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CLIMATE VILLAGE STRATEGY IN MADIUN AS A FORM OF CLIMATE CHANGE MITIGATION TOWARDS A SMART ENVIRONMENT

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ABSTRACT

The Ministry of Environment and Forestry initiated the Climate Village Program (ProKlim) to increase community involvement in climate change adaptation and mitigation. This study aims to analyse the Climate Village Program implementation strategy in Madiun City as a form of climate change mitigation and the embodiment of the Smart Environment concept. The qualitative research approach uses data collection techniques through field observations, in-depth interviews, and questionnaires distributed to 96 respondents from 24 climate villages spread across Madiun City. The main informants consisted of representatives of the environmental service, community leaders, and ProKlim actors. The study results showed that the ProKlim implementation strategy received positive support from the community, local government, and the private sector. The main strategies include strengthening local institutions, integrating environmentally friendly technology, and increasing community capacity through environmental education. However, private sector participation and technology utilisation still need to be improved for more efficient environmental management. These findings confirm that multi-stakeholder collaboration and community-based approaches are the keys to success in realising climate-resilient cities through the Smart Environment concept.

Keywords: *Climate Village; Climate Change; Smart Environment; Mitigation*

INTRODUCTION

The issue of climate change is currently an unavoidable global problem and is the main focus of international discourse. Climate change is a form of environmental damage that impacts almost all aspects of life, from threats to ecological, social, and local and global economic systems (Yuliartini & Suwanto, 2022). It is estimated that by the end of 2100, global temperatures will increase by between 1.8 and 4°C compared to the average temperature of 1980–1999 (Leontinus, 2022). The general impacts include thinning of the ozone layer, increasing global temperatures due to greenhouse gas (GHG) emissions, rising sea levels, melting glaciers, and disruption to people's lifestyles (Saleh, 2020).

The Indonesian government is committed to reducing GHG emissions as part of its national contribution to global climate control efforts. One of the strategies taken is through the Climate Village Program (ProKlim), which involves active community participation in strengthening resilience to the impacts of climate change and mitigation efforts at the local level (Santoso & Rahaju, 2020; Alifiyah, 2023). ProKlim has four categories, namely Pratama, Madya, Utama, and Lestari, and consists of adaptation, mitigation, and other supporting aspects (KLHK, 2016). According to the Directorate General of Climate Change Control (2021), this program has reduced emissions by 259,096.01 tons of CO_2 during 2015–2021. However, no local study has specifically measured ProKlim's contribution to emission reduction targets in certain areas, including in Madiun City.

Madiun City, the fourth largest city in East Java, has experienced an average population growth of 2.58% per year (Disdukcapil Kota Madiun, 2023). Population growth triggers challenges in resilience to climate disasters (Nurhayati, 2015). This resilience is important to maintain social, economic, cultural, and environmental sustainability (Valentina & Elsera, 2023). Madiun City was also selected for the Movement Towards 100 Smart Cities program by the Ministry of Communication and Information, with one of its important dimensions being Smart Environment (Syarif, 2020). Innovative Environment aims to create good, responsible, and sustainable environmental governance through technology and community participation (Nooringsih & Susanti, 2022). ProKlim can be integrated into achieving Smart Environment indicators, for example, through biopores, digital waste banks, and IoT-based urban agriculture (Sharif & Pokharel, 2022). However, little research has reviewed how the ProKlim strategy explicitly supports the achievement of Smart Environment indicators at the city level.

Based on this background, this study aims to determine the conditions for implementing the Climate Village Program in Madiun City and formulate an ideal climate village development strategy according to the Smart Environment concept.

MATERIALS AND METHODS

This research was conducted in Madiun City, East Java, from December 2023 to January 2024. The location selection was based on the high environmental dynamics and community involvement in climate programs, as well as the completeness of the available data. This study used a descriptive qualitative approach with data triangulation from observations, questionnaires, and in-depth interviews.

The number of questionnaire respondents was 96, and they were representatives of 24 climate villages (4 respondents per village) using probability sampling techniques. The key informants were selected purposively, consisting of representatives of the Environmental Service, RW/RT heads, and local environmental activists. The indicators in the questionnaire include: (1) level of understanding of climate change, (2) involvement in ProKlim activities, (3) perceptions of local policies, (4) use of environmentally friendly technology, and (5) socio-economic impacts of ProKlim activities.

Sampling methods in this study were differentiated based on the data collection type. Probability sampling, specifically simple random sampling, was used for the quantitative data obtained through questionnaires. This technique ensures that each individual in the population has an equal chance of being selected, allowing for unbiased generalisation of findings (Nurdin et al., 2018).

In contrast, informants were selected using purposive sampling for the qualitative data obtained through in-depth interviews. This technique is commonly used in qualitative research where informants are selected intentionally by the researcher based on specific criteria or relevance to the research objectives. This approach enables a deeper exploration of the subject matter that aligns with the research strategy.

The data collection methods in this study included observations, questionnaires, and in-depth interviews. The data consisted of both primary and secondary sources.

Primary data were collected through questionnaires distributed to community members involved in the Climate Village Program and through direct field observations. The questionnaire was designed with several key indicators, including:

1. Public awareness of climate change
2. Community participation in climate adaptation and mitigation efforts
3. Perceived benefits of the Climate Village Program
4. Behavioural changes related to environmental practices

In-depth interviews were conducted to explore these indicators further and gather deeper insights from selected key informants. Meanwhile, secondary data comes from the portfolio documents of each climate village. Related interviews aim to find problems and find in-depth opinions, or desires from respondents (Edi, 2016). All data from the interview results are then poured into a descriptive narrative form.

The method used in this study is a qualitative approach with a case study as the research design. Qualitative research is a method to explore and understand the meaning that several individuals or groups of people attribute to social or humanitarian problems (Assa & Dachi, 2023). Description of Questionnaire Values shown in **Table 1**.

Table 1. Description of Questionnaire Values

Mark	Information
1	Not good
2	Not good
3	Pretty good
4	Good
5	Very good

This study uses a qualitative descriptive approach where researchers can gain an in-depth understanding of the context, processes, and interactions that occur in government collaboration. Meanwhile, this study also used a participatory approach to determine the supporting and inhibiting factors in the sustainable climate village program in Madiun City. Data Analysis diagram shown in **Figure 1**.

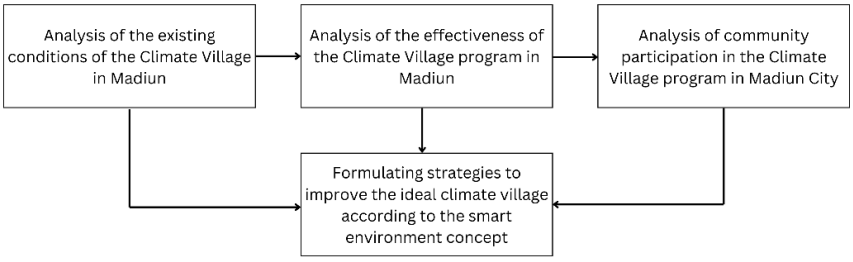

Figure 1. Data Analysis Diagram

An analysis of the conditions of Climate Villages in Madiun City was carried out through literature studies and observations of communities directly involved in 24 Climate Villages. Data analysis used the DPSIR (Driving Force, Pressure, State, Impact, Response) framework approach, which is used to analyse the causal relationship between human activities and environmental conditions. The details of its application in this study are as follows:

1. Driving Force: Increasing global temperatures and population growth in Madiun City create the need for mitigation programs.
2. Pressure: Increasing community needs for climate adaptation and sustainable environmental management.
3. State: Current conditions of implementing the Climate Village Program in 24 locations in Madiun City, including the level of participation and effectiveness of activities.
4. Impact: ProKlim is effective in reducing emissions and increasing public environmental awareness.
5. Response: Innovation in regional policies, private sector participation, and integration with Smart Environment indicators such as waste banks, green parks, and climate monitoring applications.

The data was analysed descriptively to describe the relationship between DPSIR components and to formulate an ideal climate village development strategy in Madiun City.

RESULTS AND DISCUSSION

The age range of respondents in this survey showed a fairly even distribution, although there was a greater concentration in certain age groups. The 41-45 age group dominated with 25 respondents, followed by the 51-55 age group with 26 respondents. Respondents from the 36-40 and 46-50 age groups were also quite significant, with 21 and 10 respondents, respectively. The fact that the majority of respondents were of productive age indicates that the people involved in the Climate Village program are individuals who are likely to have an active role in social and environmental activities (Ardinal & Amanah, 2021).

Most respondents rated the current environmental conditions in Kampung Iklim as "Good" to "Very Good". A total of 58 respondents rated their Environment as good, and 31 rated it as very good. This shows that the Kampung

Iklim program has succeeded in improving or maintaining environmental conditions in the area. However, there is still room for improvement, especially in ensuring that all aspects of the Environment are considered carefully. This public perception is an important benchmark for evaluating the program's success and designing the following steps (Novalinda et al., 2020).

Adaptation to climate change related to natural disaster management, such as drought, flood, and landslide, received a very good rating from most respondents. As many as 59 people rated it good, and 23 rated it very well. This reflects the success of the adaptation measures, such as planting trees, improving drainage systems, or managing water resources more effectively. High community support can also indicate that they feel safe with these measures, which is important in creating a sense of stability amidst an uncertain climate change (Gusty et al., 2024).

Activities aimed at improving food security in Kampung Iklim also received a positive response. As many as 60 respondents considered this activity good, and 29 considered it very good. Improving food security is one of the key strategies in dealing with climate change, especially considering its adverse impacts on food production (Legionosuko et al., 2019). Positive responses from the community indicate that initiatives such as urban farming, local food garden management, and food crop diversification have a real impact.

Respondents also assessed adaptation to climate-related diseases, such as dengue fever or diseases caused by extreme weather. As many as 58 people rated this effort as good, and 24 rated it very good. Climate-related diseases can increase with changes in temperature and rainfall patterns, so preventive activities such as fogging, health education, and improving sanitation are very important (Tazkiyati & Sabila, 2024). Respondents who gave an upbeat assessment indicated that the implemented disease prevention and handling activities were quite practical.

Mitigation activities related to waste and solid waste management in Kampung Iklim were considered good. As many as 50 people rated this activity as good, and 20 rated it as very good. Waste management is one of the biggest challenges in climate change mitigation, especially in reducing greenhouse gas emissions from waste accumulation (Rahman et al., 2023). Recycling

programs, reducing plastic use, and managing organic waste appear to have been successfully implemented in the area.

A total of 50 respondents rated this activity as good, while 20 rated it as very good. Only two respondents gave a poor rating, indicating that the liquid waste management program runs quite effectively. Good liquid waste management is important because it can reduce water and soil pollution caused by domestic waste and small industries (Syaputri, 2017). In addition, good liquid waste management also contributes to reducing greenhouse gas emissions from the wastewater treatment process (Yekti & Mirwan, 2021).

Fifty-nine respondents rated the mitigation activities related to energy use as good, while 18 rated it very good. This shows that the community has received the steps to reduce energy use or increase energy efficiency. Energy-related mitigation is very important in climate change, especially in efforts to reduce dependence on fossil fuels and switch to renewable energy. Efficient energy use reduces greenhouse gas emissions and household operating costs (Fadhilla & Nazarudin, 2023).

Sixty-three respondents rated mitigation activities on low-emission agricultural land as good, and 15 rated it very good. Only four respondents gave a poor rating. This activity is important because the agricultural sector significantly contributes to greenhouse gas emissions, especially through fertilisers and inefficient land management. Using environmentally friendly and sustainable agricultural techniques, such as organic farming, can reduce these emissions (Wihardjaka, 2018).

Regarding maintaining and increasing vegetation cover, 65 respondents gave a good rating, while 21 gave a very good rating. In addition, good vegetation cover also helps reduce the risk of soil erosion and improves air quality (Alam et al., 2024). This indicates that the community understands the importance of maintaining and increasing green cover in their area. The success of this program can be improved by continuing to involve the community in reforestation activities, forest conservation, and increasing green open spaces (Kurniawan et al., 2020).

Fifty-eight people assessed mitigation activities related to handling forest and land fires, with 23 people assessing it as very good. Forest and land fires are a

major threat to climate change, because in addition to destroying the ecosystem, these fires also release a large amount of greenhouse gas emissions (Samidjo & Suharso, 2017). This excellent assessment shows that the community appreciates the fire prevention and control measures that have been taken. This can include routine patrols, community education, and safe planting patterns.

Fifty-five respondents rated the water, land, and air protection program very good, while 46 others rated it as good. The program focuses on natural resource conservation and pollution control to maintain ecosystem balance. Protecting water, land, and air includes waste management, reforestation, and monitoring air quality. Improving environmental quality through this program also positively impacts the community's quality of life, such as cleaner air. And safer water sources.

Policy support for the Climate Village Program was rated as good by 62 respondents, with 23 others rating it as very good. Supportive policies can include incentives for communities involved in mitigation activities, regulations on environmental management, and the provision of resources to accelerate program implementation (Ulum & Ngindana, 2017). Strong policy support from the government is essential to ensure the sustainability of the program in the long term.

Sixty-six people rated government support in this program as good, and 23 people rated it as very good. Strong government support also increases community motivation to participate actively in mitigation and adaptation activities (Kartika et al., 2023). However, there is room for improvement in collaboration between the government and the community in implementing this program.

A total of 55 respondents rated the involvement of the private sector in this program as good, with 36 people rating it very good. The involvement of the private sector is important in accelerating the implementation of the Climate Village program, either through the provision of funds, technology, or special expertise. Collaboration with the private sector also allows for innovation in applying more effective, environmentally friendly technologies (Nainggolan et al., 2023).

Sixty-five respondents rated NGO involvement as good, and 21 rated it as

very good. NGOs play an important role in advocating, educating, and disseminating information related to environmental issues, including climate change. NGO support usually strengthens community capacity and facilitates active participation in environmental programs (Budianto & Ghanistyana, 2024). This positive assessment shows that collaboration between NGOs and communities is going well and is mutually supportive.

Fifty-eight respondents rated the university's involvement in this program as good, and 26 people rated it as very good. Universities can be centres for research and innovation in climate change mitigation. In addition, the involvement of academics in this program also helps to increase community capacity through training and counselling. With scientific support from universities, the Climate Village program can be implemented more effectively and based on data.

Sixty-two respondents rated the community dynamics as good, while 21 others rated it very good. Strong community dynamics are an important foundation for the success of environmental programs because active community involvement is needed to maintain the initiative's sustainability (Sukomardojo et al., 2023). However, the absence of respondents who gave poor or poor ratings indicates that the program has succeeded in accommodating community needs and building close collaboration between residents.

A total of 65 respondents rated the Climate Village community institutions as good, and 20 others rated them as very good. Strong institutions help provide structure and direction for communities in implementing climate change mitigation and adaptation programs. Local institutions that support communities, such as working groups or discussion forums, play a major role in distributing information and coordinating environmental activities.

As many as 62 people rated it good, and 23 others rated it very good. This capacity includes the community's knowledge, skills, and resources to implement the Climate Village program independently. A good capacity level is very important to ensure that the mitigation activities implemented can run effectively and sustainably (Rifai et al., 2024). This highly positive assessment indicates that the community has sufficient understanding and

expertise to manage this program independently.

Sixty-two respondents rated community participation as good, while 23 others rated it very good. Active community participation is crucial to the success of the Climate Village program because they are the main actor in implementing various adaptation and mitigation activities. A high level of participation indicates that the community has realised the importance of their role in protecting the Environment (Rifai et al., 2024).

A total of 47 respondents rated their involvement as quite good, with 32 people rating it very good, and 24 rating it poor. This shows that most of the community has been actively involved in various activities in Climate Village, such as reforestation, waste management, and outreach activities. A good level of participation is essential to maintain the program's sustainability and ensure that all levels of society contribute to protecting the Environment.

Sixty-six respondents rated this activity as good, while 23 others rated it very good. Educational activities are important in increasing public awareness and understanding of climate change issues. With adequate information, the community can be better prepared to face environmental challenges and actively participate in mitigation programs (Lubis, 2024).

Fifty-nine respondents rated their direct involvement in program planning as good, 32 very good, and only one as poor. Community involvement in planning is crucial because it better understands local conditions and challenges (Kurniawan et al, 2020). The high level of involvement in this planning also shows that the community has an active role in decision-making related to climate change mitigation, which strengthens policy implementation at the local level.

The assessment of the suitability of the smart environment concept with the Climate Village Program showed that 56 respondents considered this concept appropriate, and 29 others considered it very appropriate. Smart environments involve using technology and innovative solutions to manage resources more efficiently and sustainably (Rahman et al., 2023).

Ninety-one respondents rated the application of technology in environmental management as very good, while 16 others rated it as good, and only four rated it as less good.

Technology, such as using smart irrigation systems, water quality monitoring, or technology-based waste management, helps improve the efficiency and effectiveness of mitigation efforts (Wahditiya et al., 2024). This very positive assessment also shows that communities have seen the real impact of technology in managing their natural resources.

The DPSIR (Driving Force-Pressure-State-Impact-Response) analysis in this study shows that the main driving factors in Madiun City are population growth and rapid development, which cause an increase in greenhouse gas emissions, waste production, and the risk of natural disasters. This pressure impacts environmental conditions, where, despite improvements in mitigation and adaptation activities such as reforestation and waste management, challenges still exist in terms of wastewater management, energy, and private sector participation. Most respondents consider the current environmental condition " good, " but pressure increases due to urbanisation and climate change. Responses to these pressures include policy support from the government and active community participation in the Climate Village Program, especially in terms of environmental education, more efficient energy use, and reforestation. The application of technology for environmental management has begun to be implemented, although not yet optimally. In addition, the involvement of the private sector through CSR programs still needs to be improved to expand the positive impact. In conclusion, although the Climate Village Program has shown positive results, further steps are needed in cross-sector collaboration and broader application of technology to deal with increasing environmental pressures.

Overall, the Climate Village Program in Madiun has received a positive response from the community, with strong support for the various adaptation and mitigation activities implemented. Active community involvement, government support, and private sector participation are key factors in the success of this program, making it an effective model for addressing the challenges of climate change at the local level. However, there is still room for improvement, especially in increasing the participation of less active sectors, such as the private sector, and in maximising the use of technology for more efficient environmental management. Strong institutional

support and the application of technology in environmental management have also had a significant impact, although further efforts are needed to ensure full involvement of all community groups.

Practical suggestions to increase private sector participation are to encourage local companies to invest in environmental initiatives through corporate social responsibility (CSR) programs, conduct government-community-private sector cooperation in innovative environmental projects such as green infrastructure development or integrated waste management, and facilitate a green investment platform that allows companies to invest in green projects in Madiun Climate Village. Meanwhile, to maximise the use of technology, the method that can be done is to train the community to use technology in environmental management, such as smart irrigation system applications and encourage the use of environmentally friendly technology in local industries, such as technology-based waste management.

To increase the involvement of community groups in running the Climate Village, what can be done is to conduct intensive socialization to community groups with interesting educational methods such as short videos, interactive workshops, or social media campaigns to increase their awareness and understanding and by creating local working groups that involve various levels of society as a bridge of communication and action, so that everyone feels they have a role in the Climate Village program. With these steps, it is hoped that private sector participation, utilisation of technology, and involvement of all community groups can be increased effectively to support the sustainability of the Climate Village Program in Madiun.

CONCLUSIONS

The Climate Village Program in Madiun City has successfully increased community and stakeholder participation in climate change mitigation efforts. Active community participation, strong policy support, and the application of technology in environmental management have been the main factors in the success of this program. However, to further increase effectiveness, there needs to be an increase in collaboration with the private sector and broader application of technology. Strengthening environmental education and more

intensive socialisation are also needed to involve community groups that are not yet fully involved. With these steps, the Climate Village Program can continue to grow and become an effective model for facing the challenges of climate change at the local level, as well as supporting the realisation of a smart environment in Madiun City.

For further research, it is expected that more in-depth development can be carried out regarding the optimisation strategy of the Climate Village Program in various regions with different geographical and demographic conditions. Further research can also focus on measuring the long-term impact of implementing technology in environmental management and the effectiveness of private sector involvement in supporting climate change mitigation programs.

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