gedangan Village only had a Posyandu for toddlers, focusing solely on toddler health services. However, it has expanded to include a Posyandu for the elderly. The Elderly Posyandu aims to enhance the welfare of the elderly population in Gedangan Village, both physically and psychologically, through independent elderly health activities within the community. Additionally, whereas Posyandu services were initially limited to the village level, they are now available in each neighborhood (RT). The establishment of neighborhood-level Posyandus has been made possible by the support of local residents who volunteer as Posyandu cadres to educate the community in each RT.

Gedangan Village has a combined farmer group (Gapoktan) consisting of 14 farmer groups within the village. Other institutions in Gedangan Village, such as the treasurer and similar roles, have not yet undergone transformation. Typically, these positions only experience changes in leadership during specific periods.

3.4 Technology transfer in Gedangan Village

The technology transfer process in Gedangan Village, Cepogo District, Boyolali Regency, is carried out by involving the combined farmer groups (gapoktan) and individual farmer groups under the guidance of village management institutions. Members of the farmer groups are aware that their biggest challenge in farming is the quick spoilage and decay of harvested produce. Typically, harvested vegetables are only rinsed with running water and then placed in simple crates, resulting in some vegetables being damaged and not fresh by the time they reach distribution points the next day. To address this issue, UNS University, with assistance from the Directorate General of Higher Education (Dikti),

provided a post-harvest technology solution by installing an ozone generator machine. This technology helps maintain vegetable freshness for a longer period. The ozone (O₃) produced by the machine acts as a disinfectant capable of killing pathogenic microorganisms (viruses, bacteria, and fungi), removing heavy metals, and eliminating the need for pesticides, thereby extending the shelf life and ensuring the safety of the vegetables.

According to the village head, UNS University recognizes the necessity of providing guidance to implement appropriate technology within the community. One of their initiatives included introducing post-harvest processing technology that could be developed in the village. UNS students have conducted socialization programs on using the ozone generator machine to ensure the optimal application of the technology among the villagers, particularly the farmers

The technology transfer in Gedangan Village also involves the Livestock Farmer Group (KTT), which has constructed three biogas reactors in collaboration with the Agricultural Technology Development Agency in 2000, followed by a single-tank reactor model built later. Biogas energy has been used for cooking and lighting during power outages. Gedangan Village has significant biogas energy potential due to the numerous biogas reactors. Community service activities have been conducted to convert biogas energy into electricity (PLT-Biogas) at three locations, each with a potential energy capacity of 15 kW. The generated electricity is primarily used by livestock farmers to operate equipment such as water pumps and grass choppers. However, the issue remains that the substantial energy potential of the biogas reactors is not being utilized optimally. The solution requires readjusting the equipment at the PLT-Biogas reactors.

Another challenge in the non-agricultural sector is the poor network connectivity. The implementation of technology, especially internet access, in Gedangan Village is still suboptimal. Villagers struggle to access information related to agricultural strategies or innovations through platforms like Google and YouTube due to poor internet connectivity. This issue arises from the unequal distribution of internet facilities, particularly in Gedangan Village. Although WiFi technology has been implemented, it only covers the area around the Gedangan Village Head Office.

3.5 Agricultural development in Gedangan Village

Currently, agricultural development in Gedangan Village focuses on diversifying agricultural products. This is evidenced by the cultivation of tobacco for commercial purposes. Initially, farmers in Gedangan Village planted various vegetables such as tomatoes, shallots, mustard greens, scallions, and others. They also have an orientation towards broader marketing of their vegetable products. Farmers in Gedangan Village have established farmer groups that serve as a platform to consolidate agricultural products for joint sales, thereby achieving higher sales prices. These farmer groups market their produce to restaurants and hotels.

The model implemented in Gedangan Village is the Conservation Agriculture Model. Conservation agriculture is a sustainable land management system that improves soil quality while simultaneously enhancing crop productivity, sequestering carbon in the soil, and reducing greenhouse gas emissions. This model emphasizes increasing soil organic matter content through a combination of minimum tillage, mulching, and crop rotation management.

This model is applied by planting various types of vegetables on a single plot of land (intercropping). The goal of intercropping is to achieve optimal yields and maintain soil fertility. Furthermore, much of the agriculture in Gedangan Village has adopted organic farming practices. Organic farming is favored because organic vegetables are perceived to have more advantages, thus increasing their market value. Most farmers in Gedangan Village also engage in livestock rearing as a supplementary occupation. Livestock such as cattle, goats, and chickens are commonly raised. One of the by-products of livestock rearing is manure, which is subsequently used as fertilizer for the cultivated vegetable plots. This

creates a symbiotic relationship between livestock and farmland, ensuring the overall utilization of resources. Organic vegetable cultivation also supports the conservation agriculture model, as it yields higher outputs compared to conventional vegetables.

4. Conclusions

Gedangan Village, located 14 km west of Boyolali's town center, is a key rural center in Cepogo Subdistrict and a major vegetable-producing area. The village's primary potentials include tourism sites such as Sari Temple, Lawang Temple, Ngatpaingan Market, and agriculture. However, the village faces challenges in tourism infrastructure development and monkey pests affecting vegetable farming. Structural transformation in the agricultural sector is ongoing to support the village's economy, while institutional transformation is minimal, occurring only in the youth organization (karang taruna). Technological advancements in the village include the construction of three biogas reactors in collaboration with the Agricultural Technology Development Agency. Currently, agricultural development in Gedangan Village focuses on product diversification, evidenced by the cultivation of tobacco for sale. To fully leverage its potential, Gedangan Village should optimize the use of available technology and enhance human resources, particularly vegetable farmers, through training and utilization of technologies such as the ozone machine provided by UNS.

Author Contribution

All author contributed fully to the writing of this article.

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Conflicts of Interest

The author declare no conflict of interest.

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